DEPARTMENT OF ENERGY
FY 1999 PRESIDENT'S BUDGET REQUEST
OFFICE OF ENERGY RESEARCH

The FY 1999 budget request for the Office of Energy Research (ER) contains a $246 million increase above FY 1998. This increase will permit initiation of the Spallation Neutron Source (SNS), the first world class neutron source built by the United States in more than 30 years. The increase will also sustain the availability of the Department of Energy's (DOE) other unique scientific user facilities that serve the DOE missions as well as other national research needs. Within the proposed budget, ER will build on its existing programs to undertake increased efforts in areas of science that support efficient new technologies for the production and use of energy as well as the sequestration of carbon. The University and Science Education program will enable DOE to utilize the human and scientific assets of its National Laboratories to inspire and educate young scientists and engineers from the elementary grades through undergraduate school. These new efforts, along with the base ER program meet the mission and goals of the office within the Department of Energy.

Mission and Goals

The DOE Strategic Plan

The mission of the Office of Energy Research is to produce the scientific and technical knowledge needed to develop energy technology options, to understand the health and environmental implications of energy production and use, to maintain U.S. leadership in understanding the fundamental nature of energy and matter, to provide and operate the large-scale facilities required in natural sciences, to ensure a U.S. leadership position in the search for knowledge, and to support the availability of scientific talent for future generations.

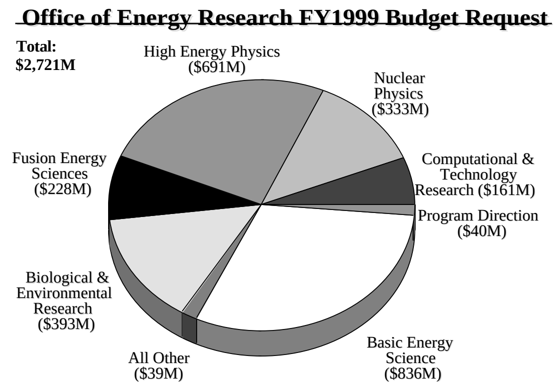


Figure 1

The ER budget is the Department of Energy's investment in basic science. ER directs the long-term, basic research programs that support the Department's mission for national energy needs, environmental management, and national security. ER's FY 1999 budget request, depicted in Figure 1 and Table 1, is structured to meet our mission consistent with DOE goals and strategies.

The Department of Energy is a science agency because its mission and goals require technologies and scientific knowledge far beyond that which is currently available. From safeguarding the nuclear stockpile to ensuring our Nation's energy supply for the next century, the DOE continues to challenge the frontiers of science and technology. The DOE Strategic Plan outlines the vision, goals and strategic objectives that will, through leadership in science and technology, help the DOE to meet those challenges. In keeping with the Government Performance and Results Act (GPRA), ER's FY 1999 budget request includes program specific goals, strategies, and measures that focus our research activities and ensure continuity with Departmental plans and national goals. These measures and mechanisms will continue to be refined with use and as we benchmark our activities against the other federal science agencies and the best of the private sector.

ER's nationally and internationally recognized research programs support national laboratory, university, and industry based research in five key areas: High Energy and Nuclear Physics, Biological and Environmental Research, Basic Energy Sciences, Computational and Technology Research, and Fusion Energy Sciences. This support entails thousands of individual projects at hundreds of research facilities across the United States. As a result, the programs help to expand the Nation's human and intellectual resources, continuously replenishing the Nation's capabilities for scientific and technological innovation. In addition to this diverse research portfolio, ER plays a unique role in providing researchers, professors and students nationwide with access to the large-scale, state-of-the-art research equipment and scientific user facilities that are critical to their scientific work.

ER strives to be the premier basic research organization in the basic energy and natural sciences in order to contribute to a more secure energy future with a clean environment, a healthy citizenry, and a strong economy including the ability to meet future challenges. Consistent with the Department's Strategic Plan, ER's five strategic goals, listed in Figure 2, help us to realize that vision. These goals sustain our longstanding tradition of emphasizing scientific excellence in partnership with other organizations that are dedicated to advancing energy and supporting science. Achieving these goals will help to provide the Nation with the range of energy and policy options necessary for future prosperity.

For over 50 years, ER and its predecessor organizations, have demonstrated an unwavering commitment to the pursuit of cutting-edge scientific research. More recently, ER has committed to forging more effective partnerships that leverage our research investments and connect us more closely with other federal science programs and the direct beneficiaries of our research. ER is fostering new kinds of partnerships among its national laboratory, university and industry based researchers to maximize the effectiveness and impact of research activities. In partnership with the Department's applied programs, ER is also working to bridge the gap between basic research and application to ensure the continued relevance of our research portfolio and maximize the return on the taxpayers' investment. These partnerships include: joint planning of long-term research; joint solicitations and funding of

The Energy Research goals are:

- Enable the United States to uphold and enhance its world leadership in science, mathematics and engineering needed by all sectors of the Nation to enhance energy productivity and ensure reliable energy services while preserving human and environmental heath and safety.
- Obtain major new insights into the nature of energy and matter to better understand our natural world.
- Provide the best and most advanced scientific research facilities and infrastructure to advance science, improve existing energy options and create new energy choices.
- Ensure that ER programs are of the highest quality and are highly productive; that they strengthen and diversify the Nation's scientific work force; and that research and results are widely known, valued and trusted.
- Ensure that ER activities are protective of our workers, the public and the environment.

Figure 2

targeted research efforts; and annual integration workshops that bring together program managers from across DOE.

Strategies

- *Ensure excellence in research.* ER emphasizes initiation of proposals by investigators and selects the best using peer review. Scientific advisory committees use the scientific and technological communities to help identify the most important areas of research to support and the most efficient methods of support. ER program managers measure research quality within scientific areas through periodic evaluations using external technical experts. For excellence in the future, we reach out to improve the quality of and access to science, mathematics, and engineering education.

- *Support science with a purpose.* Throughout 1998, ER will conduct a series of planning activities designed to ensure the continued relevance of our research program to DOE missions and national needs. These activities will result in selected roadmaps to guide our research program and enhance connectivity between the Department's basic and applied research efforts.

- *Coordinate research on complex national problems important to DOE missions*. ER programs coordinate and fund multidisciplinary research at universities and the national laboratories on complex national problems requiring a long investment horizon to find satisfactory solutions. Joint programs and partnerships are ongoing in such areas as environmental management, human genome, and global climate. In FY 1999 ER will expand partnerships and coordination.

- *Provide major scientific facilities.* ER supports large, sophisticated research facilities that are too expensive for a single institution, or group of institutions, to build in support of the Department's and the Nation's science and technology goals. These facilities are selected and designed to meet the highest priority research goals of the scientific community. ER is dedicated to optimizing the utilization, safety and scientific value of existing facilities while ensuring forefront capability.

DNA Sequencing - *high throughput sequencing facility*

- *Continuously improve the quality of administrative processes.* Increase ER effectiveness and productivity by improving program management practices using performance based contracts with our laboratories, strategic plans, goals, measures and metrics to focus and track our research programs. Quality improvements include leveraging resources through partnerships.

Success stories

ER has achieved great success in advancing science, DOE missions, and the welfare of the Nation. Each year, ER research and investigators have been recognized by national and international scientific societies, magazines, and prizes. For example, Paul Boyer, supported by ER and its predecessor organizations for over 30 years, was awarded the 1997 Noble Prize in Chemistry for his work on “elucidation of the enzymatic mechanism underlying the synthesis of adenosine triphosphate“ (ATP). ATP is frequently called the "energy currency" of the cell because the energy cycle of all biological organisms involves this central molecule.

Each year *Science* Magazine lists the top ten significant developments in scientific research. The 1997 list included three topics strongly supported by ER programs - synchrotrons, fullerenes and genomes. Richard Smalley's Noble Prize winning discovery of fullerenes continues to generate exciting science at the nano- (one billionth of a meter) scale, such as Lawrence Berkeley National Laboratory's nanotubes. Microbial genome research, that builds on our capabilities and contributes to our mission, has contributed to "what once seemed a pie-in-the-sky goal--analyzing whole genomes". Third generation synchrotron radiation sources, the Advanced Photon Source and the Advanced Light Source were called out for enabling breakthroughs in the structure of materials.

The Advanced Photon Source (APS) completed its first year of operation in 1997. The floor of the APS was filled with experiments many of which could not have been conducted anywhere else. Results are beginning to flow out of those experiments in many fields including: materials science and condensed matter physics, biological sciences, plant and environmental sciences, and geosciences. For example, a new structural determination and biochemical analysis of the human fragile histidine triad (FHIT) protein was performed at the APS during its first year of operation. This protein derives from a fragile site of human chromosome 3 that is commonly disrupted in association with cancer development. The unique capabilities of the APS are advancing our understanding of this tumor suppressor protein and a great many other scientific mysteries.

ER's advanced materials research is also contributing to human health. A new sensor (figure 3) has been invented that makes it possible to instantly and inexpensively detect a wide range of biological toxins and common disease-causing organisms such as cholera and the botulism toxins, similar to those recently discovered in fruit and fast food hamburgers, that are responsible for hundreds of American deaths each year. Existing tests require a 24 hour culture, but with development, the new sensors could be placed on packaging for instant and simple identification of contaminated foods and materials.

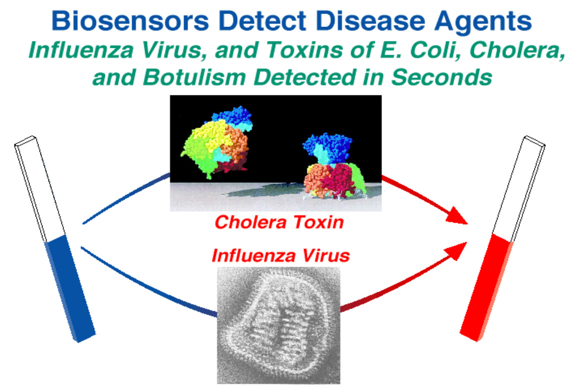


Figure 3

In 1997, the *Wall Street Journal* recognized another ER material- aerogel films. A breakthrough in the processing of ceramic aerogel films overcame a 60 year barrier to large scale production and utilization of this material. Aerogels have a foam-like structure with exceptional lightness and transparency, and make ideal insulating materials for double-pained windows and other applications.

Research from the 1997 field experiments of the Atmospheric Radiation Measurement Project included atmospheric measurements in the arctic region near Point Barrow, Alaska taken in collaboration with the National Science Foundation. This coordinated research will help to improve current climate models and will contribute to our understanding of global climate change.

The William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), a unique scientific user facility for molecular-level research in environmental and life sciences, was officially dedicated at Pacific Northwest National Laboratory in FY 1997. In addition to its potential for breakthrough research in environmental sciences and remediation technologies, EMSL has advanced the concept of "virtual and remote" laboratory research.

Building on some of the successes mentioned last year, ER research has taken the Noble prize winning buckyballs, which continue to open up new areas of chemistry, and has created "buckybowls" and other fullerene structures for the development of new materials. In addition, last years sequencing of the Archea *Methanococcus Jannaschii* - a third branch of life - enables scientists to develop procedures for manipulating the genes involved in Methane (natural gas) production. This advances our understanding of the nature and properties of these organisms and holds the potential for bioproduction of methane as a renewable energy source.

Research at ER's high energy physics laboratories has resulted in the most precise measurements ever made of key particles and interactions supporting the Standard Model including: the Top Quark, W Boson, and Weak Mixing Angle. Full operation of the superconducting accelerator at the Thomas Jefferson National Accelerator Facility is accumulating data and research results that further our understanding of the sub-atomic world.

DOE and NSF have completed negotiations with the European Physics Lab CERN regarding contributions to the Large Hadron Collider (LHC) accelerator and detectors as part of the U.S. participation in the LHC program. Participation will provide U.S scientists with continued access to the forefront high energy physics facilities in the next decade.

Initiatives for FY 1999

The initiatives that the Office of Energy Research will undertake in FY 1999 are listed in figure 4 and described below.

The Spallation Neutron Source - The U.S. currently lags far behind both Europe and Japan in neutron research capability and planned foreign neutron sources threaten to further increase their lead. The importance of neutron science for fundamental discoveries and technological development has been enumerated in all of the major materials science studies over the past two decades, including the National Research Council's 1984 study "Major Facilities for Materials Research and Related Disciplines" (the Seitz-Eastman Report).

The unique information that neutrons provide about the hundreds of materials that we use every day affects us all. For example, chemical companies use neutrons to make better fibers, plastics, and catalysts; drug companies use neutrons to design drugs with higher potency and fewer side effects; and research on magnetism has led to higher strength magnets for more efficient electric generators and motors and to improve magnetic materials for magnetic recording tapes and computer hard drives.

ER is addressing the current situation in two ways: first by effecting modest upgrades of existing reactor and spallation neutron sources within the Basic Energy Sciences program; and second by planning the next-generation, pulsed Spallation Neutron Source (SNS) that will meet the future neutron scattering needs of the United States research community.

FY 1999 Initiatives

- The Spallation Neutron Source
- Climate Change Technology Initiative
- Scientific Facilities Utilization
- The Next Generation Internet
- University Science Education

Figure 4

The SNS will provide about 1 megawatt power or around six times that currently available worldwide. The new facility will serve over 1,000 users per year and provide expanded capabilities for research in physical, chemical, materials, biological, and medical sciences. On August 19, 1996, the Secretary of Energy reviewed and approved the Justification of Mission Need for the SNS. Conceptual design work and R&D began in FY 1996 and was completed in June of 1997, taking into account the recommendations of the scientific community.

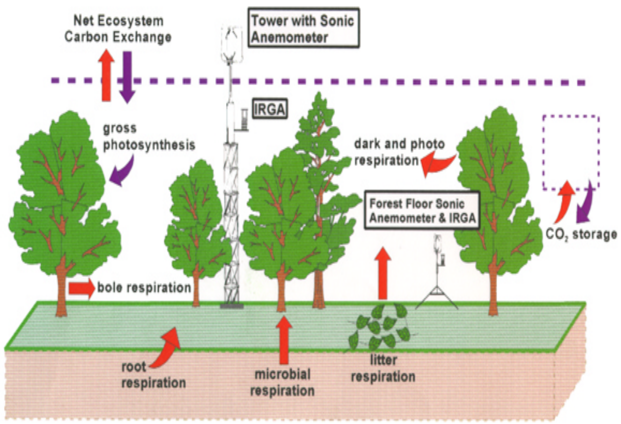
The SNS Total Project Cost (over 7 year schedule) is $1,333 million. In August of 1997, ER's Division of Construction Management reviewed the Design with a team of 60 experts and concluded that the design was credible and the costs reasonable. The DOE Independent Cost Estimate done by Burns and Roe, validated the cost to within (less than) 1%. On December 23, 1997, the Secretary reviewed and approved the SNS Baselines.

The SNS project is an excellent example of an interlaboratory effort that uses the DOE laboratories as a system. Under DOE leadership, Oak Ridge National Laboratory is responsible for the project with participation from Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, Brookhaven National Laboratory, and Argonne National Laboratory. The laboratories have been working together most effectively and critical R&D is proceeding smoothly.

The Environmental Impact Statement (EIS) for the SNS began with the Notice of Intent published on July 25, 1997. Public scoping meetings have been held at Oak Ridge, Argonne, Los Alamos, and Brookhaven. There were no issues affecting the EIS at any of these meetings. The final EIS is expected in July of 1998. The Project Execution Plan has been prepared and MOU's among all of the parties have been drafted. A workshop on industrial applications is scheduled for March 3-4 of 1998.

We are organizing our management, in the labs, the field offices, and headquarters, to be ready for prompt initiation of the project in FY 1999. Key lab management positions have been filled and development of the Cost and Schedule Control System is proceeding as planned. A Steering Committee has been formed, consisting of distinguished members of the neutron science community, to provide input on instrumentation and user needs.

Climate Change Technology Initiative - Energy drives our economy but also challenges environmental stewardship locally, regionally and globally. About 85% of manmade greenhouse gas emissions are associated with energy production and use. To control or reduce these emissions we must rethink our use of carbon based fuels. New technologies for efficient conversion, sequestration, or use of renewable fuels will be key. The foundation for both technology and policy innovation is new knowledge. Building on existing programs and capabilities, DOE is proposing a significant increase in energy-related science and technology programs.



ER contributions to the Department initiative will include research directed at the themes of: science for efficient technologies; low-carbon science; and sequestration science. The new research efforts in carbon management, as well as existing activities, will be closely related to DOE's technology programs and will provide the knowledge base for the development of advanced technologies to reduce carbon dioxide emissions. Many activities will impact the Office of Energy Efficiency and Renewable Energy by providing technology options for increasing efficiency and reducing energy consumption. The basic research program will also provide the knowledge base needed to increase the use of renewable resources and alternate energy sources. Other aspects of the research program impact the Office of Fossil Energy by providing a foundation for effective and safe underground sequestration, new materials, a better understanding of combustion, and improved catalysts.

The ER part of the Climate Change Technology Initiative will provide the science base for new technologies that will lead to a reduced atmospheric concentration of greenhouse gases. For example: fundamental materials science will be used to develop low-friction, lightweight, and nano-scale materials that improve energy efficiency; biomimetic (biological-mimicking) chemistry, biochemistry, and molecular genetic analysis will promote low- and non-carbon emitting energy sources; catalysis research will be used to advance energy efficient chemical processes; and the natural sequestration processes of ecological systems will be explored for possible enhancements. These topics and our integration approach flow naturally from the recommendations of the “11 Lab Study”, that incorporated findings from the ER workshops reports entitled *Carbon Management: Fundamental Research Needs Assessment*, and the President’s Committee of Advisors on Science and Technology (PCAST) report on Energy R&D entitled *Federal Energy Research and Development for the Challenges of the Twenty-First Century.*

This initiative will study areas of carbon cycle management, including areas jointly identified and implemented by the BER and BES programs. In addition to solicitations for individual research projects, proposal notifications will be developed jointly with the DOE energy technology programs with the possibility of establishing multi-disciplinary centers at universities and National Laboratories and enhanced use of major scientific user facilities and scientific computation, modeling and simulation in support of Climate Change Technology.

<u>Scientific Facilities Utilization</u> - To meet the demand for operating time and to improve research capabilities at existing facilities, the Science Facilities Initiative began in Fiscal Year 1996. In FY 1999, this initiative will enable ER to sustain or increase the utilization of 23 scientific user facilities nationwide.

The user community is extremely pleased with the results of the Science Facilities Initiative as seen in many letters and customer surveys. However, the full impact of the Initiative has not yet been realized since new beamlines and instrumentation are not yet fully operational. Many of the instrument funding commitments are spread over multiple years and continued support in FY 1999 is important to the success of this Initiative.

This FY 1999 budget request continues to strongly support the Scientific Facilities Utilization initiative in the following programs: Basic Energy Sciences, High Energy Physics, Nuclear Physics and Biological and Environmental Research. Each year, over 15,000 university, industry, and government sponsored scientists conduct cutting edge experiments at these large and small user facilities that include particle accelerators, neutron sources, synchrotron light source, and smaller facilities.

<u>The Next Generation Internet</u> - Key to the solution of large complex multidisciplinary problems is the ability to maintain strong communications and collaborations between researchers in remote locations. As the complexity of the problem grows, it increases the need to communicate and transmit massive amounts of data. DOE’s science and technology intensive mission demands increasingly complex

collaborations that include distributed computing, national collaboratories, and remote access to facilities. As a result, DOE's projected data transmission requirements of about a thousand-trillion bytes per year (peta bytes/year) will critically stress existing internet capabilities.

The Next Generation Internet (NGI) program was developed to address the existing and projected challenges to Internet capabilities. DOE's science and technology activities and their reliance on internet technology makes success of the NGI initiative critical to the success of DOE's mission. ER participation in the NGI initiative will advance the DOE mission and the interagency initiative will benefit from more than 24 years of DOE experience as a user and developer of advanced networks.

DOE currently utilizes advanced networks to provide thousands of remote users nationwide with access to its large, unique computer facilities. In addition, DOE uses the internet to link researchers in universities, laboratories, and industry who are working to solve the multidisciplinary problems that underpin the DOE mission. These problems include computing the effects of greenhouse gases on global warming, designing the next generation of clean diesel engines, and guaranteeing the safety of the nuclear stockpile.

The proposed DOE NGI program for FY 1999 has the following three components. First, a core program of networking and advanced applications R&D that builds on the Department's successful networking R&D, DOE 2000's national collaboratory tools and pilot projects, and ESnet interconnections with other networks. Second, strategic enhancements that include work on very high speed optical networks, operating systems improvements that take full advantage of advanced networks, and an "OC-12" high speed link (622mb/s) ESnet infrastructure linking several DOE labs. The third element is the DOE University Applications Consortia which represents a significant change in the way in which we partner with universities. Under the new approach, we will solicit proposals from consortia of researchers, labs and network providers to build flexible networked application testbeds that provide an integrated network view to the applications scientists.

ER's NGI initiative builds on DOE's expertise in integrating advanced technologies into mission-critical applications as well as ESnet's demonstrated effectiveness in providing services that cross administrative and network boundaries.

<u>University and Science Education</u> -The ER programs support university faculty, graduate students and post-docs in specific areas as part of their ongoing research efforts. ER also operates its unique research facilities for the peer reviewed use of university scientists. The scientific and technical challenges of the DOE missions demand the availability of an adequate and diverse supply of excellent scientists, engineers, and technicians. Therefore, the Department, also uses the resources of its national laboratories to provide hands-on research opportunities to undergraduate students and faculty, and to K-12 teachers to contribute to the national effort to improve math and science education.

In line with this educational philosophy ER's FY 1999 budget includes a modest request to support University and Science Education (USE) programs aimed at maintaining a diversity of students in the science pipeline from small colleges and universities and minority serving institutions across the country. The Department has requested $15 million to reestablish this effort and provide a focus for DOE corporate investments in the next generation of scientists and engineers in support of DOE missions. The proposed USE program will support activities that utilize DOE resources in partnership with other agencies thereby ensuring against duplication of efforts. By opening its laboratories to students and teachers, providing them with hands-on research opportunities, utilizing and advancing the Internet and other technical tools, DOE fills an important gap in math and science education across the Nation.

Major Program Activities for FY 1999

Basic Energy Sciences - In support of DOE's missions in energy and the environment, the Basic Energy Sciences (BES) program will continue to be one of the Nation's foremost sponsors of fundamental research in materials sciences, chemical sciences, geosciences, plant and microbial sciences, and engineering sciences. BES will also continue to provide premier national scientific user facilities to researchers from academia, industry, government and other laboratories

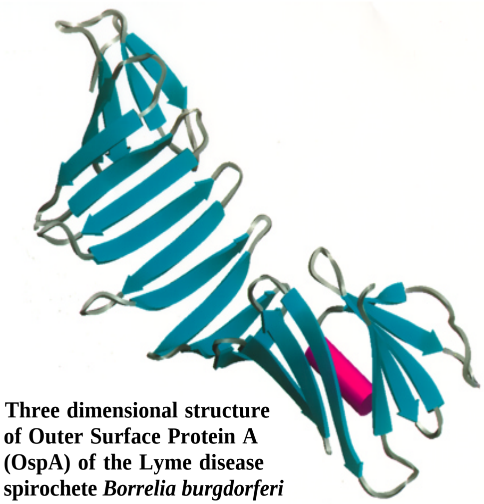
To maintain a strong U.S. position in the field of neutron science, the BES program will continue to support selected enhancements of existing reactor and spallation neutron sources and will proceed with the construction of the Spallation Neutron Source (SNS).

Other neutron science enhancements include the fabrication of instrumentation for the short-pulse spallation source at the Manuel Lujan Jr. Neutron Scattering Center at the Los Alamos Neutron Science Center and scheduled maintenance of the ORNL High Flux Isotope Reactor, including replacement of the beryllium reflector and improvements to the beam tubes and monochromators that will significantly increase thermal neutron flux to the instruments.

Within the base research effort, a program in Complex and Collective Phenomena will be initiated to support work at the frontiers of basic research. This new effort will help to bridge the gap between an atomic level understanding (reductionist view) and a continuum mechanics understanding (classical view) of complex and collective phenomena. In addition, a Partnership for Academic-Industrial Research (PAIR) program will be initiated to encourage and facilitate research partnerships between academic researchers, their students, and industrial researchers.

In addition, BES partners with all appropriate DOE technology offices to ensure awareness and application of research results. BES programs are influenced by the needs of the technology offices resulting in a great many joint activities. For example, in November, 1997, more than 30 program staff from the Office of Energy Research (ER) -- primarily from BES -- and from EE Offices of Utility Technologies and Transportation Technologies met to discuss programs in biomass, wind energy, photovoltaics, hydrogen, and solar photoconversion. Follow on meetings between program managers in both offices are ongoing for identification of research needs and gaps to further define priority research opportunities for both offices.

Biological and Environmental Research - The Biological and Environmental Research (BER) program supports basic research and facilities that contribute to a healthy citizenry, environmental cleanup, and our understanding of the global environment through programs in the life sciences, environmental processes and remediation, medical applications and measurement sciences.

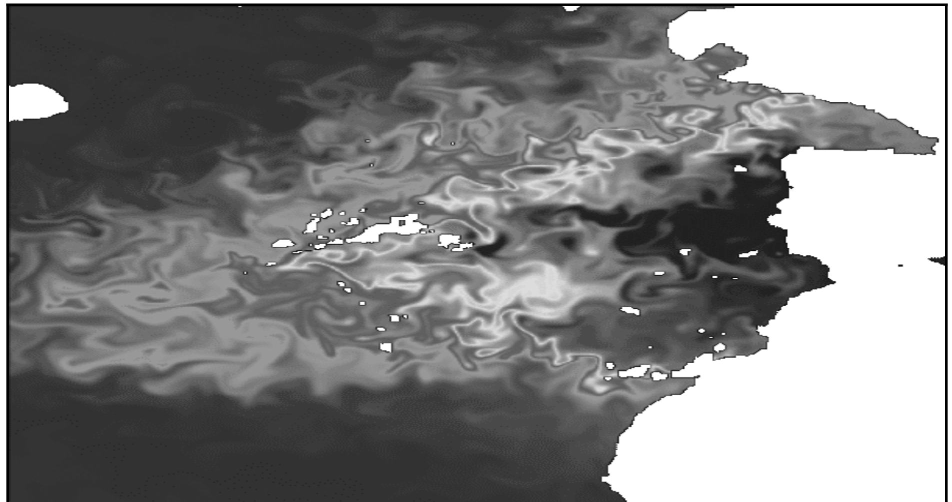


Three dimensional structure of Outer Surface Protein A (OspA) of the Lyme disease spirochete *Borrelia burgdorferi*

BER will contribute to a healthy citizenry by emphasizing high-throughput DNA sequencing methods for the human genome program. The new Joint Genome Institute, which integrates the activities of the human genome centers at Los Alamos, Lawrence Livermore, and Lawrence Berkeley National Laboratories, will enable ER to accomplish about one third of the U.S effort to sequence all 3 billion base sequences of the human genome by the year 2005. In addition, BER will pursue structural biology and innovative imaging methodologies for medical diagnosis and treatment. BER's low dose rate exposure activity provides the scientific basis for understanding exposures and risks to humans, associated with low level radiation and chemical exposures. This information is critical to the accuracy of risk assessment for low exposure levels.

In support of DOE's environmental mission, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), will provide a unique scientific resource for research in environmental remediation that will underpin safe, cost-effective environmental remediation methods and technologies. The Natural and Accelerated Bioremediation Research (NABIR) program will conduct basic research in bioremediation, complementing ongoing efforts in pollution prevention.

BER will strengthen collaborations with the Office of Environmental Management and the Office of Energy Efficiency and Renewable Energy through joint planning and funding of research. For example, in partnership with the Office of Environmental Management, BER performs fundamental research that addresses problems in environmental management, remediation, and restoration that are intractable without new, fundamental scientific information and technologies.



Salt Water Eddies: This figure of the oceanic salinity 1 km below the ocean surface shows eddies forming in very salty water flowing out of the Mediterranean Sea, in a simulation made with the Los Alamos Parallel Ocean Program. The LANL CM-5 was used to carry out the highest resolution simulation ever made of the north Atlantic Ocean: 11 km (1/10=B0) at the equator down to 3 km (at 73=B0) N on a Mercator grid. Forty levels ranging from 10m at the surface to 250m at great depth were used in the vertical with realistic bottom topography and coastlines. The solid white area shows the coastlines topography at 1 km depth.

Computational and Technology Research - The Computational and Technology Research (CTR) program conducts a forefront integrated effort in high performance computing and communications, information infrastructure, applied mathematical sciences, advanced energy projects and technology research.

Through high performance computing, communications, and networking CTR extends the availability and utility of our laboratories and user facilities. The DOE 2000 program and the new capabilities for NGI will enable scientists nationwide to work together on problems as easily as if they were at the same Laboratory or facility.

Program emphasis in FY 1999 supports these national "collaboratories", advanced computational testing, simulation, and high performance computing and networking facilities in support of all of the Energy

Research programs, CTR will emphasize national collaboratory technologies, advanced computational testing, simulation, and high performance computing and networking facilities.

The Laboratory Technology Research and Advanced Energy Projects programs will bridge basic research and technology development to the point that industry can utilize and exploit the innovations originally developed for DOE energy applications.

Fusion Energy Sciences - The three goals of the Fusion Energy Science (FES) program are to advance plasma science, develop fusion science and concept innovation, and pursue fusion energy as an international collaboration.The FES mission is to advance the knowledge base needed to make fusion an economically and environmentally attractive power source for the future.

The FES program provides national stewardship for the fundamental discipline of plasma science, contributing to many scientific and technical goals, ranging from industrial processing to national security. The new NSF/DOE Joint Partnership in Plasma Science and Engineering has resulted in more than 15 new awards in basic plasma science and engineering.

Fundamental discovery and analysis have led to remarkable new insights regarding transport barriers that reduce the loss of energy from magnetically confined plasma. Experiments on the DIII-D and Alcator C-Mod tokamaks will be carried out in combination with continuing theoretical development to extend the range in time and space where energy losses are dramatically reduced. Collaborative experiments with our major international partners will also attempt to scale these results to energy producing plasmas.

Preparations will begin for a second national proof-of-principle experiment using facilities and infrastructure available at PPPL. This would include national working groups selecting a candidate physics concept from ongoing smaller experiments and beginning pre-conceptual design.

Following the completion of the six year Engineering Design Activities (EDA) Agreement supporting the International Thermonuclear Experimental Reactor (ITER), the United States will restructure its participation into a more limited and focused, post-EDA role. In this post-EDA period, possible sites will be explored by our international partners to bring regulatory concerns into the design process, and a broad range of lower cost options will be jointly developed to increase the likelihood of proceeding to construction with an ITER design. The U.S. fusion technology program, previously focused solely on ITER project requirements, will be restructured to focus on domestic program needs and, where possible in a dual purpose sense, ITER needs as well. Both the technology and science programs will be seeking to accomplish their aims through broader coordinated use of both domestic and international facilities.

An important new facility, the National Spherical Torus (NSTX) will begin operations in FY 1999. This proof-of-principle level facility will investigate the physics of the promising spherical torus concept. Located at Princeton Plasma Physics Laboratory, this experiment will be operated as a national collaboratory with expected participation from 10-15 institutions.

The FES program will increase emphasis on alternative concepts. Through the Innovative Concepts Initiative three new university scale experiments and one theoretical study began in FY 1998.

High Energy Physics - The High Energy Physics (HEP) program is a major component of the Department's basic research program. It is directed at understanding the nature of energy and matter at the most fundamental level. An integral component of this effort is the construction and operation of state-of-the-art research facilities.

The foremost high energy physics research facility of the next decade will be the Large Hadron Collider (LHC) at Europe's CERN facility. DOE and NSF have completed negotiations with CERN regarding contributions for the LHC accelerator and detectors as part of the U.S. participation in the LHC program.This will ensure access for U.S. scientists to the frontier of high energy physics. Participation will primarily involve U.S. design and fabrication of accelerator and detector subsystems supported by DOE and NSF. In FY 1999, HEP will support R&D, design and the start of component and subsystem fabrication for US-LHC participation.

The HEP program has two construction projects in the FY 1999 budget, Neutrinos at the Main Injector (NuMI) and the Wilson Hall Safety Improvement Project, both at Fermilab. The NuMI project provides new facilities at Fermilab and at the Soudan Underground Laboratory in Minnesota to search for neutrino oscillations. The Wilson Hall Safety Improvement Project provides urgently needed rehabilitation of the building.

The Fermilab Main Injector Project is proceeding well and is within planned cost and schedule profiles. All relevant milestones have been met. The final data collection from the Fermilab 800 GeV external fixed-target program, will be completed in FY 1999. The prime focus of the Fermilab program will next turn to Tevatron research with the higher luminosity of the Main Injector.

At the end of FY 1998, construction of the SLAC B-factory Project will be complete. Commissioning will be completed in FY 1999 and physics, using the BaBar detector, will begin. During the 3rd quarter of FY 1999, the Alternating Gradient Synchrotron, at Brookhaven National Laboratory (BNL), will be transferred to the Nuclear Physics program for use as the injector for the new Relativistic Heavy Ion Collider (RHIC) facility.

Nuclear Physics - The Nuclear Physics (NP) program complements the HEP program in the study of the nature of energy and matter. NP research investigates the structure and interactions of atomic nuclei to advance our understanding of the fundamental forces and particles of nature as manifested in extended nuclear matter.

FY 1999 is a transition year for the Nuclear Physics program. RHIC construction will be completed in the third quarter of FY 1999, the research program will be initiated in the fourth quarter, with full operation beginning in FY 2000. The Thomas Jefferson National Accelerator Facility will continue to improve performance and expand experimental capabilities. The new joint US/Canadian Sudbury Neutrino Observatory (SNO) will be completed in FY 1999 and will begin to investigate the solar burning process. The new Radioactive Ion Beam (RIB) facility at Oak Ridge National Laboratory will focus on improving performance, developing new beams to address the needs of the experimental program, and carrying out high-priority experiments with the developed beams.

Other - The Technical Information Management (TIM) Program will advance electronic availability and utility of DOE information. The Energy Research Analyses (ERA) program will continue to evaluate the quality and impact of ER programs and provide analysis of key issues for planning and performance evaluation. The Multiprogam Energy Laboratories - Facilities Support (MEL-FS) program will provide line item construction funding to support the general purpose infrastructure of the five ER multiprogram labs.

Program Direction - There continues to be constraints on our program direction budget and FTE ceiling. Despite strong support for our programs by the Administration and the Congress, and despite one of the lowest federal ratios of people per million dollars managed, ER is managing its staffing levels consistent with the Department's Strategic Alignment Initiative.

We have completed a detailed activity-based analysis to identify the most time-consuming and costly functions that we perform and those activities that did not add value to our work products. As a result of a customer survey, the activity-based analysis, and management prioritization, we have begun a number of process improvement and re-engineering activities, including a major effort to improve how we communicate, store, and disseminate program information.

These efforts were recognized in the 1997 Department of Energy quality award. In addition, ER was recognized for performing our major functions (budgeting, planning, managing programs, and internal operations) with good input from customers and stakeholders and using a variety of avenues to obtain that input. ER was also recognized for our focus on excellent science, including our review processes that verify performance to high standards.

Recent events at Brookhaven National Laboratory have led to a reevaluation of the manner in which infrastructure, Environment, Safety and Health and general laboratory management are addressed and funded within DOE and the Office of Energy Research. ER is providing leadership, corporate focus and integration for the operations; infrastructure; environment, safety and health; and construction management activities at its laboratories using the principles of integrated safety management.

Closing

The significant increase in the FY 1999 budget for the Office of Energy Research recognizes the critical role that fundamental knowledge plays in achieving the mission of the Department as well as for the general advance of the Nation's economy and the welfare of its citizens. The SNS, the Scientific Facility Utilization, and Next Generation Internet initiatives will build upon and sustain the Department's role in the development and operation of large, unique scientific instruments and facilities. The Climate Change Technology Initiative will provide fundamental knowledge for a long term portfolio of clean, efficient energy technologies. On behalf of the administration and the Department, I am pleased to present this budget for the Energy Research programs and welcome the challenge to deliver the required results.

Martha A. Krebs
Director
Office of Energy Research

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
SCIENCE
(Tabular dollars in thousands, Narrative in whole dollars)

HIGH ENERGY PHYSICS

PROGRAM MISSION

The High Energy Physics (HEP) program is a major component of the Department's fundamental research mission. It is directed at understanding the nature of matter and energy at the most fundamental level, and the basic forces which govern all processes in nature. Fundamental research provides the necessary foundation that ultimately enables the Nation to progress in its science and technology capabilities, to advance its industrial competitiveness, and to discover new and innovative approaches to our energy future.

The GOAL of the High Energy Physics program is to:

Provide new insights into the nature of energy and matter to better understand the natural world.

The OBJECTIVES related to this goal are:

1. TO CONTINUE TO SUPPORT HIGH QUALITY RESEARCH - Support high quality university and laboratory based high energy physics research, both theoretical and experimental. Experimental research is primarily performed by university scientists using particle accelerators located at major laboratories in the U.S. and abroad.

2. TO EFFECTIVELY OPERATE THE DEPARTMENT'S HIGH ENERGY PHYSICS ACCELERATOR FACILITIES - Provide optimal and cost effective operation for research of the Fermi National Accelerator Laboratory, the Stanford Linear Accelerator Center, and the Alternating Gradient Synchrotron complex at the Brookhaven National Laboratory.

3. TO CONTINUE TO PROVIDE WORLD CLASS RESEARCH FACILITIES - Plan for and build new, state-of-the-art research facilities that allow researchers to advance the forefront of the science of high energy physics. Support essential improvements and upgrades at the major accelerator laboratories. Manage the completion of the Fermilab Main Injector project, the initial operation of the B-factory at SLAC and the initiation of a new experimental facility at Fermilab called Neutrinos at the Main Injector (NuMI).

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

4. TO CONTINUE TO PROVIDE THE PROGRAM'S TECHNOLOGICAL BASE - Support long-range accelerator and detector R&D in order to develop the advanced concepts and technologies which are critical to the long-range viability of high energy physics research.

5. TO CONTINUE TO PURSUE INTERNATIONAL COLLABORATION ON LARGE HIGH ENERGY PHYSICS PROJECTS - Continue to champion U.S. participation in the Large Hadron Collider (LHC) program at CERN. Recommend and defend funding for U.S. participation on the LHC project as recommended by the High Energy Physics Advisory Panel's (HEPAP) "Subpanel on the Vision for the Future of High Energy Physics".

SCIENTIFIC FACILITIES UTILIZATION:

The High Energy Physics request includes $433,520,000 to maintain support of the Department's scientific user facilities. This investment will provide significant research time for thousands of scientists in universities, and other Federal laboratories. It will also leverage both Federally and privately sponsored research, consistent with the Administration's strategy for enhancing the U.S. National science investment. The proposed funding will support operations at all three of the Department's major high energy physics facilities: the Tevatron at Fermilab, the B-factory at SLAC, and the Alternating Gradient Synchrotron at BNL until its transfer to the Nuclear Physics program in FY 1999 for use as part of the RHIC facility .

PERFORMANCE MEASURES:

Performance measures related to basic science activities are primarily qualitative rather than quantitative. The scientific excellence of the HEP program is continually reevaluated through the peer review process. Some specific performance measures are:

1. Quality of scientific results and plans as indicated by expert advisory committees, recognition by the scientific community, and awards received by DOE-supported HEP researchers. The results of these reviews and other quality measures will be used to determine programmatic directions aimed at maintaining the world leadership position of the U.S. high energy physics program.

2. Sustained achievement in advancing knowledge, as measured by the quality of the research based on results published in refereed scientific journals, and by the degree of invited participation at national and international conferences and workshops.

3. Operation of research facilities in a manner that meets user requirements, as indicated by achieving performance specifications while protecting the safety of the workers and the environment, and by the level of endorsement by user organizations; operating facilities that are used for research at the forefront of science and operating facilities reliably and according to planned schedules.

4. Progress on the Fermilab Main Injector and the Neutrinos at the Main Injector projects as measured by accomplishment of scheduled milestones; progress on achieving luminosity and operational efficiency for the B-factory at SLAC as measured by comparison with stated project goals.

5. At least 80 percent of the research programs will be reviewed by appropriate peers.

6. The major upgrade of scientific facilities will be managed to keep them on schedule and within cost.

7. HEP will begin operating the B-factory at SLAC, the Main Injector for the Tevatron at Fermilab, and will deliver on the 1999 US/DOE commitments to the international Large Hadron Collider project.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

1. Measurement, by teams of university and laboratory scientists working at Fermilab, of the mass and production properties of the top quark. This is the last, and by far the heaviest, of the fundamental building blocks of matter (quarks) whose existence was predicted by the Standard Model of elementary particles. The mass of the top quark is now measured more accurately than any of the other quarks.

2. The world's most precise measurement, by a team of university and laboratory scientists working at Fermilab, of the mass of the W boson. This result is considerably more precise than the best measurement from LEP.

3. The world's highest precision single measurement was made, by a group of university and laboratory scientists working at SLAC, of the weak mixing angle, a fundamental parameter of the Standard Model.

4. A major advance in theoretical physics was achieved when it was shown and verified that all of the known "string" theories are equivalent. This greatly reduces the number of possible theories which describe all of the known forces including gravity.

PROGRAM MISSION - HIGH ENERGY PHYSICS (Cont'd)

5. Operation, for the first time ever, of a high energy particle beam transfer line using permanent magnets, thus saving the power and cooling needed for conventional magnets. This was done at Fermilab as part of the Main Injector project.

6. A test of a superconducting accelerator-style magnet fabricated at LBNL achieved a new world record field strength of 13.5 teslas (previous record 11 teslas.)

7. The 1996/1997 fixed target run at Fermilab was highly successful. The accelerator and the experiments performed well, and the researchers have a large amount of data which is in the process of being analyzed.

8. The final data collection with the Fermilab external fixed-target program at 800 GeV will be completed in FY 1999, and the prime focus of the Fermilab program will turn to research with Tevatron collider with higher luminosity of the new Main Injector.

9. The final data collection with the Stanford Large Detector will be completed during FY 1998 and the prime focus of the SLAC program will turn to research with the B-factory.

10. The Fermilab Main Injector Project is proceeding well and is within the planned cost and schedule profiles. All relevant milestones have been met. At the end of FY 1998, the construction phase of the project will be nearly complete and commissioning will be about to start.

11. The C-Zero Experimental Hall project at Fermilab will provide a new underground experimental area at the C-Zero location on the Tevatron ring. When completed in FY 1999, this will provide space for a new program of fixed target and modest sized collider experiments now being planned at Fermilab.

12. The B-factory Project at SLAC will be completed and is within the planned cost and schedule profiles. At the end of FY 1998, the project will be complete and commissioning will be underway. The physics research program, using the BaBar detector will begin during FY 1999.

13. The experiment at BNL designed to study the magnetic properties of the muon was brought into operation with the initial performance of the apparatus exceeding the design goals.

14. The Alternating Gradient Synchrotron at BNL will be transferred to the Nuclear Physics program for use as the injector for the RHIC facility. This will occur during the 3rd quarter of FY 1999.

15. Waste Management activities at Fermilab and SLAC were included as a new (beginning in FY 1998) responsibility transferred from the Environmental Management (EM) program. The Department has initiated a pilot program intended to evaluate opportunities to reduce the volume of newly generated waste and its associated management and disposal costs resulting from Departmental mission activities. Beginning in FY 1998, the Department will implement the Pilot Waste Management Re-Engineering Program at a limited number of sites, at which the responsibility for the newly generated waste management programs will be transferred from the Office of Environmental Management to the generating program. Throughout the implementation of the pilot, the regulatory accountability will remain with the program that currently holds the regulatory permits. In addition, the Office of Environmental Management will be responsible for any unavoidable funding shortfalls due to underestimates for FY 1998 waste generation.

    The Department expects that this re-engineered waste management structure will result in increased awareness on the waste generating organizations' part, thereby creating a financial incentive to minimize waste generation. Waste generating programs will be able to clearly track the true cost of their waste generation, as well as incorporate the associated costs within the formulation of the outyear budgets. To the extent that the programs minimize waste generation, the savings will be available to support increased mission activity. The impacts of this pilot arrangement will be carefully evaluated throughout FY 1998. The Pilot Waste Management Re-Engineering Program was initiated in response to several recommendations received from several Departmental stakeholders, including the National Academy of Sciences and the Environmental Management Advisory Board.

16. The European Center for Nuclear Research (CERN) in Geneva, Switzerland has initiated the Large Hadron Collider (LHC) project. This will consist of a 7 on 7 TeV proton-proton colliding beams facility to be constructed in the existing Large Electron-Positron Collider (LEP) machine tunnel (LEP will be removed). The LHC will have an energy 7 times that of the Tevatron at Fermilab. Thus the LHC will open up substantial new frontiers for scientific discovery.

    Participation by the U.S. in the LHC program is extremely important to U.S. High Energy Physics program goals. The LHC will become the foremost high energy physics research facility in the world around the middle of the next decade. With the LHC at the next energy frontier, American scientific research on that frontier depends on participation in LHC. The HEPAP Subpanel on Vision for the Future of High-Energy Physics (Drell) strongly endorsed participation in the LHC, and this endorsement has been restated by HEPAP on several occasions.

    The physics goals of the LHC are outstanding; they include a search for the origin of mass as represented by the "Higgs" particle, exploration in detail of the structure and interactions of the top quark, and the search for totally unanticipated new phenomena. Although LHC will have a lower energy than the Superconducting Super Collider (cancelled in 1993), it has strong potential for answering the question of the origin of mass. The LHC energies are sufficient to test theoretical arguments for a totally new type of matter. In addition, history shows that major increases in the particle energy nearly always yield unexpected discoveries.

DOE and NSF have completed negotiations with CERN about contributions to the LHC accelerator and detectors as part of the U.S. participation in the LHC program to provide access for U.S. scientists to the next decade's premier high energy physics facility. The resulting agreements have been approved by CERN and by the DOE and the NSF and were signed in December of 1997.

Participation in the LHC project (accelerator and detectors) at CERN will primarily take the form of the U.S. accepting responsibility for designing and fabricating particular subsystems of the accelerator and of the two large detectors. Thus, much of the funding will go to U.S. laboratories, university groups, and industry for fabrication of subsystems and components which will become part of the LHC accelerator or detectors. A portion of the funds will be used to pay for purchases by CERN of material needed for construction of the accelerator. As a result of the negotiations CERN has agreed to make these purchases from U.S. vendors.

The agreement provides for a U.S. DOE contribution of $450,000,000 to the LHC accelerator and detectors over the period FY 1996 through FY 2004 (with approximately $81,000,000 being provided by the NSF). The DOE contribution is tentatively broken down as follows: detectors $250,000,000; accelerator $200,000,000 (including $90,000,000 for direct purchases by CERN from U.S. vendors and $110,000,000 for fabrication of components by U.S. laboratories).

The total cost of the LHC on a basis comparable to that used for U.S. projects is estimated at about $6,000,000,000. Thus the U.S. contribution represents less than 10% of the total. (The LHC cost estimates prepared by CERN, in general, do not include the cost of permanent laboratory staff and other laboratory resources used to construct the project). Neither the proposed U.S. DOE $450,000,000 contribution nor the estimated total cost of $6,000,000,000 include support for the European and U.S. research physicists working on the LHC program.

The agreement negotiated with CERN provides for U.S. involvement in the management of the project through participation in key management committees (CERN Council, CERN Committee of Council, LHC Board, etc.). This will provide an effective base from which to monitor the progress of the project, and will help ensure that U.S. scientists have full access to the physics opportunities available at the LHC. The Office of Energy Research has conducted a cost and schedule review of the entire LHC project and similar reviews of the several proposed U.S. funded components of the LHC. All of these reviews concluded the costs are properly estimated and that the schedule is feasible.

In addition to the proposed U.S. DOE $450,000,000 contribution and $81,000,000 NSF contribution to the LHC accelerator and detector hardware fabrication, U.S. participation in the LHC will involve a significant portion of the U.S. High Energy Physics community in the research program at the LHC. This physicist involvement has already begun. Over 500 U.S. scientists have joined the U.S.-ATLAS detector collaboration, the U.S.-CMS detector collaboration, or the U.S.-LHC accelerator consortium, and are hard at work helping to design the initial physics research program to be carried out at the LHC and helping to design the planned physics capabilities of the LHC accelerator and detectors.

Fabrication of LHC subsystems and components by U.S. participants will begin in FY 1998. Funding was provided in FY 1996 ($6,000,000) and FY 1997 ($15,000,000) for preliminary R&D, design and engineering work on the subsystems and components being proposed for inclusion in the agreement with CERN. This funding was essential in order to provide the cost and technical bases for the proposed U.S. responsibilities in LHC, and to be ready for rapid start to satisfy the anticipated timetable for the project. Funding in the amount of $35,000,000 will be provided in FY 1998 and $65,000,000 in FY 1999 to support continuation of these R&D and design efforts, and the initiation of fabrication of those subsystems and components which will be specified in the agreements with CERN. The $329,000,000 required to complete DOE funding of the project will be requested in FY 1999 as an advance appropriation.

Funding of Contractor Security Clearances

In FY 1999, the Department will divide the responsibility for obtaining and maintaining security clearances. The Office of Security Affairs, which has been responsible for funding all Federal and contractor employee clearances, will pay only for clearances of Federal employees, both at headquarters and the field. Program organizations will be responsible for contractor clearances, using program funds. This change in policy will enable program managers to make the decisions as to how many and what level clearances are necessary for effective program execution. In this way, it is hoped that any backlog of essential clearances which are impeding program success can be cleared up by those managers most directly involved. The Office of Energy Research is budgeting $373,000 for estimated contractor clearances in FY 1999 within this decision unit.

The proposed U.S. funding for the LHC project is summarized below.

U.S. LHC ACCELERATOR AND DETECTOR FUNDING
(Dollars in thousands)

	US Contribution	FY 1996*	FY 1997*	FY 1998*	FY 1999*	FY 2000	FY 2001
Accelerator	$200,000**	$ 2,000	$ 6,670	$ 15,600	$ 29,000	$ 31,200	$ 31,200
Detector	$250,000	$ 4,000	$ 8,330	$ 19,400	$ 36,000	$ 38,800	$ 38,800
Total DOE	$450,000	$ 6,000	$ 15,000	$ 35,000	$ 65,000	$ 70,000	$ 70,000
NSF***	$ 81,000				$ 22,150	$ 15,900	$ 16,370

	FY 2002	FY 2003	FY 2004
Accelerator	$ 31,200	$ 29,000	$ 24,100
Detector	$ 38,800	$ 36,000	$ 29,900
Total DOE	$ 70,000	$ 65,000	$ 54,000
NSF***	$ 16,860	$ 9,720	

This estimated annual funding profile is based on the needs of the LHC project and is consistent with flat out year funding for the HEP program. The profile is subject to change as additional planning detail is derived. The total of $450,000,000 from DOE for the project is firm.

* The FY 1996 and FY 1997 funding was for R&D, design and engineering work in support of the proposed U.S. participation in LHC. Beginning in FY 1998 funding will be used for: fabrication of machine and detector hardware, supporting R&D, prototype development of subsystems, and purchases by CERN from U.S. vendors.

** Includes $110,000,000 for LHC supporting R&D and accelerator components to be fabricated by U.S. laboratories and $90,000,000 for purchases by CERN from U.S. vendors.

*** The NSF funding has been approved by the National Science Board.

HIGH ENERGY PHYSICS

PROGRAM FUNDING PROFILE

(Dollars in thousands)

Subprogram	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation	
Research and Technology....................	$ 207,364		$ 210,240		-$342	a/	$ 209,898	
Facility Operations	350,806		418,945		0		418,945	
Subtotal...	558,170		629,185		-342	a/	628,843	
Construction..	100,000		50,850		0		50,850	
Subtotal, High Energy Physics............	658,170		680,035		-342	a/	679,693	
Adjustment..	-1,051	b/	-1,766	c/	0		-1,766	c/
Adjustment..	0		-342	a/	342	a/	0	
TOTAL, HEP.......................................	$657,119	d/	$677,927		$0		$677,927	

a/ Share of Science general reduction for contractor training.

b/ Share of General Science and Research general reduction for use of prior year balances assigned to this program. The total reduction is applied at the appropriation level.

c/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is ap at the appropriation level.

d/ Excludes $12,410,000 which was transferred to the SBIR program and $745,000 which was transferred to the STTR progra

Public Law Authorization:

Public Law 95-91, "Department of Energy Organization Act"

FY 1999 Request
$ 213,365
456,635
670,000
21,000
691,000
0
0
$691,000

general

pplied

m.

HIGH ENERGY PHYSICS
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$880	$890	$0	$890	$894
Chicago Operations Office					
Argonne National Laboratory	8,861	9,058	0	9,058	8,475
Brookhaven National Laboratory	75,860	77,801	0	77,801	56,395
Fermi National Accelerator Laborat	263,211	274,972	0	274,972	256,070
Oakland Operations Office					
Lawrence Berkeley National Labor	27,192	23,794	0	23,794	22,820
Lawrence Livermore National Labo	683	380	0	380	380
Stanford Linear Accelerator Center	165,892	149,638	0	149,638	147,035
Oak Ridge Operations Office					
Thomas Jefferson National Accelerator Facility	15	0	0	0	0
Oak Ridge National Laboratory	379	272	0	272	240
Richland Operations Office					
Pacific Northwest Laboratory	10	10	0	10	10

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation	FY 1999 Request
All Other Sites a/	115,187		143,220		-342	b/	142,878	198,681
Subtotal	658,170		680,035		-342	b/	679,693	691,000
Adjustment	-1,051	c/	-1,766	d/	0		-1,766	0
Adjustment	0		-342	b/	342	b/	0	0
TOTAL	$657,119	e/	$677,927		$0		$677,927	$691,000

a/ Funding provided to universities, industry, other federal agencies and other miscellaneous contractors.
b/ Share of Science general reduction for contractor training.
c/ Share of General Science and Research general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.
d/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.
e/ Excludes $12,410,000 which was transferred to the SBIR program and $745,000 which was transferred to the STTR program.

HIGH ENERGY PHYSICS

RESEARCH AND TECHNOLOGY

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The High Energy Physics Program has two major subprograms. The Research and Technology subprogram provides support for the scientists who perform the research and the technology R&D which is the core of the program. The Facility Operations subprogram, described later, provides the large facilities - accelerators, detectors, etc. - needed for the research program.

The Physics Research activity in the Research and Technology subprogram provides support for university and laboratory based research groups conducting experimental and theoretical research in high energy physics. This research probes the nature of matter and energy at the most fundamental level, and the characteristics of the basic forces in nature. Experimental research activities include: planning, design, fabrication and installation of experiments; conduct of experiments; analysis and interpretation of data; and publication of results. Theoretical physics research provides the framework for interpreting and understanding observed phenomena and, through predictions and extrapolations based on current understanding, identifies key questions for future experimental explorations. This subprogram supports research groups at more than 100 major universities and at 8 DOE laboratories.

The High Energy Technology activity in the Research and Technology subprogram provides the specialized advanced technology R&D required to sustain and extend the technology base and provide operational support for the highly specialized accelerators, colliding beams facilities, and detector facilities which are essential to the overall high energy physics program goal of carrying out forefront research. The objectives of this activity include: 1) carry out R&D in support of existing accelerator and detector facilities aimed at maintaining and improving their performance parameters and cost effectiveness; 2) carry out R&D in support of planned and proposed projects to maximize their performance goals and cost effectiveness; 3) carry out R&D to transfer new concepts and technologies into practical application in the HEP context; and 4) carry out R&D to search for and develop new concepts and ideas which could lead to significant enhancements of research capabilities or to significant cost savings in the construction and operation of new facilities. This activity supports work primarily at the DOE labs, but also at universities, other federal labs, and in industry.

In FY 1997, the Research and Technology subprogram included funding for a major portion of the LHC related R&D effort; the other portion was provided as capital equipment in the Facility Operations subprogram. Beginning in FY 1998, when fabrication by U.S. groups of LHC hardware components began, all of the LHC project funding is budgeted as a separate activity in the Facility Operations subprogram. This provides improved visibility of LHC component funding and will facilitate DOE management by consolidating all funding in a single subprogram.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Physics Research	$ 139,483	$ 142,136	$ 146,855	$+4,719	+ 3.3%
High Energy Technology	67,881	64,309	61,677	-2,632	- 4.1%
SBIR/STTR	0	3,453	4,833	+1,380	+40.0%
Total	$207,364	$209,898	$213,365	$+3,467	+ 1.7%

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
Physics Research			
Fermilab—Provides support primarily for Fermilab research physicists working on CDF, D-Zero, and several fixed target experiments, on the CMS detector for LHC, on particle astrophysics experiments, and on theoretical analyses. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	$9,698	$ 9,991	$ 9,680
SLAC—Provides support primarily for SLAC research physicists working on the B-factory, on the SLD at SLC, on the Beijing Electron Synchrotron detector at the accelerator in Beijing, China, on fixed target experiments at SLAC, and on theoretical analyses. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	11,028	11,778	11,840
BNL—Provides support primarily for BNL research physicists working on the high priority Rare k-decay experiments at the AGS at BNL, on the D-Zero detector at Fermilab, on the experiment to make a precision measurement of the muon's magnetic	7,584	7,642	7,720

properties, on the Atlas detector for LHC, on other AGS experiments, and on theoretical analyses. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
LBNL—Provides support primarily for LBNL research physicists working on the CDF and D-Zero detectors at Fermilab, on the BaBar detector for the B-factory at SLAC, on the Atlas detector for the LHC, on the SLD at the SLC at SLAC, on an underground experiment to search for cosmic dark matter, and on theoretical analyses. Also provides for the Particle Data Group which serves as a clearing house and archivist for data on elementary particles.	10,055	10,275	10,535
ANL—Provides support primarily for ANL research physicists working on the CDF detector at Fermilab, on the ZEUS detector at DESY, on the Atlas detector for LHC, on the underground Soudan-2 detector, on the MINOS detector for the planned NuMI project at Fermilab, and on theoretical analyses.	5,564	5,475	5,605
Universities and Other Laboratories—Provides support for research physicists at over 100 U.S. universities working at all of the U.S. and at several foreign accelerator laboratories, on a number of non-accelerator experiments, and performing theoretical analyses. Provides support for similar research scientists at LANL, LLNL, and ORNL.	95,554	96,975	101,475
Total Physics Research	$139,483	$142,136	$146,855
High Energy Technology			
Fermilab—Provides funding for technology R&D in support of the commissioning of the Fermilab Main Injector, for technology R&D aimed at improving the performance	$13,811	$16,106	$13,415

and reliability of the Fermilab accelerator complex and the detectors used in Fermilab research program, for R&D to develop the muon collider concept, for technology R&D related to

	FY 1997	FY 1998	FY 1999

III. Performance Summary- Accomplishments:

future machines, and for advanced technology R&D of general benefit to the HEP program. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

	FY 1997	FY 1998	FY 1999
SLAC—Provides funding primarily for technology R&D support of the commissioning of the B-factory and the BaBar detectors, for technology R&D aimed at improving the performance and reliability of the SLC and the other parts of the SLAC accelerator complex. Also provides for advanced technology R&D of general benefit to the HEP program. In FY 1999, R&D and pre-conceptual design for the Next Linear Collider will continue. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	12,589	14,250	16,900
BNL—Provides funding for technology experiments exploring novel accelerator techniques using the Accelerator Test Facility, R&D aimed at developing the muon collider concept, for technology R&D of general benefit to the HEP program, and R&D in support of the AGS and the AGS experimental program. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	6,197	8,320	5,410
LBNL—Provides support for technology R&D in the areas of superconducting magnets for accelerators, high performance RF power systems, plasma lenses using the accelerator R&D beam at the Advanced Light Source, R&D in support of the joint SLAC/LBNL/ LLNL B-factory project, R&D related to large linear colliders, and for	9,474	9,385	9,615

technology R&D of general benefit to the HEP program.

Large Hadron Collider—Provided support for the R&D and planning necessary to provide an informed basis on which to negotiate an agreement with CERN relative to U.S. participation in the LHC Project. In FY 1997 an additional $2,365,000 was budgeted as capital equipment under the Facility Operations subprogram. Beginning in FY 1998, when	12,635	0	0

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
fabrication of LHC subsystems and components will begin, all LHC funds for component fabrication and supporting R&D are budgeted under the Facility Operations subprogram.			
Universities, Other Laboratories, and Other Contractors—Provides support for relevant, high priority technology R&D at universities, other DOE laboratories, and private industry. Areas being studied include improved superconductors; laser, and collective effect accelerator techniques; novel, high powered RF power generators; non-linear dynamics; and theoretical studies.	13,175	16,248	16,337
Total High Energy Technology	$67,881	$64,309	$61,677
SBIR/STTR - Provides funding for the mandated SBIR and STTR programs. Additional funding for the SBIR program is contained in the Facility Operations subprogram. In FY 1997, $1,841,000 and $745,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.	0	3,453	4,833
Total Research and Technology	$ 207,364	$ 209,898	$ 213,365

HIGH ENERGY PHYSICS
RESEARCH AND TECHNOLOGY

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Increase for the support of university and other laboratory based researchers.	+$4,589,000
Decrease at Fermilab reflecting primarily the completion of much of the R&D for the NuMI project.	-$3,002,000
Increase at SLAC primarily for increased support of linear collider R&D activities.	+$2,712,000
Decrease at BNL reflecting the transition of the AGS to becoming the injector for RHIC.	-$832,000
Decrease at BNL in High Energy Technology reflecting the end of a unique FY 1998 arrangement for support for the Instrumentation Division.	-$2,000,000
Increase at LBNL to partially offset the impact of inflation.	+$490,000
Increase at ANL to partially offset the impact of inflation.	+$130,000
Increase in this portion of the SBIR/STTR assessment.	+$1,380,000
Total Funding Change, Research and Technology:	+$3,467,000

HIGH ENERGY PHYSICS

FACILITY OPERATIONS

(Tabular dollars in thousands, narrative in whole dollars)

I. <u>Mission Supporting Goals and Objectives</u>: The Facility Operations subprogram includes the provision and operation of the large accelerator and detector facilities which are the essential tools that enable scientists in university and laboratory based research groups to perform experimental research in high energy physics. This subprogram includes funding for the operation and maintenance of the national laboratory research facilities including accelerators, colliders, secondary beam lines, detector facilities for experiments, experimental areas, computing, and computing networking facilities. It includes the costs of detector and accelerator components, personnel, electric power, expendable supplies, replacement parts and subsystems, and inventories. General plant projects (GPP) funding will be provided for minor new construction, other capital alterations and additions, and for buildings and utility systems. General purpose equipment (GPE) funding for Brookhaven National Laboratory and landlord GPP funding for Brookhaven National Laboratory, Fermi National Accelerator Laboratory and Stanford Linear Accelerator Center are also included. Accelerator Improvement Projects (AIP) funding support for additions and modifications to accelerator facilities which are supported by the HEP research program is also included. As discussed in the preceding program mission statement, funding for a pilot program concerning transfer from EM to ER of waste management responsibility at Fermilab and SLAC is also included beginning in FY 1998.

Beginning in FY 1998, when fabrication of hardware for the LHC project begins, this subprogram includes all of the U.S. DOE funding for LHC machine and detector hardware.

The principal objective of the Facility Operations subprogram is to maximize the quantity and quality of data collected for approved experiments being conducted at the HEP facilities. The ultimate measure for success in the Facility Operations subprogram is whether the research scientists have data of sufficient quantity and quality to do their planned measurements or to discover new phenomena. The quality of the data is dependent on the accelerator and detector capabilities, and on the degree to which those capabilities are achieved during a particular operating period. The quantity of the data relates primarily to the beam intensity, the length of the operating periods, and the operational availability of the accelerator and detector facilities.

Planned Accelerator Operations
(in weeks)

		FY 1997	FY 1998	FY 1999
Fermilab	Fixed Target	45	a/	26
	Collider		a/	
	Commissioning	__	13	14
	Total	45	13	40
SLAC	SLC	23	16 b/	0
	Fixed Target	10	0	0
	B-factory Commissioning .	0	17	6
	B-factory Operation	0	0	36
	Total	33	33	42
BNL	AGS-HEP c/	12	12	26

a/ Operation of the Tevatron in collider or fixed target mode in FY 1998 is precluded by the long shutdown needed for completion of the Fermilab Main Injector project.

b/ Operation of the SLC at SLAC in FY 1998 is constrained by the long shutdown needed for the completion of the B-factory project.

c/ The AGS is also funded and operated by the Nuclear Physics program for operation with heavy ions. In FY 1999 the AGS will transition to the Nuclear Physics program for operation as an injector for RHIC.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Fermi National Accelerator Laboratory	$ 183,796	$ 192,545	$ 209,755	$+ 17,210	+ 8.9%
Stanford Linear Accelerator Center	94,275	111,460	115,535	+ 4,075	+ 3.7%
Brookhaven National Laboratory	58,210	56,322	43,265	- 13,057	- 23.2%
Universities and Other Laboratories	12,160	8,298	8,302	+ 4	0.0%
Large Hadron Collider	2,365a/	35,000	65,000	+30,000	+85.7%
Waste Management	0b/	4,960	4,980	+ 20	+ 0.4%
SBIR	0	10,360	9,798	- 562	- 5.4%
Total	$350,806	$418,945	$456,635	$+37,690	+ 9.0%

a/ As previously discussed, $12,635,000 in FY 1997 was budgeted for LHC R&D in the High Energy Technology activity within the Research and Technology subprogram.
b/ Waste Management activities in FY 1997 were funded by the Environmental Management Program.

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
Fermilab—Provides support for operation, maintenance, improvement, and enhancement of the Tevatron accelerator complex, the large detector facilities (CDF and D-Zero), the smaller fixed target experiments, and the on-site computing resources required to design the detectors and analyze the experimental data. Also provides for maintenance of the laboratory physical plant. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	$ 183,796	$ 192,545	$ 209,755

- Tevatron operation
  --FY 1997 - operation in fixed target mode for about 45 weeks.
  --FY 1998 - a 9 month long shutdown required to complete construction and install components of the Main Injector followed by 13

	FY 1997	FY 1998	FY 1999
weeks of Main Injector commissioning and Tevatron startup.			

III. Performance Summary- Accomplishments:

--FY 1999 - Operation in fixed target mode for about 26 weeks together with 14 weeks of operation to complete commissioning of the new Main Injector.

	FY 1997	FY 1998	FY 1999
SLAC—Provides for the operation, maintenance, improvement and enhancement of the accelerator and detector complex on the SLAC site. The accelerators include the electron linac and the SLC, and to these is being added the B-factory. The detector facilities include the SLD, the End Station A experimental set-ups, and BaBar, the detector which is being constructed for use with the B-factory. Also provides for maintenance of the laboratory physical plant. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	94,275	111,460	115,535

- SLAC operation

--FY 1997 - operation of the SLC with SLD for about 23 weeks and operation for fixed target experiments in End Station A for about 10 weeks.
--FY 1998 - operation of the SLC with the SLD for about 16 weeks followed by a long shutdown to complete the B-factory. B-factory commissioning will require about 17 weeks of linac operation.
--FY 1999 - operation of the B-factory for about 6 weeks to complete commissioning and for about 36 weeks for initial physics research.

	FY 1997	FY 1998	FY 1999
BNL—Provides support for the operation, maintenance, improvement, and enhancement of the accelerator and detector complex on the BNL site. The principal facility is the AGS and its complement of experimental set ups. The	58,210	56,322	43,265

	FY 1997	FY 1998	FY 1999
AGS will be transferred to the Nuclear Physics program during FY 1999 for			

III. Performance Summary- Accomplishments:

operation as part of the RHIC project. Also provides for maintenance of the laboratory physical plant. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

- AGS operation
  --FY 1997 - operation of the AGS for HEP for 12 weeks.
  --FY 1998 - operation of the AGS for HEP for about 12 weeks.
  --FY 1999 - operation of the AGS for HEP for about 26 weeks.
  The AGS is also operated by the Nuclear Physics program for heavy ion research.

	FY 1997	FY 1998	FY 1999
Universities and other labs - Provides for capital equipment funding at ANL, LBNL, some smaller DOE labs, and for university based researchers. Provides for certain computer networking expenses.	12,160	8,298	8,302
Large Hadron Collider - Beginning in FY 1998 and continuing in FY 1999 funding will be used for: R&D and measurement/testing on superconducting materials, cable, and wire; calculations and R&D on accelerator physics issues regarding the design, instrumentation, and prototypes of the magnets and RF accelerating cavities for the colliding beam intersection regions. Activities on the detectors will include R&D and prototype development of subsystems such as tracking chambers, calorimeters, and data acquisition electronics. Funding in FY 1996 and FY 1997 was for R&D activities and capital equipment in preparation for the U.S. participation in the project. These initial R&D activities were	2,365	35,000	65,000

budgeted, in part, in	**FY 1997**	**FY 1998**	**FY 1999**

III. Performance Summary- Accomplishments:

the Research and Technology subprogram ($12,635,000 in FY 1997) presented earlier and, in part, in this subprogram. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

The LHC work is being performed at various locations including 4 major DOE labs and more than 55 U.S. universities.

HIGH ENERGY PHYSICS
FACILITY OPERATIONS

The DOE funding for LHC hardware fabrication (which begins in FY 1998) and supporting R&D is displayed below for completeness and clarity.

LHC Accelerator and Detector Funding
(B/A in thousands)

		FY 1997	FY 1998	FY 1999
Facility Operations				
LHC				
accelerator	- Operating Expenses	$ 0	$ 7,800	$14,500
	- Capital Equipment	300	7,800	14,500
detectors	- Operating Expenses	0	12,600	23,400
	- Capital Equipment	2,065	6,800	12,600
Total Facility Operations		$2,365	$35,000	$65,000
Research and Technology a/				
High Energy Technology		$12,635	$ 0	$ 0
Total LHC		$15,000	$35,000	$65,000

a/ These R&D funds are displayed here for comparability purposes only. These FY 1997 funds were budgeted in the Research and Technology subprogram.

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
Waste Management - Provides for a pilot program concerning packaging, shipment and disposition of hazardous, radioactive or mixed waste generated in the course of normal operations at Fermilab and SLAC. This pilot program is intended to evaluate opportunities to reduce the volume of newly generated waste and its associated management and disposal costs.	0	4,960	4,980
SBIR - Additional funding for the SBIR program and all funding for the STTR program is contained in the Research and Technology subprogram. In FY 1997, $10,569,000 was transferred to the SBIR program. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of the SBIR program.	0	10,360	9,798
Total Facility Operations	$350,806	$418,945	$456,635

HIGH ENERGY PHYSICS
FACILITY OPERATIONS

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Increase in operating funds at Fermilab to support an aggressive commissioning schedule for the Fermilab Main Injector and an enhanced operating schedule. +$12,880,000

Decrease in capital equipment funding for the CDF and D-Zero detector upgrades at Fermilab. -$11,200,000

Provision in capital equipment funding at Fermilab for the initiation of the NuMI (MINOS) detector. +$3,000,000

Increase in capital equipment funding at Fermilab primarily for computing hardware needed for analysis of the next round of data. +$7,530,000

Increase in AIP at Fermilab reflecting restoration after the temporary reduction to fund the C-Zero Hall project. +$5,000,000

Increase in operating funds at SLAC to support an aggressive commissioning schedule for the B-factory and an enhanced operating schedule. +$8,235,000

Decrease in capital equipment funding at SLAC for the B-factory detector. -$17,000,000

Increase in capital equipment funding at SLAC primarily for computing hardware needed for the initial round of B-factory data. +$9,310,000

Increase in AIP at SLAC reflecting technical needs which are anticipated to arise during commissioning
+$2,740,000
and initial operation of the B-factory.

Increase in GPP at SLAC reflecting the priority given to certain infrastructure needs.
+$790,000

Increase in operating funds at BNL to support enhanced operation of the AGS. +$2,000,000

HIGH ENERGY PHYSICS
FACILITY OPERATIONS

Reduction in operating funds reflecting the transition of the AGS to the Nuclear Physics Program in the third quarter of FY 1999.	-$13,960,000
Decrease in capital equipment funding at BNL reflecting the approaching completion of the AGS HEP research program.	-$1,207,000
Increase in General Purpose Equipment at BNL reflecting restoration to the normal level after mutually acceptable one-time reduction in FY 1998.	+$2,020,000
Decrease in AIP funding at BNL reflecting the transition of the AGS to the Nuclear Physics program to serve as the injector for RHIC.	-$940,000
Decrease in GPP at BNL reflecting a one-time increment in FY 1998. -$970,000	
Increase in the funding for the LHC project.	+$30,000,000
Decrease in this portion of the SBIR assessment; the portion in Research and Technology shows an increase of $1,380,000.	-$562,000
Beginning in FY 1999, this program will budget $373,000 for estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+$373,000
Adjustments in a number of other places.	-$349,000
Total Funding Change, Facility Operations:	+$37,690,000

HIGH ENERGY PHYSICS

CONSTRUCTION

I. Mission Supporting Goals and Objectives: This provides for the construction of major new facilities needed to meet the overall objectives of the HEP Program.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Construction	$100,000	$50,850	$21,000	-$29,850	-58.7%
Total	$100,000	$50,850	$21,000	-$29,850	-58.7%

III. Performance Summary- Accomplishments:	**FY 1997**	**FY 1998**	**FY 1999**
Fermilab Main Injector Project - This project provides for a new accelerator to replace the injector accelerator for the Tevatron complex. The present injector for the Tevatron is the original Fermilab main ring which is less than fully adequate and nearing the end of its useful lifetime. By the end of FY 1998, the project will be about 98% complete. The accelerator will be commissioned and the project completed during FY 1999.	$52,000	$30,950	$ 0
B-factory Project - This project provides for the construction of a B-factory in the PEP storage ring tunnel at SLAC. The B-factory will be completed in FY 1998 and will begin operation for physics research in FY 1999.	45,000	0	0

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
SLAC Master Substation Upgrade - This project provides for an upgrade and reconfiguration of the main electric power substation on the SLAC site. Obsolete (and hazardous) switch gear will be replaced and load balancing will be implemented thus extending the useful life of the existing main 230kv transformers. Procurement of long lead switch gear items will be initiated in FY 1997, and the project will be completed by the end of FY 1998.	3,000	9,400	0
Neutrinos at the Main Injector (NuMI) - The FY 1999 funding will provide for an Architect-Engineer firm to accomplish detailed design of several parts of the project and the initiation of wetlands mitigation and the excavations and furnishing for the beam line and target hall. This project provides for the construction of new facilities at Fermilab and at the Soudan Underground Laboratory in Soudan, Minnesota which are especially designed for the study of the properties of the neutrino and in particular to search for the neutrino oscillations. The overall project is NuMI; the large detector in the project is designated as MINOS.	0	5,500	14,300
C-Zero Area Experimental Hall - This project provides for the construction of a new experimental hall at the C-Zero location on the Fermilab Tevatron ring. This will be used to house modest sized collider and fixed target experiments in a new experimental program being planned at Fermilab.	0	5,000	0

III. Performance Summary- Accomplishments:	**FY 1997**	**FY 1998**	**FY 1999**
Wilson Hall Safety Improvement Project (Fermilab) - This project provides for urgently needed rehabilitation of the main structural elements of Wilson Hall, and for urgently needed rehabilitation of windows, plumbing, the roof and the exterior of the building.	0	0	6,700
Total Construction	$100,000	$50,850	$21,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

The Fermilab Main Injector project will be completed in FY 1998.	-$30,950,000
The SLAC Master Substation Upgrade project will be completed in FY 1998.	-$9,400,000
Continuation of the Fermilab NuMI project.	+$8,800,000
C-Zero Area Experimental Hall project at Fermilab will be completed in FY 1998.	-$5,000,000
Initiation of the Wilson Hall Safety Improvement Project at Fermilab.	+$6,700,000
Total Funding Change, Construction:	-$29,850,000

HIGH ENERGY PHYSICS
CAPITAL OPERATING EXPENSES & CONSTRUCTION SUMMARY
(Dollars in thousands)

	FY 1997	FY 1998	FY 1999	$ Change	% Change
Capital Operating Expenses					
General Plant Projects (total)	$11,760	$13,945	$13,785	$-160	-1.1%
Accelerator Improvement Projects (total)	4,940	2,810	9,610	+6,800	+242.0%
Capital Equipment (total)	56,381	84,141	89,510	+5,369	+6.4%

Construction Project Summary (both Operating and Construction Funded)

Project Number	Project Title	TEC	Previous Approp.	FY 1997 Approp.	FY 1998 Approp.	FY 1999 Request	Unapprop. Balance
92-G-302	Fermilab Main Injector	$229,600	$146,650	$52,000	$30,950	$ 0	$ 0
94-G-304	B-factory	177,000	132,000	45,000	0	0	0
97-G-303	SLAC Master Substation Upgrade .	12,400	0	3,000	9,400	0	0
98-G-304	Neutrinos at the Main Injector	75,800	0	0	5,500	14,300	56,000
98-G-305	C-Zero Area Experimental Hall . . .	5,000	0	0	5,000	0	0
99-G-306	Wilson Hall Safety Improvements	15,600	0	0	0	6,700	8,900
Total Construction		--	$278,650	$100,000	$50,850	$21,000	$64,900

CAPITAL OPERATING EXPENSES & CONSTRUCTION SUMMARY-HEP (Cont'd)

Major Items of Equipment (CE $2 Million and Above)	TEC	Previous Approp.	FY 1997 Approp.	FY 1998 Approp.	FY 1999 Request	Acceptance Date
1. g-2 Experiment	$ 17,685	$ 16,893	$ 792	$ 0	$ 0	FY 1997
2. D-Zero Upgrade	55,270	20,562	7,925	14,700	9,200	FY 2000
3. CDF Upgrade	57,940	20,032	7,925	14,700	9,000	FY 2000
4. B-factory detector (BaBar)a/	67,000	22,700	20,300	20,500	3,500	FY 1999
5. Antimatter in Space	3,192	2,125	867	200	0	FY 1997
6. Super-Kamiokande	3,584	2,460	593	531	0	FY 1998
7. Large Hadron Collider - Machine**	96,000	0	0	7,800	14,500	FY 2005
8. Large Hadron Collider - Detectors**	85,000	0	0	6,800	12,600	FY 2005
9. MINOS	45,000	0	0	0	3,000	FY 2002

a/ The funding for the B-factory detector reflects cost savings of about $20,000,000 resulting from contributions of components and subsystems by non-U.S. collaborating institutions.

** The FY 1998 and FY 1999 funding and the TEC in both cases are based on preliminary estimates and will need to be revised in future years as additional detailed planning is completed. Substantial additional LHC funding is being provided as operating expenses. The overall multiyear DOE contribution to LHC fabrication is capped at $450,000,000.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1998 Congressional Budget Request are denoted with a vertical line in left margin.)

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

HIGH ENERGY PHYSICS

1. Title and Location of Project:	Neutrinos at the Main Injector (NuMI) Fermi National Accelerator Laboratory	2a.	Project No.: 98-G-304 2b. Construction Funded

SIGNIFICANT CHANGES

- Total Estimated Cost and Total Project Cost have been adjusted since project is proceeding from design only to continuation of design and initiation of construction activities.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1998 Congressional Budget Request are denoted with a vertical line in left margin.)

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

HIGH ENERGY PHYSICS

1. Title and Location of Project:	Neutrinos at the Main Injector (NuMI) Fermi National Accelerator Laboratory	2a. Project No.: 98-G-304 2b. Construction Funded

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
3a. Date A-E Work Initiated, (Title I Design Start Scheduled):	1st Qtr. FY 1998	TBD	TBD
3b. A-E Work (Titles I & II) Duration:	21 months	TBD	TBD
4a. Date physical Construction Starts:	1st Qtr. FY 1999	TBD	TBD
4b. Date Construction Ends:	4th Qtr. FY 2002	TBD	TBD

	Preliminary Estimate a/ b/	Title I Baseline	Current Baseline Estimate
5. Total Estimated Cost (TEC) --	$75,800	TBD	TBD
6. Total Project Cost (TPC) --	$135,300	TBD	TBD

7a. Design Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Adjustments	Obligations	Costs
1998	$5,500		$5,500	$1,375

a/ The FY 1998 request provided only for architect-engineering and technical design work for the facility construction and technical systems.
b/ The TEC and TPC will be refined during FY 1998 using the funds provided for architect-engineer and technical design work.

1.	Title and Location of Project:	Neutrinos at the Main Injector (NuMI) Fermi National Accelerator Laboratory	2a. Project No.: 98-G-304 2b. Construction Funded

7b. Construction Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Adjustments	Obligations	Costs
1999	14,300		14,300	6,325
2000	28,000		28,000	15,525
2001	18,000		18,000	26,575
2002	10,000		10,000	26,000

8. Project Description, Justification and Scope

The project provides for the design, engineering and construction of new experimental facilities at Fermi National Accelerator Laboratory in Batavia, Illinois and at the Soudan Underground Laboratory at Soudan, Minnesota. The project is called NuMI which stands for Neutrinos at the Main Injector. The purpose of the project is to provide facilities which will be used by particle physicists to study the properties of neutrinos, which are fundamental elementary particles. In the Standard Model of elementary particle physics there are three types of neutrinos which are postulated to be massless and to date, no direct experimental observation of neutrino mass has been made. However, there are compelling hints from experiments which study neutrinos produced in the sun and in the earth's atmosphere that indicate that if neutrinos were capable of changing their type it could provide a credible explanation for observed neutrino deficits in these experiments.

The primary element of the project is a high flux beam of neutrinos in the energy range of 1 to 40 GeV. The technical components required to produce such a beam will be located on the southwest side of the Fermilab site, tangent to the new Main Injector accelerator at the MI-60 extraction region. The beam components will be installed in a tunnel of approximately 1 km in length and 6.5 m diameter. The beam is aimed at two detectors (MINOS) which will be constructed in experimental halls located along the trajectory of the neutrino beam. One such detector will be located on the Fermilab site, while a second will be located in the Soudan Underground Laboratory. Two similar detectors in the same neutrino beam and separated by a large distance are an essential feature of the experimental plan.

The experiments which are being designed to use these facilities will be able to search for neutrino oscillations occurring in an accelerator produced neutrino beam and hence determine if neutrinos do have mass. Fermilab is the only operational high energy physics facility in the U.S. with sufficiently high energy to produce neutrinos which have enough energy to produce tau leptons. This gives Fermilab the unique opportunity to search for neutrino oscillations occurring between the muon and the tau neutrino. Additionally, the NuMI facility is designed to accommodate future enhancements to the physics program that could push the search for neutrino mass well beyond the initial goals established for this project.

1. Title and Location of Project:	Neutrinos at the Main Injector (NuMI) Fermi National Accelerator Laboratory	2a.	Project No.: 98-G-304 2b. Construction Funded

9. Details of Cost Estimate*

	Item Cost	Total Cost
a. EDI&A		
1. Conventional construction	$8,163	
2. Technical components	1,200	
		$9,363
b. Construction costs		
1. Conventional construction	37,298	
2. Technical components	6,807	
		44,105
c. Contingencies at approximately 29 percent of above costs		
1. Conventional construction	13,002	
2. Technical components	2,530	
		15,532
d. Project management and indirect costs		
1. Project Management	2,700	
2. Indirect costs	4,100	
		6,800
Total		$75,800

* the annual escalation rates assumed for FY 1996 through FY 2002 are 2.5, 2.8, 3.0, 3.1, 3.3, 3.4, and 3.4 percent respectively.

1.	Title and Location of Project:	Neutrinos at the Main Injector (NuMI) Fermi National Accelerator Laboratory	2a. Project No.: 98-G-304 2b. Construction Funded

10. Method of Performance

Design of the facilities will be by the operating contractor and subcontractor as appropriate. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

11. Schedule of Project Funding and Other Related Funding Requirements

a. Total project costs	Prior Years	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	Total	
1. Total facility costs								
(a) Line item (Section 9) TEC	$0	$1,375	$6,325	$15,525	$26,575	$26,000	$75,800	
Total facility costs	$0	$1,375	$6,325	$15,525	$26,575	$26,000	$75,800	
2. Other project costs								
(a) Capital Equipment	$0	$0	$3,000	$16,500	$20,000	$10,500	$50,000	
(b) R&D costs necessary to complete the project	600	1,400	0	0	0	0	2,000	
(c) Conceptual Design Cost	700	100	0	0	0	0	800	
(d) Decontamination & Decommissioning Costs	0	0	0	0	0	0	0	
(e) NEPA Documentation Costs	0	0	0	0	0	0	0	
(f) Pre-operating costs	0	0	0	0	0	0	0	
(g) Other project-related costs	0	0	2,000	3,000	1,000	700	6,700	
Total other project costs	$1,300	$1,500	$5,000	$19,500	$21,000	$11,200	$59,500	
Total project costs (TPC)	$1,300	$2,875	$11,325	$35,025	$47,575	$37,200	$135,300	d/

b. Related annual costs

1. NuMI facility operating costs . . . . $ 500
2. Incremental utility costs (estimate based on FY 1997 rate structure) 500

Total related annual costs $1,000

Total operating costs (FY03-07) $5,000

d/ The Total Project Cost will be refined during the FY 1998 design effort.

1. Title and Location of Project:	Neutrinos at the Main Injector (NuMI) Fermi National Accelerator Laboratory	2a.	Project No.: 98-G-304 2b. Construction Funded

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

a. Total project costs

1. Total facility costs

(a) Construction line item - explained in items 8, 9.

2. Other project costs

(a) Capital equipment - Costs to fabricate the near detector at Fermilab and the far detector at Soudan. Includes systems and structures for both near detector and far detector, active detector elements, electronics, data acquisition, and passive detector material.

(b) Direct R&D operating costs - This provides for project conceptual design activities, for design and development of new components, and for the fabrication and testing of prototypes. R&D on all elements of the project to optimize performance and minimize costs will continue through early stages of the project. Specifically included are development of active detectors and engineering design of the passive detector material. Both small and large scale prototypes will be fabricated and tested using R&D operating funds.

(c) Conceptual design costs - includes operating costs for development of conceptual design and scope definition for the NuMI facility.

(d) Decontamination & Decommissioning costs - none required.

(e) NEPA Documentation costs - Costs to develop an Environmental Assessment, including field tests and measurements at the proposed construction location are included in the conceptual design costs

(f) Pre-operating costs - Included in detector and beam prototyping costs

(g) Other project-related costs - Include funding required to complete the construction and outfitting of the Soudan Laboratory for the new far detector by the University of Minnesota.

b. Related annual costs

1. NuMI facility operating costs - including personnel and M&S costs (exclusive of utility costs), for operation, maintenance, and repair of the NuMI facility.

2. Incremental utility costs (estimate based on FY 1997 rate structure) - including incremental power costs for delivering 120 GeV protons to the NuMI facility during Tevatron collider operations, and utility costs for operation of the NuMI facilities will begin beyond FY02.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST

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

HIGH ENERGY PHYSICS

1. Title and Location of Project:	Wilson Hall Safety Improvements Project Fermi National Accelerator Laboratory	2a. Project No.: 99-G-306 2b. Construction Funded

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
3a. Date A-E Work Initiated, (Title I Design Start Scheduled):	1st Qtr. FY 1999	TBD	TBD
3b. A-E Work (Titles I & II) Duration:	17 months	TBD	TBD
4a. Date physical Construction Starts:	3rd Qtr. FY 1999	TBD	TBD
4b. Date Construction Ends:	3rd Qtr. FY 2002	TBD	TBD

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
5. Total Estimated Cost (TEC) --	$15,600	TBD	TBD
6. Total Project Cost (TPC) --	$18,800	TBD	TBD

1. Title and Location of Project:	Wilson Hall Safety Improvements Project Fermi National Accelerator Laboratory	2a. Project No.: 99-G-306 2b. Construction Funded

7a. Design Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Adjustments	Obligations	Costs
N/A				

7b. Construction Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Adjustments	Obligations	Costs
1999	$ 6,700		$6,700	$1,690
2000	4,700		4,700	6,340
2001	4,200		4,200	6,990
2002	0		0	580

8. Project Description, Justification and Scope

Wilson Hall, constructed in 1972, is the central laboratory facility for the Fermilab site. It is a 17 story reinforced concrete building with a 16 story atrium. The great majority of its area is devoted to office space. In addition, the building contains the cafeteria, the communications center, medical office, some light industrial and shop areas, and an 800 seat auditorium.

The Wilson Hall Safety Improvements Project is a comprehensive project to remediate the deficiencies in this facility. Among the causes for the deficiencies are the age of the building and its systems, safety issues and updating to current code standards, and building components and systems that have reached their useful life expectancy.

The structural deficiencies are currently resulting in the ongoing safety issue of falling concrete debris in occupied areas of the building, and will eventually threaten the integrity of the entire facility. Additional spalling of the concrete could occur on the exterior faces of the building. The current glazing in the sloped window walls is not the code required safety glass. Breakage could result in the falling of sharp edged shards of glass into the atrium area. The quality of the existing drinking water is poor (taste & color) resulting in low usage which allows levels of lead and copper to exceed regulatory requirements.

8. Project Description, Justification and Scope (continued)

The building structure portion of this project provides for the rehabilitation of the existing concrete structure at the crossover bays, which connect the two towers that comprise Wilson Hall. The joints between the crossover bays and tower are experiencing significant structural degradation, resulting in the ongoing safety issue of falling debris and the probability of continued deterioration of the joints. Recent computer analysis of the movement of the building structure has indicated that the joints need to be reworked to allow for the seasonal movement caused by temperature changes. This project will implement the solution to the joint erosion problem. It will consist of reconstructing the joints (assuring effective independent movement of each tower). Since a number of areas in the building will have restricted occupancy while the repairs are being made, this project will include the staff relocation required to accommodate the construction as part of Other Project Costs. At the completion of the structural joint repairs, a thorough exterior inspection will be conducted and any necessary repairs completed.

The building envelope portion of this project provides for the weatherproofing of components of the building shell that are currently allowing water penetration, the refurbishment of the existing skylight system, refinishing and partially reglazing the north and south curtain walls, and replacing the exterior entrances, including the entrance plaza:

Entry Plaza: The plaza that covers the "catacomb" area will have clear sealer applied to the sloped portions of the concrete walls enclosing the catacombs. The raised plaza portions will have waterproofing and pavers installed over the existing concrete. The existing paving at the entrance plaza will be removed and a new waterproof membrane and new paving will be installed.

North and South Curtain Wall: The north and south curtain walls of Wilson Hall are comprised of an anodized aluminum framing system that extends the full height of the building. The lower 6 floors of the system are sloped but do not have the current code required safety glazing. The finish of the aluminum framing is deteriorating and the system is allowing water penetration into the building. Safety glazing will be installed and the system will be repaired to resolve the water penetration.

8. Project Description, Justification and Scope (Continued)

Building Entrances: The north (main) entrance doors will be replaced with revolving doors. The south entry doors will also be replaced, as well as the window walls adjacent to all of these locations.

Skylight: Water penetration is causing structural deterioration and damage to Wilson Hall. The skylight system requires disassembly, cleaning, replacement of damaged panels and glazing materials, and repair of the internal drainage system. Failure to complete this work may result in safety concerns for the entire system which functions as the roof to the 16 story Atrium.

The building systems portion of this project provides for the repairs, alterations, and improvements of the Wilson Hall domestic water system. The work includes replacement of piping known to be either substantially blocked or substantially deteriorated. The quality of the domestic water supplied to the drinking fountains will be improved by installation of a re-circulating piping loop and filtration system.

9. Details of Cost Estimate

	Item Cost	Total Cost
a. Design and Management Costs		$ 4,010
1. Engineering design and inspection	$1,790	
2. Construction Management Costs	1,820	
3. Project management	400	
b. Construction costs (buildings)		8,670
c. Contingencies at approximately 30 percent of above costs		2,920
d. Total line item cost (Section 11. a. 1. (a))		$15,600

Note: The economic escalation rates from FY 1997 dollars for FY 1999 through FY 2001 are 5.3%, 2.9%, and 2.9% respectively from the Department Price Change Index FY 1999 Guidance, General Construction

1. Title and Location of Project: Wilson Hall Safety Improvements Project
Fermi National Accelerator Laboratory

2a. Project No.: 99-G-306
2b. Construction Funded

10. Method of Performance

Overall project management, quality assurance, supervision of design and construction efforts and coordination with the US. Department of Energy for this project will be the responsibility of the Fermi National Accelerator Laboratory, through the Facilities Engineering Services Section (FESS). Design will be accomplished by a combination of FESS staff and consultant A/E fixed price contracts under the direction of the Facilities Engineering Services Section. Construction for project completion will be accomplished by means of one or more competitively bid, fixed price construction subcontracts. Construction Management and overall project management during the construction phase of this project will remain the responsibility of the Facilities Engineering Services Section of the Fermi National Accelerator Laboratory.

11. Schedule of Project Funding and Other Related Funding Requirements

	Previous Years	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	Total
a. Total project costs							
1. Total facility costs							
(a) Line item (Section 9. d.)	$0	$0	$1,690	$6,340	$6,990	$580	$15,600
(b) (Federal and Non-federal)		$0	$0	$1,690	$6,340	$6,990	$580
$15,600							
2. Other project costs							
(a) Design development costs	$530	$270	$ 0	$ 0	$ 0	$ 0	$ 800
(b) Other project-related costs	0	0	560	380	1,000	460	2,400
(c) Total other project costs	$530	$270	$ 560	$ 380	$1,000	$ 460	$3,200
(d) Total project cost	$530	$270	$2,250	$6,720	$7,990	$1,040	$18,800

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

a. Total project funding
   1. Total facility costs
      (a) Line item--Narrative not required.
      (b) PE&D--None.
      (c) Expense-funded equipment--None
      (d) Inventories--None.

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

2. Other project costs
   (a) R&D necessary to complete construction--None.
   (b) Design development--No narrative required.
   (c) Decontamination and Decommissioning (D&D)--None.
   (d) NEPA Documentation-- A Categorical Exclusion (CX) has been issued for this project, resulting in insignificant cost at this level of detail.
   (e) Other project related costs: Relocation of tenants before and after the construction, and rebuilding of their workspaces. Refurbishment of existing elevators which will be used for construction purposes, and then restored to public use.

b. Related annual costs - None.

NUCLEAR PHYSICS

PROGRAM MISSION

The Nuclear Physics program of the Department of Energy (DOE) has the lead responsibility for Federal support of nuclear physics research and supports fundamental research activities under the mandate provided in Public Law 95-91 which established the Department. The primary mission of the program is to develop and support the basic research scientists and facilities, and to foster the technical and scientific activities needed to understand the structure and interactions of atomic nuclei, and to understand the fundamental forces and particles of nature as manifested in extended nuclear matter. Atomic nuclei can be described as a collection of nucleons (protons and neutrons), bound together by the mechanism of exchange of mesons, mainly pi mesons (pions). The research forefront in nuclear physics now requires incorporation of the quark substructure of the nucleon into the understanding of nuclear structure and of quark-antiquark pairs to form the mesons. Quarks, which are the most elementary building blocks of matter, are bound together in groups of three by the exchange of gluons to form the nucleons.

Attendant upon this core mission are responsibilities to enlarge and diversify the Nation's pool of technically trained talent and to facilitate transfer of technology and knowledge acquired to support the Nation's economic base. The program works in close coordination with the Nuclear Physics program at the National Science Foundation (NSF), and jointly with the NSF charters the Nuclear Science Advisory Committee to advise on setting scientific priorities. The program’s intent is to be closely aligned with the Administration's science policies as put forward in "Science in the National Interest."

The GOAL of the Nuclear Physics program is to:

Understand the structure of atomic nuclei and the fundamental forces required to hold their constituents in place, based on a series of systematic experimental and theoretical scientific investigations.

PROGRAM MISSION - NUCLEAR PHYSICS (Cont'd)

The OBJECTIVES related to the goal are to:

1. Conduct a program of maximum effectiveness to provide new insights into the nature of energy and subatomic matter, based on evaluation by rigorous peer review.

2. Conceive, develop, construct, and operate world class scientific accelerator facilities in a timely, and effective manner. In the execution of this responsibility together with other Energy Research organizations, act as the Nation's leader in developing standards and management techniques to optimize construction and operations of facilities in a cost effective, safe, and environmentally benign way.

3. Leverage United States objectives by means of international cooperation through exchanges of scientists and participation in internationally cooperative projects.

4. Continue the advanced education and training activities of young scientists to maintain the skills and conceptual underpinning of the Nation's broad array of nuclear related sciences and technologies.

PERFORMANCE MEASURES:

1. Evaluate the scientific quality and appropriateness of the total DOE Nuclear Physics program to maintain the United States position as world leader in nuclear physics research. Evaluations will be based on rigorous peer reviews conducted by internationally recognized scientific experts. Maintain the highest quality research by taking appropriate corrective management actions based on results of the reviews.

2. Determine the production trends of diverse, highly trained young scientists - an essential ingredient for the vitality of the nation's technological base, using the Nuclear Physics annual census of scientific personnel. Funding patterns of university grants will include consideration of the optimum production rate of scientists.

3. Use the assistance of technical experts to monitor the performance in scope, costs and schedule of construction projects for world class nuclear physics facilities such as the Relativistic Heavy Ion Collider. Measure project performance against cost and schedule milestones contained in project plans. Working with the relevant DOE project manager and laboratory project management, identify and establish programmatic modifications needed to enable projects to meet schedules and costs.

PROGRAM MISSION - NUCLEAR PHYSICS (Cont'd)

4. Use peer reviews and user feedback to monitor the effectiveness of facility operations. Evaluate facility performance against objectives set in program guidance based on funding availability, and measure achieved beam hour availability against guidelines developed for the Scientific User Facility Initiative. Identify participation and contributions by foreign scientists at facilities, and obtain input from user's groups at facilities. Develop appropriate facility funding profiles so as to best provide overall beam availability for the Nuclear Physics program.

5. Measure overall program against the scientific priorities recommended in the long range plans that are regularly provided by the DOE/NSF Nuclear Science Advisory Committee (NSAC). Obtain assessments from NSAC and other community forums on the overall direction of the DOE Nuclear Physics program and its coordination with the NSF Nuclear Physics program. Based on this feedback, programmatic changes will be made, where necessary, to assure the Nuclear Physics program is appropriately directed towards highest priority topics in the long range plan.

6. At least 80 percent of the research programs will be reviewed by appropriate peers.

7. The major upgrade of scientific facilities will be managed to keep them on schedule and within cost.

8. NP will begin operating RHIC at BNL in FY 1999.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- The Thomas Jefferson National Accelerator Facility (TJNAF) continues to improve performance and expand experimental capabilities. Simultaneous beams are now available in all three experimental halls.

- In FY 1999 activities at the MIT Bates facility will be refocused to concentrate entirely on the development of large acceptance detector and internal target capabilities to exploit the unique scientific opportunities possible with the very high currents in the South Hall Ring.

- The Relativistic Heavy Ion Collider (RHIC) construction project at Brookhaven National Laboratory (BNL) continues on scope and budget with a completion date of the third Quarter of FY 1999. Following a successful sextant test in February 1996, installation is proceeding rapidly and overall collider construction was over 80% complete at the end of FY 1997. Fabrication of RHIC detectors, including the additional experimental equipment recommended by NSAC for purposes of particle detection and data analysis, also proceeds on schedule.

FY 1999 is a transition year. The RHIC Project will be completed in the 3rd Quarter and will begin Operations in the 4th Quarter. The BNL AGS/Booster Complex undergoes a transition from a High Energy Physics-supported facility providing primarily protons for a fixed target program to being an integral part, the injector, of the Nuclear Physics-supported RHIC facility in the 4th Quarter. FY 2000 will be the first full year of RHIC Operations.

- The Radioactive Ion Beam (RIB) facility at Oak Ridge National Laboratory (ORNL) initiated its experimental program in astrophysics and unstable nuclei in FY 1997. In FY 1998 and FY 1999 efforts at this facility will focus on improving performance, developing new beams to address the needs of the experimental program and carrying out high-priority experiments with the developed beams.

- The joint US/Canadian Sudbury Neutrino Observatory (SNO) project will be completed in FY 1998 and will initiate investigation of the solar burning process.

- In FY 1998 Gammasphere will be moved from the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory to the ATLAS facility at Argonne National Laboratory for about a year to carry out research focused on the study of the structure of nuclei far from stability in measurement which utilize Gammasphere coupled with the existing Fragment Mass Analyzer (FMA) at ATLAS.

- The Nuclear Physics request includes $180,279,000 to maintain support of the Department's scientific user facilities. This funding will provide research time for thousands of scientists in universities, Federal agencies, and U.S. companies. It will also leverage both Federally and privately sponsored research consistent with the Administration's strategy for enhancing the U.S. National science investment.

Funding of Contractor Security Clearances

- In FY 1999, the Department will divide the responsibility for obtaining and maintaining security clearances. The Office of Security Affairs, which has been responsible for funding all Federal and contractor employee clearances, will pay only for clearances of Federal employees, both at headquarters and the field. Program organizations will be responsible for contractor clearances, using program funds. This change in policy will enable program managers to make the decisions as to how many and what level clearances are necessary for effective program execution. In this way, it is hoped that any backlog of essential clearances which are impeding program success can be cleared up by those managers most directly involved. The Office of Energy Research is budgeting $106,000 for estimated contractor clearances in FY 1999 within this decision unit.

NUCLEAR PHYSICS
PROGRAM FUNDING PROFILE
(Dollars in thousands)

Subprogram	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Request
Medium Energy Nuclear Physics.........	$111,271		$117,990		-$87	a/	$117,903		$116,918
Heavy Ion Nuclear Physics..................	88,194		95,610		-70	a/	95,540		150,312
Low Energy Nuclear Physics...............	30,290		32,585		-20	a/	32,565		33,200
Nuclear Theory....................................	15,245		15,340		-10	a/	15,330		15,550
Subtotal...	245,000		261,525		-187	a/	261,338		315,980
Construction..	65,000		59,400		0		59,400		16,620
Subtotal, Nuclear Physics....................	310,000		320,925		-187	a/	320,738		332,600
Adjustment..	-49	b/	-969	c/	0		-969	c/	0
Adjustment..	0		-187	a/	187	a/	0		0
TOTAL, Nuclear Physics.....................	$309,951	d/	$319,769		$0		$319,769		$332,600

a/ Share of Science general reduction for contractor training.

b/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.

c/ Share of Science general reduction for use of prior year balances assigned to this program.The total general reduction is applied at the appropriation level.

d/ Excludes $5,447,000 which was transferred to the SBIR program and $328,000 which was transferred to the STTR program.

Public Law Authorization:

Pub. Law 95-91, DOE Organization Act

NUCLEAR PHYSICS
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$11,213	$10,290	$0	$10,290	$10,430
Chicago Operations Office					
Argonne National Laboratory	16,257	16,532	0	16,532	16,787
Brookhaven National Laboratory	106,476	107,585	0	107,585	117,905
Idaho Operations Office					
Idaho National Engineering Laboratory	125	90	0	90	100
Oakland Operations Office					
Lawrence Berkeley National Laborator	24,871	22,560	0	22,560	22,960
Lawrence Livermore National Laborat	620	520	0	520	550
Oak Ridge Operations Office					
Thomas Jefferson National Accelerator Facility	68,260	68,600	0	68,600	70,600
Oak Ridge National Laboratory	15,295	15,405	0	15,405	16,396
Oak Ridge Institute for Science & Edu	589	540	0	540	590

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Request
All Other Sites a/	66,294		78,803		-187	b/	78,616		76,282
Subtotal	310,000		320,925		-187		320,738		332,600
Adjustment	-49	c/	-969	d/	0		-969	d/	0
Adjustment	0		-187	b/	187	b/	0	d/	0
TOTAL	########	e/	#######		$0		$319,769		$332,600

a/ Funding provided to universities, industry, other federal agencies and other miscellaneous contractors.
b/ Share of Science general reduction for contractor training.
c/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.
d/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is app at the appropriation level.
e/ Excludes $5,447,000 which has been transferred to the SBIR program and $328,000 which has been transferred to the STTR program.

NUCLEAR PHYSICS

MEDIUM ENERGY NUCLEAR PHYSICS

(Tabular dollars in thousands, narrative in whole dollars)

I. **<u>Mission Supporting Goals and Objectives</u>:** The Nuclear Physics Program supports the basic research necessary to identify and understand the fundamental features of atomic nuclei and their interactions. The Medium Energy Nuclear Physics subprogram supports academic fundamental research, and facility operations and research at electron and proton accelerator facilities at the higher energies of interest to nuclear physics. In addition, the subprogram supports research at accelerators operated by other Department of Energy programs (e.g., High Energy Physics and Basic Energy Sciences) and at other unique domestic or foreign facilities. The research programs are ultimately aimed at achieving an understanding of the structure of the atomic nucleus in terms of the quarks and gluons, the objects which apparently combine in different ways to make all the other sub-atomic particles. Just as important is the achievement of an understanding of the "strong force", one of only four forces in nature, and the one which holds the nucleus of the atom together. Research efforts include studies of the role of excited states of protons and neutrons in nuclear structure, investigations of the role of specific quarks in the structure of protons and neutrons, studies of the symmetries in the behavior of the laws of physics, investigations of how the properties of protons and neutrons change when imbedded in the nuclear medium, measurements with beams of electrons or protons whose "spins" have all been lined up in the same direction (polarizing the beams) to determine unique "structure functions", and studies of how particles interact with each other inside the nucleus. Two national accelerator facilities are operated entirely under the Medium Energy subprogram - the Thomas Jefferson National Accelerator Facility (TJNAF) in Newport News, Virginia, operated by the Southeastern Universities Research Association (previously the Continuous Electron Beam Accelerator Facility), and the Bates Linear Accelerator Center in Middleton, Massachusetts, operated by the Massachusetts Institute of Technology. These accelerator facilities serve a nationwide community of Department of Energy and National Science Foundation supported scientists from over 100 American institutions, of which over 90% are universities. Both facilities provide major contributions to American education at all levels. At both TJNAF and Bates, the National Science Foundation has made a major contribution to new experimental apparatus in support of the large number of NSF users. A significant number of foreign scientists collaborate in the research programs of both facilities. The planned research program at the new TJNAF, for example, involves 600 scientists from 17 foreign countries; 81 of these scientists are from Conseil Europeen pour la Recherche Nucleaire (CERN) member states. At TJNAF, foreign collaborators have also made major investments in experimental equipment.

Since FY 1996, operation of the Clinton P. Anderson Meson Physics Facility (LAMPF) has been supported by DOE Defense Programs.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
University Research	$ 11,278	$ 11,810	$ 11,895	$ +85	+0.7%
National Laboratory Research	14,358	15,256	13,985	-1,271	-8.3%
TJNAF Research	25,100	28,280	28,570	+290	+1.0%
TJNAF Operations	42,650	39,790	41,500	+1,710	+4.3%
MIT Research/Bates Operations	17,885	18,265	16,575	-1,690	-9.3%
SBIR/STTR	0	4,502	4,393	-109	-2.4%
Total, Medium Energy Nuclear Physics	$111,271	$117,903	$116,918	$ -985	-0.8%

III. Performance Summary- Accomplishments:

University Research	FY 1997	FY 1998	FY 1999
The university research program supports a broad program in Medium Energy Nuclear Physics at 33 universities utilizing not only each of the accelerator facilities supported under the Medium Energy program, but also using other U.S. and international accelerator laboratories. For example, university scientists are collaborating on important ongoing and future experiments at TJNAF which include studies of the charge structure of the neutron in Hall C, planned measurements of the electric form factor of the proton in Hall A, and a series of planned studies of the excited states of the proton in Hall B. At the MIT/Bates accelerator, university researchers have been carrying out "symmetry violation" studies on the proton in the North Hall. Out-of-plane measurements are being carried out in the South	$ 11,278	$ 11,810	$ 11,895

	FY 1997	FY 1998	FY 1999
Hall on the proton, deuteron, and complex nuclei including measurements of the transition of the proton to its excited state. In FY 1998, important measurements will be completed. There will be a limited experimental program in FY 1999. The future experimental program will be based on a new large acceptance detector and unique new internal targets in the South Hall Pulse Stretcher Ring. University scientists and National Laboratory collaborators will continue to carry out the HERMES experiment at the DESY laboratory in Hamburg, Germany. This experiment will measure what components of the proton or neutron determine the "spin" of these particles, an important and timely scientific issue. A new underground neutrino detector in Arizona is beginning a search for neutrino oscillations near the Palo Verde nuclear power reactors. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.			
National Laboratory Research			
Scientists at Argonne National Laboratory have used institutional expertise to develop major spectrometer and detector packages for the new TJNAF experimental program in Hall C, as well as for the HERMES experiment which is being carried out at the DESY laboratory in Hamburg, Germany. At Brookhaven National Laboratory's Laser Electron Gamma Source (LEGS), which generates high quality gamma rays by back-scattering laser light from electron beams at the National Synchrotron Light Source, scientists and university collaborators are developing a unique new polarized hydrogen ice target and upgraded detector for a program of spin physics. Also at Brookhaven, scientists at the Alternating Gradient Synchrotron are working with university researchers on experiments to look at the behavior of strange quarks in nuclei and to do spectroscopy of other particles. These efforts involve large detectors which were recently	$ 14,358	$ 15,256	$ 13,985

	FY 1997	FY 1998	FY 1999

moved from Los Alamos and the Stanford Linear Accelerator Center. This program may phase out as the Alternating Gradient Synchrotron is increasingly utilized as an injector for the new Relativistic Heavy Ion Collider. At the Clinton P. Anderson Meson Physics Facility, Los Alamos National Laboratory scientists and collaborators may continue to carry out highly interesting but controversial measurements in search of neutrino oscillations, depending on review of existing results and whether DOE Defense Programs will continue operating the high intensity proton beam into Area A. If oscillations are found, then neutrinos would have mass, in disagreement with our present understanding of the laws of physics. Los Alamos scientists and collaborators are developing detectors for the Relativistic Heavy Ion Collider which will enable use of polarized protons and which builds upon an experiment to measure the quark structure of the proton at Fermilab. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

TJNAF Research

	FY 1997	FY 1998	FY 1999
Scientists at TJNAF, with support of the user community, have completed assembly of new experimental apparatus for Halls A, B, and C in collaboration with university users. All three experimental Halls are now operational; eight experiments have been completed in Hall C. Experimental equipment in Hall A is complete and the experimental program is underway. Three experiments have completed data accumulation in Hall A. The complex large-angle spectrometer in Hall B has been completed and the research program is now underway. TJNAF will maintain and operate the apparatus for safe and effective utilization by the user community and will participate in the research program. Specific attention will be given to providing additional scientific and technical manpower and materials	$ 25,100	$ 28,280	$ 28,570

	FY 1997	FY 1998	FY 1999

needed to integrate rapid assembly, modification, and disassembly of large and complex experiments for optimization of schedules. Research support for rapid implementation of the G0 experiment is not provided. Also at TJNAF, capital equipment funding will be provided for assembling and installing a state-of-the-art polarized electron injector for the accelerator. Capital equipment funds will be used to install ancillary equipment items such as polarized targets for experimental Halls A, B, and C spectrometer systems, complete a major upgrade of the data reduction system to handle massive amounts of raw data, and to continue construction of second generation experiments such as a spectrometer that is designed to investigate the strange quark content of the proton. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

TJNAF Operations

	FY 1997	FY 1998	FY 1999
TJNAF is presently operating in Halls A, B, and C. Continuous beam for experiments is now available in all three experimental halls at different energies and different currents, simultaneously.	$ 42,650	$ 39,790	$ 41,500

(hours of beam for research)

	FY 1997	FY 1998	FY 1999
TJNAF	4,465	4,500	4,500

AIP funding will provide for polarized injector and beam handling components which enable simultaneous polarized beam capability with varied operating parameters in the three experimental halls. AIP funding also supports other additions and modifications to the accelerator facilities. GPP funding is provided for minor new construction and utility systems.

MIT Research/Bates Operations

	FY 1997	FY 1998	FY 1999
At Bates, MIT scientists have been developing out-of-plane spectrometer (OOPS) measurement capability in collaboration with the university users. The OOPS system and multiple spectrometer systems are carrying out unique spin physics measurements in the South Experimental Hall using a new polarimeter and the new spectrometers and detectors in FY 1998. Use of these South Hall spectrometers will end in FY 1998. Capital equipment funds will be used for construction of a new internal target and a new large acceptance detector (BLAST) needed to conduct a physics program using polarized internal targets and the continuous wave beams of the South Hall Ring. In FY 1999, the Bates effort will concentrate on development of this new and unique facility. Bates operations will be limited until completion of the new internal target area and BLAST detector. At that time, Bates operations will concentrate entirely on the use of this new facility, and will operate at a considerably reduced cost. Levels of these activities will be determined by a major upcoming review of the Bates Laboratory within the context of the world-wide electronuclear program. MIT scientists also utilize other facilities. Significant efforts are underway on the HERMES experiment at the DESY laboratory in Germany, and at TJNAF.	$ 17,885	$ 18,265	$ 16,575

(hours of beam for research)

	FY 1997	FY 1998	FY 1999
MIT/Bates	1,320	2,000	1,000

Present accelerator operations (FY 1998) provides beam for the research programs in the North and South Halls and also for testing of internal

	FY 1997	FY 1998	FY 1999
continuous beams in the South Hall Ring, and extracted continuous beams for delivery to the existing South Hall spectrometers. AIP funding is supporting additions and modifications to the accelerator facilities; GPP funding is provided for minor new construction and utility systems.			
SBIR/STTR			
In FY 1997 $4,052,000 and $328,000 were transferred to the SBIR and STTR programs $ 4,393 respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.		$ 0	$ 4,502
Total, Medium Energy Nuclear Physics	$111,271	$117,903	$116,918

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

University Research

The university research program effort has been maintained. +$85,000

National Laboratory Research

National Laboratory research support is decreased. Beginning in FY 1999, this program will budget $106,000 for estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory. -$1,271,000

TJNAF Research

NUCLEAR PHYSICS
MEDIUM ENERGY NUCLEAR PHYSICS

Jefferson Laboratory research increases in the area of support for experimental setup, and decreases in capital equipment support.	+$290,000

TJNAF Operations

Funding for Jefferson Laboratory facility Operations maintains FY 1998 operating levels for research.	+$1,710,000

MIT Research/Bates Operations

The decrease in Bates funding reflects limited operations at Bates in FY 1999 while pursuing the construction of BLAST, and the move toward future operations of Bates which is much more narrowly focused.	-$1,690,000

SBIR/STTR

Estimated FY 1999 funds for SBIR decrease compared to FY 1998.
-$109,000

Total Funding Change, Medium Energy Nuclear Physics
-$985,000

NUCLEAR PHYSICS

HEAVY ION NUCLEAR PHYSICS

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The Heavy Ion Nuclear Physics subprogram supports research directed at understanding the properties of atomic nuclei and nuclear matter over the wide range of conditions created in nucleus-nucleus collisions. Using beams of accelerated heavy ions at low bombarding energies, research is focused on the study of the structure of nuclei which are only gently excited (cool nuclear matter), but taken to their limits of deformation and isotopic stability. With higher energy heavy-ion beams it is possible to study highly excited nuclei (warm nuclear matter) which, when sufficiently heated, are expected to vaporize in a process analogous to the liquid-gas phase transition of heated water. At relativistic bombarding energies the properties of hot**,** dense nuclear matter are studied with a goal of observing the deconfinement of normal matter into a form of matter, a quark-gluon plasma, which is believed to have existed in the early phase of the universe, a millionth of a second after the Big Bang.

Scientists and students at universities and national laboratories are funded to carry out this research on Department of Energy (DOE) supported facilities, as well as on National Science Foundation (NSF) and foreign supported accelerator facilities. The Heavy Ion Nuclear Physics subprogram supports and maintains accelerator facilities located at two universities (Texas A&M and Yale) and three National Laboratories (Argonne, Brookhaven and Berkeley) for these studies. The Relativistic Heavy Ion Collider (RHIC), under construction at Brookhaven National Laboratory since FY 1991, is scheduled to begin operations in the 4th Quarter of FY 1999, initiating a high-priority research program addressing fundamental questions about the nature of nuclear matter. In FY 1999 resources will be directed towards initiating RHIC Operations, and completing fabrication and installation of RHIC detectors and starting research. All the National Laboratory facilities are utilized by DOE, NSF and foreign supported researchers whose experiments undergo peer review prior to approval for beam time. Capital Equipment funds are provided for detector systems, for data acquisition and analysis systems and for accelerator instrumentation for effective utilization of all the national accelerator facilities operated by this subprogram. Accelerator Improvement Project (AIP) funds are provided for additions, modifications, and improvements to the research accelerators and ancillary experimental facilities to maintain and improve the reliability and efficiency of operations, and to provide new experimental capabilities. The Heavy Ion Nuclear Physics subprogram also provides General Purpose Equipment (GPE) and General Plant Project (GPP) funds, for minor new construction, for other capital alterations and additions, and for improvements to land, buildings, and utility systems, for the Lawrence Berkeley National Laboratory (LBNL) as part of Nuclear Physics' landlord responsibilities for this laboratory.

NUCLEAR PHYSICS
HEAVY ION NUCLEAR PHYSICS

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
University Research	$ 16,448	$ 16,505	$ 16,705	$ + 200	+1.2%
Laboratory Experimental Support and Research	34,709	36,025	40,215	+4,190	+11.6%
National User Facilities Operations	20,614	17,890	18,162	+272	+ 1.5%
BNL RHIC Pre-Operations/Operations	10,973	19,000	67,680	+48,680	+256.2%
LBNL GPP and GPE	5,450	5,450	5,450	0	0.0%
SBIR	0	670	2,100	+1,430	+213.4%
Total, Heavy Ion Nuclear Physics	$ 88,194	$ 95,540	$ 150,312	$+54,772	+57.3%

III. Performance Summary-Accomplishments:

University Research	FY 1997	FY 1998	FY 1999
Support is provided for the research of scientists and students at over 30 universities. Research using low energy heavy ion beams, involving about a third of the university scientists, is focussed on the study of the structure of nuclei with priorities on (1) use of the Gammasphere detector for studies of high-spin, deformed nuclei at the 88-inch Cyclotron in FY 1997 and short-lived nuclei at the limits of isotopic stability when moved to ATLAS in FY 1998, and (2) operation and utilization of university accelerator facilities (Yale and Texas A&M) for in-house research programs that include an emphasis on student training. Research using relativistic heavy ion beams is focussed on the study of the production and properties of hot, dense nuclear matter with priorities on (1) completion of analysis of data obtained from experiments at the BNL Alternate Gradient Synchrotron (AGS) and CERN Super Proton Synchrotron (SPS) facilities, and (2)	$ 16,448	$ 16,505	$ 16,705

	FY 1997	FY 1998	FY 1999
participation in the planning, construction and implementation of detectors for the RHIC program scheduled to begin in FY 1999. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.			
National Laboratory Experimental Support and Research			
Support is provided for the research programs of scientists at five National Laboratories. Laboratory researchers associated with accelerator facilities at ANL (ATLAS), LBNL (88-inch Cyclotron) and BNL (Tandem AGS and RHIC) have major responsibilities for maintaining, improving and developing instrumentation for use by the user community at their facilities. Researchers at LANL, LBNL, and ORNL utilize their laboratory competencies in undertaking R&D, management and construction responsibilities for major initiatives such as RHIC detectors (e.g., STAR and PHENIX). The priorities for capital equipment funding are: (1) support for the ongoing research activities at the supported accelerator facilities, and (2) additional experimental equipment for RHIC, (see Major Items of Equipment), recommended in a NSAC review as important for addressing the physics objectives of the RHIC program. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	$ 34,709	$ 36,025	$ 40,215
National Users Facilities Operations			
Support is provided for three National User Facilities: the ATLAS facility at ANL and the 88-inch Cyclotron facility at LBNL for studies of nuclear reactions, structure and fundamental interactions, and the Tandem/AGS facility at BNL for studies of the properties of hot, dense nuclear matter. FY 1998	$ 20,614	$ 17,890	$ 18,162

	FY 1997	**FY 1998**	**FY 1999**

ATLAS and 88-inch operations funding (and beam hours) reflected the move of the high priority Gammasphere program to ATLAS in FY 1998. Support is provided for the first three Quarters of FY 1999 to complete the AGS heavy ion research program and to continue the development of the capabilities needed for the Tandem/AGS to act as an injector for RHIC and to provide the beams needed for RHIC commissioning activities. Funding for operations of the RHIC complex in the 4th Quarter of FY 1999 is listed in the next paragraph. These facilities are planned to provide yearly hours of beam for research as indicated below:

	(hours of beam for research)		
	FY 1997	FY 1998	FY 1999
ATLAS	5,369	5,700	5,700
88-inch Cyclotron	6,243	4,500	4,500
Tandem/AGS	1,831	672	500

Both the 88-inch Cyclotron and BNL Tandem injector provide heavy ion beams for non-Nuclear Physics supported applied programs including susceptibility of space-based electronics circuits to cosmic rays and production of "micro-pore" filters for medical use.

Accelerator Improvement Project (AIP) funds and capital equipment are provided for the maintenance and upgrade of these facilities.

NUCLEAR PHYSICS
HEAVY ION NUCLEAR PHYSICS

	FY 1997	FY 1998	FY 1999

BNL RHIC Pre-Operations/Operations

Pre-operating, inventory and capital equipment funds are provided for the RHIC project $ 10,973 $ 19,000
$ 67,680
as part of the Total Project Costs (TPC) to conduct beam tests and collider commissioning, to procure special-process magnet element spares, and to acquire equipment that serves project operations. (See Data Sheet for RHIC Project Number 91-G-300.) The RHIC Project is scheduled to be completed in the 3rd Quarter of FY 1999. Funding of $31,457,000 is provided for RHIC operations for the 4th Quarter of FY 1999.

LBNL GPP and GPE

GPP funding will be provided for minor new construction, other capital alterations and $ 5,450 $ 5,450 $ 5,450
additions, and for buildings and utility systems at Lawrence Berkeley National Laboratory (LBNL). Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. Since it is difficult to detail this type of project in advance, a continuing evaluation of requirements and priorities may result in additions, deletions, and changes in the currently planned projects. The total estimated cost of each project will not exceed $5,000,000. In addition, the program has landlord responsibility for providing general purpose equipment (GPE) at LBNL.

SBIR

In FY 1997 $540,000 was transferred to the SBIR program. The FY 1998 and FY 1999 $ 0 $ 670
$ 2,100

amounts are the estimated requirement for the continuation of these programs.

Total, Heavy Ion Nuclear Physics	$ 88,194	$ 95,540	$150,312

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

University Research

FY 1999 funding for University Research maintains research and educational activities with emphasis on supporting groups working at RHIC. Operations at the two university facilities (Texas A&M and Yale) obtain constant funding compared to FY 1998. +$200,000

Laboratory Experimental Support and Research

FY 1999 operating funding for research at National Laboratories is about constant compared +$4,190,000
with FY 1998, but distributed unequally with enhanced support for detector and computer efforts at BNL to initiate the RHIC research program in the fourth quarter. FY 1999 capital equipment is increased by about $4,200,000 compared with FY 1998, with about $3,700,000 planned for RHIC computing and experimental equipment projects which expand RHIC detector capabilities and the remainder to be directed at high priority initiatives at other National Laboratory and university facilities.

National User Facilities Operations

Operations at the ATLAS and 88-Inch Cyclotron facilities obtained constant effort funding compared to FY 1998 to maintain beam hours for research. The BNL Tandem/AGS is funded for three Quarters in FY 1999 to provide heavy ion beams to complete the AGS research program and to continue developments needed in order to perform as the RHIC injector, to provide beams for RHIC +$272,000

NUCLEAR PHYSICS
HEAVY ION NUCLEAR PHYSICS

commissioning

and to implement the transition from AGS Operations and RHIC Construction to a RHIC Operations organization. Completion at LBNL of accelerator R&D projects and of decommissioning activities related to the terminated Bevalac facility account for some reductions in this area.

BNL RHIC Pre-Operations/Operations

RHIC Pre-Operations increase as planned to $36,223,000 in FY 1999 the last year of construction (See RHIC Data Sheet).	+$17,223,000
Funds are provided for RHIC Operations for the 4th Quarter of FY 1999.	+$31,457,000

SBIR

Estimated FY 1999 funds for SBIR increase compared to FY 1998.	+$1,430,000
Total Funding Change, Heavy Ion Nuclear Physics	+$54,772,000

NUCLEAR PHYSICS

LOW ENERGY NUCLEAR PHYSICS

(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The Low Energy Nuclear Physics subprogram supports research directed at addressing issues in nuclear astrophysics, the understanding of the behavior of nucleons at the surface of the nucleus as well as the collective behavior of the entire ensemble of nucleons acting in concert; nuclear reaction mechanisms; and experimental tests of fundamental symmetries. The last of these categories can often be accomplished without the use of accelerators. The study of neutrinos from the sun, whose rate of production is not understood, is an example. University-based research is an important feature of the Low Energy subprogram. Since most of the required facilities are relatively small, they are appropriate for siting on university campuses, where they provide unique opportunities for hands-on training of nuclear experimentalists who are so important to the future of this field. Many of these scientists, after obtaining their Ph.D.s, contribute to a wide variety of nuclear technology programs of interest to the DOE. Included in this subprogram are the activities of the National Nuclear Data Center and its support sites that are aimed at providing information services on critical nuclear data and have as a goal the compilation and dissemination of an accurate and complete nuclear data information base that is readily accessible and user oriented.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Radioactive Ion Beams (RIB)	$ 12,295	$ 13,730	$ 14,440	$ +710	+5.2%
University Research	9,466	9,355	9,630	+275	+2.9%
National Laboratory Research	3,444	3,475	3,115	-360	-10.4%
Nuclear Data Program	4,780	4,900	4,900	0	0%
SBIR	0	800	810	+10	1.2%
Lawrence and Fermi Awards	305	305	305	0	0%
Total , Low Energy Nuclear Physics	$ 30,290	$ 32,565	$ 33,200	$ +635	+1.9%

	FY 1997	FY 1998	FY 1999

III. Performance Summary- Accomplishments:

Radioactive Ion Beams (RIB) at Oak Ridge National Laboratory

	FY 1997	FY 1998	FY 1999
This technically difficult project, which couples the existing cyclotron and tandem accelerators, was completed in FY 1997, and operated with initial beams of arsenic ions. The RIB facility will focus mainly on nuclear astrophysics problems bearing on the creation of the elements and nuclear properties with extreme proton/neutron ratios. Installation of the Daresbury Recoil Separator, a $2,000,000 device contributed by the United Kingdom, allows separation of the products of nuclear reactions from particles a trillion times more intense, enabling the measurement of nuclear reactions that fuel the explosion of stars. Capital equipment and AIP funds are provided to expand the list of available beam species. The RIB facility is planned to provide yearly hours of beams for research as indicated below:	$ 12,295	$ 13,730	$ 14,440

	(hours of beam for research)		
	FY 1997	FY 1998	FY 1999
RIB	1,415	2,200	2,400

Research at the Oak Ridge Electron Linear Accelerator (ORELA), which is also operated by RIB staff, is aimed at resolving discrepancies in the rate of production of primordial elements compared with theoretical predictions, such as models that predict the formation of heavy elements like carbon, nitrogen, and oxygen in the Big Bang.

NUCLEAR PHYSICS
LOW ENERGY NUCLEAR PHYSICS

	FY 1997	**FY 1998**	**FY 1999**

University Research

The three main components of research at universities in this subprogram are nuclear astrophysics, fundamental interactions in nuclei, and the structure of nuclei. $ 9,466 $ 9,355 $9,630

Two university accelerators are supported in Low Energy: the University of Washington, Nuclear Physics Laboratory (NPL), and the Triangle Universities Nuclear Laboratory (TUNL) facility at Duke University. University scientists perform research both on-site at these facilities, as user groups at National Laboratory user facilities, and at the Sudbury Neutrino Observatory (SNO).

Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

National Laboratory Research

The major effort in FY 1997, was the assembly of the 40 foot diameter plastic (acryclic) $ 3,444 $ 3,475$ 3,115
vessel that will hold 1,000 tons of heavy water for the solar neutrino detector at the SNO laboratory located 6,800 feet underground. The research that will follow the completion of filling the tank in FY 1998, will determine whether the observed dearth of solar neutrinos results from unexpected properties of the sun, or whether it results from a fundamental new property of neutrinos --- namely that neutrinos produced in radioactive decay change their nature during the time it takes them to reach the earth from the sun. Capital equipment funds were used to construct and transport special rare gas Helium-3 neutron counters (800 m total

	FY 1997	FY 1998	FY 1999
length) to their underground storage in the ultra low cosmic ray background environment of the SNO mine. They are being stored for a period of time which is sufficient to allow decay to low levels of the radioactivity induced in the detectors by the above ground cosmic ray background.			
Nuclear Data Program			
This is a service function of the Nuclear Physics program which collects, evaluates, stores, and disseminates nuclear information. Its main national and international center point is the United States National Nuclear Data Center (US-NNDC) at Brookhaven National Laboratory. In addition, the NNDC uses a network of individual investigators that assist in assessing data as well as developing new novel, user friendly electronic network and CD-ROM capabilities. The U.S. Nuclear Data Network (USNDN), a collaboration of DOE supported nuclear data scientists, supports the NNDC in data evaluation and development of on-line access capabilities. After completion of a FY 1997 review, a new activity, jointly supported with the Division of Nuclear Physics research community, will be competed for in order to serve the nuclear astrophysics community. This will be a joint activity between the US-NNDC and a collection site, which will be determined by peer review.	$ 4,780	$ 4,900	$ 4,900
SBIR			
In FY 1997 $855,000 was transferred to the SBIR program. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.		$0	$800
$810			

FY 1997	FY 1998	FY 1999

NUCLEAR PHYSICS
LOW ENERGY NUCLEAR PHYSICS

	FY 1997	FY 1998	FY 1999
Lawrence and Fermi Awards			
Provides annual monetary awards to honorees selected by the Department 305 of Energy for their outstanding contributions to nuclear science.		$ 305	$ 305$
Total, Low Energy Nuclear Physics	$ 30,290	$ 32,565	$ 33,200

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Radioactive Ion Beams (RIB)

The RIB facility at Oak Ridge National Laboratory will begin full operation in FY 1998 and increase its available beam hours for users in FY 1999.	+$710,000

University Research

An increase is provided for low energy university research to support increased level of involvement in research using RIBs.	+$275,000

National Laboratory Research

A decrease in laboratory research support reflects the completion of the Sudbury Neutrino Observatory installation phase.	-$360,000

NUCLEAR PHYSICS
LOW ENERGY NUCLEAR PHYSICS

SBIR

Estimated FY 1999 funds for SBIR increase compared to FY 1998.	+$10,000
Total Funding Change, Low Energy Nuclear Physics	+$635,000

NUCLEAR PHYSICS

NUCLEAR THEORY

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** Theoretical Nuclear Physics is a program of fundamental science research to provide new insight into the observed behavior of atomic nuclei. From continuing interaction with experimentalists and experimental data, solvable mathematical models are developed which describe observed nuclear properties, and the predictions of the models are tested with further experiments. From this process evolves a deeper understanding of the nucleus. Traditionally, there are two generic types of nuclear models: (1) microscopic models where the nucleus is viewed as a system of interacting discrete protons and neutrons, and (2) collective models where the nucleus is treated as a drop of fluid. With the establishment of the Quantum Chromodynamics and the standard model, the ultimate goal of nuclear theory now is to understand nuclear models, and hence nuclei, in terms of quarks and gluons. An area of increasing interest recently is in nuclear astrophysics-topics such as supernova explosions, nucleosynthesis of the elements, and the properties of neutrinos from the sun.

The Nuclear Theory program supports all areas of nuclear physics, and is carried out at universities and National Laboratories. Many of the programs depend crucially on access to forefront computing, and to the development of efficient algorithms to use these forefront devices. Components of the program are selected primarily on the basis of peer review by internationally recognized experts. A very significant component of the program is the Institute for Nuclear Theory (INT), where there is an ongoing series of special topic programs, workshops and visitor programs. The Institute is a seedbed for new collaborations, ideas, and directions in nuclear physics.

The program is greatly enhanced through interactions with complementary programs overseas and those supported by the National Science Foundation. Many foreign theorists participate on advisory groups and as peer reviewers. There is large participation in the INT by researchers from Europe and Japan.

A major output of the Nuclear Theory program is the development of a group of highly trained young scientists, many of whom go on to make major contributions in areas outside nuclear physics - particularly in many nuclear based technology areas.

NUCLEAR PHYSICS
NUCLEAR THEORY

II. Funding Schedule:

Program Activity	**FY 1997**	**FY 1998**	**FY 1999**	**$ Change**	**% Change**
National Laboratory Research	$ 5,221	$ 5,135	$ 5,225	$ +90	+1.8%
University Research	10,024	10,195	10,325	+130	+1.3%
Total, Nuclear Theory	$ 15,245	$ 15,330	$ 15,550	$ +220	+1.4%

III. Performance Summary-Accomplishments:

National Laboratory Research	**FY 1997**	**FY 1998**	**FY 1999**
Theoretical nuclear physicists at six National Laboratories carry out research programs aimed at developing a fundamental understanding of the properties of nucleons, nuclei, and nuclear matter. Parts of the theory research at laboratories relate directly to experimental programs at local facilities. Computer programs based on cascade models are being developed to analyze experiments at RHIC. A better understanding of effective masses of particles in nuclear matter, fundamental inputs to these cascade codes, has been developed. Properties of few body nuclei have been calculated exactly to allow detailed analysis of experiments at the Thomas Jefferson National Accelerator Facility (formerly CEBAF). Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	$ 5,221	$ 5,135	$ 5,225

NUCLEAR PHYSICS
NUCLEAR THEORY

	FY 1997	FY 1998	FY 1999
University Research			
Faculty at over 50 universities carry out research programs aimed at developing a fundamental understanding of the properties of nucleons, nuclei, and nuclear matter. Almost 100 Ph.D. students are supported in these programs, the major source of new Ph.D.s in nuclear physics. Perturbation theories and relativistic theories are being developed to be used to more accurately apply the concepts of QCD and the standard model to nuclear physics questions. The Institute for Nuclear Theory at the University of Washington is recognized as the preeminent international center for theoretical nuclear physics activities. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	$ 10,024	$ 10,195	$ 10,325
Total, Nuclear Theory	$ 15,245	$ 15,330	$ 15,550

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

National Laboratory Research

Continues research program and enhances theory support of RHIC physics.	+$90,000

NUCLEAR PHYSICS
NUCLEAR THEORY

University Research

Continues research effort.	+$130,000
Total funding change, Nuclear Theory	+$220,000

NUCLEAR PHYSICS

CONSTRUCTION

(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The Construction subprogram funds the necessary activities that enable the Nuclear Physics program to maintain a set of world-leading accelerator facilities which are essential for forefront scientific investigation. The major activity is completion of the Relativistic Heavy Ion Collider (RHIC) facility and the start of its research program in FY 1999.

II. **Funding Schedule:**

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Construction					
RHIC	$ 65,000	$ 59,400	$ 16,620	$- 42,780	-72.0%
Total, Construction	$ 65,000	$ 59,400	$ 16,620	$- 42,780	-72.0%

III. Performance Summary-Accomplishments:

RHIC	FY 1997	FY 1998	FY 1999
Collider Ring activity during the first half of FY 1997 focused on the completion of five milestones which included injection of gold beams from the AGS and testing of the First Sextant. The Sextant Test was a major project accomplishment. The successful transport of gold beams through the sextant proved the soundness of the collider design, quality of the technical components, and capability of the staff. The test utilized the production technical components such as magnets, cryogenics, electrical vacuum, instrumentation, injection, RF, control and safety, that are being installed in the entire RHIC ring. During the remaining half of FY 1997 assembly and installation work continued at a rapid pace with the remaining 5/6 of	$ 65,000	$ 0	$ 0

	FY 1997	FY 1998	FY 1999
the Collider Ring. The experimental detector portion of the project moved rapidly along. Conventional construction proceeded with the construction of the PHENIX Counting House, procurement of the cooling water systems, and final design of the electrical power installation at the experimental areas. The STAR detector magnets backlegs are assembled, and installation of the power coil is completed. Assembly of the STAR Time Project Chamber and its cosmic ray tests are completed. The PHENIX detector, following the assembly of the Muon ID steel, is focussing on the purchase, fabrication, and installation of individual detector subsystems components.			
Activity in FY 1998 will focus on twelve milestones. Collider construction will emphasize the completion of magnet production, completion of the injection line, cryogenic piping, vacuum system, acceleration RF system, and completion of collider ring installation. These major accomplishments will allow for the start of ring cool-down and set the stage for the debugging and testing which is required before collider operation. The experimental program will be rushing to meet milestones as well. The PHENIX detector is scheduled to complete the prototype data acquisition system, to test and map its magnets, to be well along in the production of detector elements, and to begin installation of the detectors in the west arm of the Central Spectrometer. Following the detailed magnetic field mapping, the STAR detector will be installing the Time Projection Chamber, shipped from LBNL to BNL in the fall 1997, completing the electronics integrated-sector test, and complete work on the magnet and support structure. The PHOBOS detector will enter into its production phase with the award of its magnet contract in October and the test of its readout chips. The BRAHMS detector is focusing on having magnets and its TPC's ready to install by the end of this fiscal year.	$ 0	$ 59,400	$ 0

	FY 1997	FY 1998	FY 1999
FY 1999 is the final year of RHIC construction activity and eighteen milestones are scheduled. The majority of RHIC hardware that is needed to bring the beams into collisions will be in place by the start of FY 1999. In the first quarter most efforts will focus on hardware systems testing. Installation of the final magnets will allow vacuum pumpdown to start in the ring. It is anticipated that portions of the ring will start cooldown sequentially until the full ring is cold in December. The first low intensity beam tests are scheduled for January-March of 1999 with only luminosity monitors in place in the experimental regions. An approximate 10 week shutdown is then planned where the detectors will roll in, and then the initial commissioning of collider operation will start. The Project Complete milestone is set for the end of June. Initial machine commissioning will take place with low-intensity single bunches of beam. For the experimental detector portion of the project, installation and testing of the RHIC detectors will be completed. As a part of this process, each of the detectors (but primarily the large detectors STAR and PHENIX) will be operated for extended periods to establish calibration parameters for the various detector subsystems. The shield walls and access control systems will be in place for the early machine phase. Full operation of RHIC is scheduled for the final quarter of FY 1999.	$ 0	$ 0	$ 16,620
Total Construction	$65,000	$59,400	$16,620

NUCLEAR PHYSICS
CONSTRUCTION

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Construction funds for RHIC are being reduced in coordination with the planned increase in operating funds -$42,780,000 as explained in item 12(a)2(b) of the RHIC Data Sheet. The increases in operating funds are needed for the start of beam tests and collider commissioning. Total Project Cost for RHIC remains unchanged.

Total Funding Change, Construction	-$42,780,000

NUCLEAR PHYSICS
CAPITAL OPERATING EXPENSE & CONSTRUCTION SUMMARY
(Dollars in thousands)

Capital Operating Expenses	FY 1997	FY 1998	FY 1999	$ Change	% Change
General Plant Projects (Total)	$ 4,570	$ 4,300	$ 4,000	-$ 300	- 7.0%
Accelerator Improvement Projects (Total) .	4,800	4,200	4,900	+ 700	+ 16.7%
Capital Equipment (Total)	24,245	26,620	31,500	+ 4,880	+ 18.3%

Construction Project Summary (both Operating and Construction Funded)

Project Number	Project Title	TEC	Previous Approp.	FY 1997 Approp.	FY 1998 Approp.	FY 1999 Request	Unapprop. Balance
91-G-300	Relativistic Heavy Ion Collider, BNL	$ 486,870	$ 345,850	$ 65,000	$ 59,400	$ 16,620	$ 0
	Total Nuclear Physics	--	$ 345,850	$ 65,000	$ 59,400	$ 16,620	$ 0

Major Items of Equipment (TEC $2 Million and Above)

	TEC	Previous Approp.	FY 1997 Approp.	FY 1998 Approp.	FY 1999 Request	Acceptance Date
1. STAR Silicon Vertex Tracker	$ 7,000	$ 1,450	$ 2,000	$ 1,500	$ 1,300	FY 2000
2. PHENIX Muon Arm Instrumentation	11,400	700	2,625	3,000	1,400	TBD
3. Analysis System for RHIC Detectors	7,900	100	675	1,700	5,425	FY 2000
4. BLAST Large Acceptance Detector	4,900	0	400	900	900	TBD

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1998 Congressional Budget Request are denoted with a vertical line in left margin.)

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

NUCLEAR PHYSICS

1. Title and location of project:	Relativistic Heavy Ion Collider Brookhaven National Laboratory Upton, New York	2a. Project No. 91-G-300 2b. Construction Funded	

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
3a. Date A-E Work Initiated, (Title I Design Start Scheduled):	N/A	N/A	1st. Qtr. FY 1991
3b. A-E Work (Titles I & II) Duration:	N/A	N/A	6 months
4a. Date physical Construction Starts:	N/A	N/A	2nd Qtr. FY 1991
4b. Date Construction Ends:	N/A	N/A	3rd Qtr. FY 1999

a/	Preliminary Estimate	Title I Baseline	Current Baseline Estimates
5. Total Estimated Cost (TEC) --	N/A	N/A	$486,870
6. Total Project Cost (TPC) --	N/A	N/A	$616,530

a/ Current Baseline Estimate is the latest baseline which reflects the approved changes to the Title I baseline.

1.	Title and location of project:	Relativistic Heavy Ion Collider Brookhaven National Laboratory Upton, New York	2a. Project No. 91-G-300 2b. Construction Funded

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Adjustments	Obligations	Costs
FY 1991	$ 15,000	- 1,500 a/	$ 13,500	$ 6,000
FY 1992	49,350		49,350	23,265
FY 1993	71,400	- 1,400 b/	70,000	60,839
FY 1994	78,000		78,000	82,244
FY 1995	70,000		70,000	86,600
FY 1996	65,000		65,000	76,048
FY 1997	65,000		65,000	59,309
FY 1998	59,400		59,400	67,400
FY 1999	16,620		16,620	25,165

a/ Reflects the reduction of funds resulting from the FY 1991 sequester and general reduction.

b/ Application of a portion of the FY 1993 General Science and Research general reduction of $30,000,000 for use of prior year balances.

8. Project Description, Justification and Scope

The Relativistic Heavy Ion Collider (RHIC) facility will be a unique, world-class research facility with opposing colliding beams that provides collision energies of 100 GeV/AMU per beam for heavy ions as massive as gold. RHIC will use the existing Alternating Gradient Synchrotron (AGS) and Tandem Van de Graaff complex as an injector. The new accelerator will be built in the existing Colliding Beam Accelerator (CBA) tunnel (3.8 km circumference), and will utilize the experimental halls, support building and liquid helium refrigerator from the partially completed CBA project.

The collider consists of two rings of superconducting magnets for accelerating and storing beams at variable energies up to 100 GeV/AMU for the heaviest ions. The collider will have the flexibility of using the full range of ion species from protons to gold which will be available from the AGS. With protons, energies of up to 250 GeV in each beam are expected. The capability for collisions between different masses in each ring will be provided. The collider is expected to have an average luminosity (a measure of the collision rate) of about 10^{26} cm^{-2} sec^{-1} for gold-on-gold collisions at full energy.

8. Project Description, Justification and Scope (Continued)

Most of the conventional construction for the collider exists, including a ring tunnel and an operating helium refrigeration system. The existing Collider Center (50,000 sq. ft. of usable area) will contain the accelerator control center, offices, technical shops, and refrigeration plant.

The existing tunnel configuration provides for six experimental areas where the circulating beams cross. Three of the experimental areas presently have completed experimental halls and support buildings for utilities. Another experimental area is an "open area" complete with support buildings and is suitable for experiments that use internal stationary targets. New construction is needed at two areas to close gaps in the ring. The standard tunnel cross section and support buildings will be constructed. Some general site work such as the paving of roads and the stabilization of the berm will also be provided. The funds requested will provide an initial complement of research detectors at beam intersection regions necessary for the first-round research program with the high-energy heavy-ion collider.

RHIC is a two-ring colliding beam accelerator dedicated to the study of nuclear matter at very high temperatures and densities where the quark-gluon degrees of freedom are expected to be directly revealed. The purpose of RHIC is to accelerate, store, and bring into collision two circular beams of very high energy heavy ions. For the heaviest ions (e.g., nuclei of gold atoms) the energies will range up to l00 GeV/AMU in each of the two colliding beams, providing a total collision energy which exceeds by more than an order of magnitude the capability of any other existing or proposed accelerator of heavy nuclear beams.

In such collisions experimenters will be able to study extended volumes of nuclear matter with energy densities greater than l0 times that of the nuclear ground state, achieving conditions of temperature and density at which this matter loses its identity as a collection of neutrons and protons and is predicted to undergo a phase transition to a plasma of quarks and gluons. This state of matter has not yet been observed. Its existence and properties are predicted by the theory of Quantum Chromodynamics (QCD), the theory of the strong interaction which has been developed over the past two decades of progress and discovery in high energy and nuclear physics.

At present the highest energy man-made heavy ion collisions are achieved with nuclear beams impinging on stationary targets, utilizing the Brookhaven AGS and CERN Super Proton Synchrotron accelerators. Recent experiments at these facilities have confirmed expectations that very energetic collisions produce increased densities and temperatures in nuclear matter. These experiments support the predictions that at much higher energies, which can be achieved only with the colliding beams of heavy ions at the RHIC facility, the most extreme temperatures and energy densities are produced in bursts of particles formed purely from the energy in the collision. These are the sought-for thermodynamic

8. Project Description, Justification and Scope (Continued)

conditions which can be directly compared with QCD calculations, and which approximate the conditions that existed before the universe condensed from a plasma of quarks and gluons to a gas of hadrons.

RHIC is designed to meet the requirements for carrying out a wide-ranging program of experiments which will open up the heretofore unexplored physics of hot dense nuclear matter and to isolate and study the new states of matter thus created. These requirements are not met by any other existing or proposed high energy colliding beams facility, all of which are designed for the acceleration of light, singly-charged particles such as protons, antiprotons, or electrons.

1. Title and location of project:	Relativistic Heavy Ion Collider Brookhaven National Laboratory Upton, New York	2a. Project No. 91-G-300 2b. Construction Funded

9. Details of Cost Estimate

		Item Cost	Total Cost
a. Engineering design inspection and administration of item b			$ 83,982
1. Engineering, design and inspection at 18% of construction costs		$ 50,172	
2. Construction management at 12% of construction costs, item b		33,810	
b. Construction Costs			279,920
1. Conventional Construction		9,640	
a. Site Improvement	1,160		
b. Tunnels and Buildings	6,260		
c. Utilities	2,220		
2. Technical Components - Collider		270,280	
a. Collider Installation	31,120		
b. Magnet System	141,240		
c. Magnet Electrical System	11,640		
d. Cryogenic System	20,390		
e. Vacuum System	10,750		
f. Injection System	11,370		
g. Beam Dump System	6,030		
h. RF System	12,140		
i. Beam Instrumentation	11,080		
j. Control System	12,260		
k. Safety System	2,260		
c. Contingencies on Collider at approximately 2.2 percent of above costs			7,968
Subtotal			$371,870
d. Research Detectors (including EDIA and Contingency)			115,000
Total line item costs			$486,870

10. Method of Performance

This type of construction project is a unique facility and therefore the design, assembly and testing will be done by the staff of the Brookhaven National Laboratory (with the assistance of an architectural-engineering (A-E) firm). 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. Building design will be on the basis of a negotiated A-E contract, and its construction will be by a competitively obtained lump-sum contract.

11. Schedule of Project Funding and Other Related Funding Requirements

a. Total project costs	Prior Years	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995
1. Total Facility Cost						
Construction line item	$ 0	$ 6,000	$23,265	$60,839	$ 82,244	$86,600
Total facility cost	$ 0	$ 6,000	$23,265	$60,839	$ 82,244	$86,600
2. Other project costs						
a. R&D necessary to complete construction	$21,450	$ 6,614	$ 7,000	$ 7,200	$ 5,880	$ 3,620
b. Start-up, Invent. & Equip.	0	0	0	0	0	2,200
Total other project costs	$21,450	$ 6,614	$ 7,000	$ 7,200	$ 5,880	$ 5,820
Total project cost	$21,450	$12,614	$30,265	$68,039	$ 88,124	$92,420

a. Total project costs	FY 1996	FY 1997	FY 1998	FY 1999	Total
1. Total Facility Cost					
Construction line item	$76,048	$59,309	$67,400	$25,165	$486,870
Total facility cost	$76,048	$59,309	$67,400	$25,165	$486,870
2. Other project costs					
a. R&D necessary to complete construction	$ 0	$ 0	$ 0	$ 0	$ 51,764
b. Start-up, Invent. & Equip.	9,500	10,973	19,000	36,223	77,896
Total other project costs	9,500	10,973	19,000	36,223	129,660
Total project cost	$85,548	$70,282	$86,400	$61,388	$616,530

11. Schedule of Project Funding and Other Related Funding Requirements (Continued)

b. Related annual funding requirements (FY 1999 dollars)*

1. Annual RHIC Collider Operating Costs	$44,400
2. Annual Injector Operating Costs	
AGS	19,300
Booster	3,200
Tandem	2,300
Total injector operating costs	$24,800
3. Annual plant and capital equipment costs related to facility operations	6,900
4. Annual RHIC Experimental Program Support	$23,700
Total related annual funding	$99,800

* The estimated total annual funding requirements described are based on the report from the DOE/NSF Nuclear Science Advisory Committee on the Operating Costs of the Brookhaven Relativistic Heavy-Ion Collider, dated August 14, 1996. Experimental program support includes some functions not included in the previous estimate. Support for the research program is not included.

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

a. Total project funding

1. Total facility costs

Explained in items 8, 9 and 10.

2. Other project costs

a. R&D necessary to complete construction

This included supporting R&D work on critical accelerator components before and during the construction phase. The funds covered the development of full-length (9.7 m) dipole magnets, quadrupole magnets, insertion magnets, and trim/correction spool pieces.

1. Title and location of project: Relativistic Heavy Ion Collider
Brookhaven National Laboratory
Upton, New York

2a. Project No. 91-G-300
2b. Construction Funded

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

This also included R&D necessary for research detectors. Tests were needed to determine detailed parameters required for large-scale detectors for the heavy-ion experimental facilities, and a continued effort to develop new techniques of detection and read-out for improved utilization of the collider facility.

b. Start-up, Inventory and Equipment

These funds are needed for operation training of crew, early testing and check-out of various systems, as well as to establish a special process spares inventory as their construction is completed. Capital equipment is identified within other project costs for acquiring equipment to serve project operations and the experimental program. Portions of the cryogenic system and the beam injection system reached operational status in FY 1996.

b. Related annual costs (Estimated life of the facility: 20 years)

1. RHIC facility operating costs assume 37 weeks of operation with appropriate manpower, material, and support services associated with the Tandem/Booster/AGS injector complex and the superconducting collider.

2. RHIC Experimental Program Support includes costs for appropriate manpower and materials needed for running and maintaining the apparatus and costs of operating the on-site computing facilities for the experimental program, as well as funds that ensure that health and safety needs are covered. For this estimate, four experimental areas are planned.

3. This item includes plant and capital equipment needed to maintain and improve reliability and efficiency of the facility and associated experimental equipment for the planned research programs.

4. The updated estimate of RHIC Operations costs ($99,800,000 per year) evaluated by NSAC differs from the previous estimate ($78,900,000 per year)* by $20,900,000. Of this $20,900,000, $8,900,000 are for activities that were planned to be supported by Research funding. Hence there is a $12,000,000 increase over what had been planned, arising from an increase of $6,000,000 in the estimated costs for facility operations and an additional $6,000,000 in the estimated costs for experimental program support.

* The previous estimate was based on the RHIC Conceptual Design Report published in May 1989.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
SCIENCE
(Tabular dollars in thousands, Narrative in whole dollars)

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

PROGRAM MISSION

The Biological and Environmental Research (BER) program mission - Investing to advance environmental and biomedical knowledge connected to energy. The BER program provides fundamental science to underpin the business thrusts of the Department's strategic plan. Through its support of peer-reviewed research at national laboratories, universities, and private institutions, the program develops the knowledge needed to identify, understand, and anticipate the long-term health and environmental consequences of energy production, development, and use. The research is also designed to provide science in support of the Energy Policy Act of 1992.

The GOAL of the BER program is:

To develop the information, scientific "know-how," and technology for identification, characterization, prediction, and mitigation of adverse health and environmental consequences of energy production, development, and use.

The OBJECTIVES related to these goals are:

1. To CONTRIBUTE TO A HEALTHY CITIZENRY - Map the fine structure of the human genome by 2005 providing resources to the international research community needed to identify disease genes and develop broad diagnostic and therapeutic strategies, including the development of individual risk assessments; conduct fundamental research necessary for the development of advanced medical technologies and radiopharmaceuticals; and use the unique National Laboratory facilities to determine biological structure and function at the molecular and cellular level in support of this nation’s biomedical sciences, pharmaceutical interests, and environmental activities.

2. To CONTRIBUTE TO CLEANUP OF THE ENVIRONMENT - Conduct fundamental research necessary for the development of advanced remediation tools for containing wastes and cleaning up DOE's contaminated sites, particularly in support of the mission of DOE's Environmental Management (EM) office.

3. To UNDERSTAND GLOBAL ENVIRONMENTAL CHANGE - Acquire the data and develop the understanding necessary to predict how energy production and use can affect the global and regional environment.

SCIENTIFIC FACILITIES UTILIZATION:

The Biological and Environmental Research request includes $42,547,000 to maintain support of the Department's scientific user facilities. Facilities used for structural biology research, such as beam lines at the synchrotron light sources and research reactors were included in the initiative for the first time in FY 1997. In FY 1999, the request includes operation of the William R. Wiley Environmental Molecular Sciences Laboratory where the research activities will underpin environmental remediation. This funding will provide for the operation of the facilities, assuring access for scientists in universities, federal laboratories, and U.S. companies. It will also leverage both Federally and privately sponsored research consistent with the Administration's strategy for enhancing the U.S. National science investment.

PERFORMANCE MEASURES:

The quality and appropriateness of the Biological and Environmental Research (BER) program and individual research projects are judged by rigorous peer reviews conducted by internationally recognized scientific experts using criteria such as scientific merit, appropriateness of the proposed approach and qualifications of the principal investigator. Highest quality research is maintained by taking appropriate and, if needed, corrective management actions based on results of the reviews. A measure of the quality of the research is the sustained achievement in advancing knowledge as indicated by the publication of research results in refereed scientific journals, by invited participation at national and international conferences and workshops, and by awards received by DOE-supported BER researchers. Progress in the field is also routinely compared to the scientific priorities recommended by the Biological and Environmental Research Advisory Committee and the National Science and Technology Council's (NSTC) committees on Environment and Natural Resources and on Fundamental Science.

An overarching and unique performance measure of the BER program is the diversity of program reviews conducted. This is particularly the case for BER program elements that are components of international research endeavors, e.g., the Human Genome Program and the Global Change Research Program. In addition to panel reviews that evaluate and select individual projects and programmatic reviews by the chartered Biological and Environmental Research Advisory Committee, these program elements are evaluated by interagency (and international) review bodies and by Boards and Committees of the National Academy of Sciences.

The BER program goes one step further in soliciting program reviews. Blue ribbon panels are charged with evaluating the quality of individual programs and with exploring ways of entraining new ideas and research performers from different scientific fields. This strategy is based on the conviction that the most important scientific advances of the new century will occur at the interfaces between scientific disciplines such as biology and information science. Groups like JASON and The Washington Advisory Group (TWAG), involving physicists, mathematicians, engineers, etc., are among the panels that have studied BER program elements such as the Atmospheric Radiation Measurement (ARM) program, climate change prediction, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), and the Human Genome Program.

Facility operations are also monitored by peer reviews and user feedback. These facilities are provided in a manner that meets user requirements (as indicated by achieving performance specifications while protecting the safety of the workers and the environment); facilities are operated reliably and according to planned schedules; and facilities are maintained and improved at reasonable costs.

Specific BER program performance measures are:

1. Excellence in basic research: At least 80 percent of the research projects will be reviewed by appropriate peers and selected through a merit-based competitive process.

2. Access to Human Genome research results: BER will complete sequencing of 40 million subunits of human DNA to submit to publicly accessible databases.

3. Microbial Genomics: BER will complete 70 percent of the genetic sequencing of over 10 additional microbes with significant potential for waste cleanup and energy production.

4. Progress in Boron Neutron Capture Therapy (BNCT) Research: Phase I/II clinical trials of BNCT at reactor sources of neutrons will be completed for at least 50 patients, and a feasibility study of accelerator-based BNCT will be underway.

5. Environmental remediation developments: Fundamental research in environmental sciences, biology, molecular sciences, and mathematical modeling will underpin the development of advanced remediation tools (e.g., bioremediation) to contain hazardous waste and clean up DOE contaminated sites.

6. Atmospheric Radiation Measurement (ARM) accomplishments: BER will conduct five intensive operations periods at the ARM Southern Great Plains site; will initiate preparation for a third atmospheric radiation and cloud station in the Tropical Western Pacific; will redeploy an atmospheric radiation and cloud station from the Arctic Ocean to Atqasuk, Alaska.

7. William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) collaboration products: will increase the number of EMSL products from collaborations (e.g., publications, patents, databases, software releases, technical reports, instruments developed, etc.).

8. The ER/EM Pilot Collaborative Research Program will complete its three-year initial phase in FY 1999 and applied developmental research will begin on the most promising technologies arising from these projects.

9. The development and upgrade of scientific facilities (including experimental stations) will be kept on schedule and within cost, not to exceed 110 percent of estimates.

10. The operating time lost at scientific facilities due to unscheduled downtime will be less than 10 percent of the total scheduled possible operating time, on average.

11. An independent assessment will judge BER research programs to have high scientific quality.

12. Education accomplishments: Continuing to make 2 to 10 appointments each in the BER Alexander Hollaender Distinguished Post Doctoral Fellowship; the multi-agency Significant Opportunities in Atmospheric Research and Science (SOARS) program for outstanding Hispanic, Native American, and African American students in the atmospheric and related sciences; and the minority colleges and university faculty and student research program. Also, initiating a Significant Opportunities program in the broader sciences of global change for outstanding undergraduate and graduate students.

13. Discovering new biological structures with more than 60 percent of them published in the peer reviewed literature resulting from data generated at synchrotron user stations served by the BER structural biology support facilities program.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- Advanced technologies continue to be developed from resources and tools produced in the human genome program to determine and mitigate the potential health effects that arise during energy activities and clean-up operations. Emphasis is placed on molecular-based tools for health surveillance, biological dosimetry, and individual susceptibility determination to understand and characterize the risks to human health from exposures to low levels of radiation and chemicals.

- The DOE Joint Genome Institute has successfully integrated high throughput genomic sequencing with analyses that “annotate” the sequence, i.e., reveal the biological content of the sequence data produced, demonstrating the power of an “industrial” approach to genomic sequencing and data analysis.

- The most recent success of the DOE Microbial Genome Initiative (MGI) was the discovery of a third branch of life, the Archaea (meaning ancient in Greek). This accomplishment was noted by Discover magazine as one of the key scientific advances of the year.

- New approaches have been developed to determine the function of and the relationships among large numbers of genes, the proteins they encode, and the biological functions of these proteins.

- New strategies for cleanup, including the use of biotechnology (e.g., microbes that break down contaminants), are being developed for stubborn remediation problems.

- Significant improvements are being made in the predictive tools needed to quantify human-induced and natural global environmental changes, including those from energy production and use. Emphasis remains on the role of clouds in climate and on developing improved climate models using the Nation's most advanced computers.

- The application of modern molecular tools to marine microbes will start to provide new information on marine microbial roles in carbon and nitrogen cycling and related processes that may affect global environmental change. In the innovative new program, Biotechnological Investigations- Ocean Margins Program, that builds on the recently completed Ocean Margins Program, active collaborations are being built between institutions with strong traditions of research in the marine sciences and those with developing research capabilities.

- New nuclear medicine technologies and new radiopharmaceuticals incorporating radioisotopes commonly used for nuclear medicine into novel chemical structures for improved medical diagnosis and therapy are being developed, contributing to improved health care delivery while reducing costs by achieving early diagnosis and treatment. Increased emphasis is being placed on improved methodologies for combined imaging of anatomical structures and physiological functions.

- The molecular nuclear medicine program will be redirected to take advantage of developments in genomics and structural biology to initiate a major effort to understand the link between genetic makeup and disease through application of innovative radioisotope tracer concepts.

- The Measurement Science Program will provide new instrumentation for addressing the growing need to characterize DOE's contaminated sites and to monitor the progress of cleanup of these sites.

- The Genome Instrumentation Research Program will be redirected to address needs of the Department for completely new types of technology for meeting DOE mission objectives that will utilize genomics.

- Research under the Climate Change Technology Initiative will be conducted to take advantage of developments in microbial genetics and biochemistry to begin development of the understanding needed to enhance the sequestration and recycling of carbon through the use of natural biological processes thus reducing levels of atmospheric carbon dioxide.

Climate Change Technology Initiative

The FY 1999 budget contains two carbon related programs, each of which cut across several agencies. The first is the Climate Change Technology Initiative (CCTI). That part of the CCTI that is within the Office of Energy Research is a joint activity between the Biological and Environmental Research (BER) and Basic Energy Science (BES) programs. The second program is the U.S. Global Change Research Program (US/GCRP) that spans eleven agencies and is coordinated through the National Science and Technology Council's Committee on Environment and Natural Resources. Within DOE, the BER program plays the lead role in US/GCRP activities. Although the two programs, CCTI and US/GCRP, are synergistic, they are different. US/GCRP research focuses on developing the fundamental understanding of the comprehensive climate system and the global and regional adaptations to it. CCTI focuses on the underpinning science that will enable mitigation of climate change while maintaining a robust National economy.

PROGRAM MISSION - BIOLOGICAL AND ENVIRONMENTAL RESEARCH - (Cont'd)

Overview

Eighty-five percent of our Nation's energy results from the burning of fossil fuels, a process that adds carbon to the atmosphere -- principally in the form of carbon dioxide -- from the sequestered fossil reservoir. Because of the potential environmental impacts of increases in atmospheric carbon dioxide, carbon management has become an international concern and has become the focus the Climate Change Technology Initiative. A comprehensive carbon management research and development program that meets the needs of the Climate Change Technology Initiative addresses the diverse aspects of this problem. The Office of Energy Research is well positioned to make significant contributions to the many solutions needed for this problem, as it is set to build on the fundamental discoveries of its core programs and extend them to the new discoveries needed to make carbon management practical and efficient. Energy Research core programs include research on both carbon and non-carbon energy sources and on both carbon sequestration and carbon recycling. These core activities can now be exploited in the generation of the science that will underpin the technologies of the future. The theme of efficiency in energy production and use must span the entire range of research activities. Research on carbon energy sources, and their impacts, is a focal point of interagency activity through the U.S. Global Change Research Program (USGCRP). Research on non-carbon energy sources is also a focal point of intra-agency activities and is led by the DOE Office of Energy Efficiency and Renewable Energy. The DOE Office of Energy Research, through activities in both the Basic Energy Sciences (BES) program and the Biological and Environmental Research (BER) program, supports research that underpins both efforts.

A research program in carbon management would include research directed at the following themes:

(1) science for efficient technologies,
(2) fundamental science underpinning advances in all low/no carbon energy sources, and
(3) sequestration science.

Energy Research has long standing programs in fundamental research that already impact these three categories. Additional resources of $11,000,000 provided specifically for the Climate Change Technology Initiative will be a natural extension of the complementary, ongoing work in several programs in Energy Research, and it will build on the foundation of excellent and relevant research already underway. Focus areas will be those that build on strengths of the current Energy Research programs and that promise maximum impact in the area of carbon management. Within the BER program, the Life Sciences subprogram activities in genomics underpin genome studies on microorganisms that may form the core of new fuel sources. Core activities within the Environmental Processes subprogram, particularly in terrestrial carbon cycle and in ocean sciences research, open up the possibility of exploiting Nature’s own carbon sequestration processes in enhanced sequestration.

Immediate Impacts of Expanded Effort in the Science for Climate Change Technology

Additional Energy Research efforts will not only address an immediate societal problem, but it will also have a major effect on many scientific disciplines by advancing the state of knowledge and by training students in areas of research that are important to carbon management. For example, biochemistry, molecular and cellular biology, structural biology, and genome science will be impacted, because the production of fuels and chemicals by plants and microorganisms and the interconversion of greenhouse gases requires a better understanding of metabolism, of the structure and function of sub-cellular components, and of enzymes. Similarly, the state-of-the-art in biochemistry, molecular biology, and ecology will be impacted. All of these biological processes are important in understanding the role of marine microorganisms in sequestering carbon. Improvements in combustion to reduce carbon emissions require a fundamental understanding in chemical dynamics and theoretical chemistry and physics. Conversion of sunlight to energy requires an understanding in many areas of science, including photochemistry, photosynthesis, metabolism, and solid state physics. The search for increased efficiency in energy production and use requires fundamental knowledge in ceramics, metals, polymers, solid state chemistry, and condensed matter physics for materials that can withstand higher temperatures, have lower coefficients of friction, and are stronger and lighter. Enhanced recovery of fuel resources and of disposal of carbon dioxide requires a fundamental understanding of geometric, structural, and hydrologic properties of reservoirs and of multiphase, nonlinear transport of fluids in porous and fractured structures. Cross-cutting programs in nano- and meso-phase materials involve research at the forefront of materials science, chemistry, engineering, surface science, and semiconductor physics.

The new research efforts supporting advances in low/no carbon energy technologies as well as existing activities, will be closely coordinated with DOE's technology programs and will provide the knowledge base for the development of advanced technologies to reduce carbon dioxide emissions. Many of the activities will impact the Office of Energy Efficiency and Renewable Energy (EE) by providing options for increasing efficiency in automobiles by reducing weight; for increasing efficiency in the use of electricity by increasing the efficiency of electric motors and generators with better magnets; for increasing efficiency in the transmission of electricity by using superconductors; and for reducing energy consumption in manufacturing with improved sensors, controls, and processes. Much of this research program will provide the knowledge base needed to increase the use of renewable resources with research aimed at understanding the metabolism of carbon dioxide and the metabolic pathways to the production of methane and other biofuels. Other aspects of the research program impact the Office

of Fossil Energy (FE) by providing a foundation for effective and safe underground sequestration, new materials, a better understanding of combustion, and improved catalysts.

Funding will be provided for areas of research in carbon cycle management including appropriate areas that will be jointly identified and implemented by the Biological and Environmental Research and Basic Energy Sciences programs. Solicitations will be issued for individual research projects. Additionally, proposal notifications may be developed jointly with the DOE energy technology programs with the intention of establishing multi-disciplinary centers at universities and national laboratories that will use the full capabilities of the institutions for a research program in carbon cycle management encompassing, for example, topics in the following areas: integration and assessment; separations; efficiency; clean fuels; bioenergy; storage and conversion; sequestration; enhanced natural terrestrial cycles; and enhanced use of major scientific user facilities to support carbon management research.

Interagency Environment

The ER program in fundamental science supporting energy technologies will be closely coordinated with, and synergistic to, the activities in its sister agencies (e.g., NASA, NSF, NOAA, USDA, DOI, and EPA) within the USGCRP. Through its leadership role in decade to century climate prediction, BER has developed the research capability for comprehensive and large scale modeling of carbon dioxide impacts on climate, on ecology, and on ocean sciences, and this expertise is augmented by complementary activities in the other agencies. Similarly, the network of carbon flux measurements and ecological experiments that BER has developed serve as a backdrop to those of many other agencies, and the state-of-the-art can thus be pushed ahead more rapidly by capitalizing on the more rapidly growing base of knowledge.
BER also has a leadership role within the USGCRP on consequence evaluation of increased greenhouse gases in global climate change, including integrated assessments that address both scientific and societal (including economic) impacts of carbon management. Finally, through its pre-eminent role in the Human Genome Program and its development of the complementary Microbial Genome Program, the BER program is ideally placed to support research that will focus on the application of genetic information of microorganisms to increase metabolic efficiency related to both carbon dioxide and methane production or consumption, and will thus underpin the related activities to be undertaken by both Energy Research and the National Science Foundation LexEN (Life in Extreme Environments) program.

BER Activities

Climate Change Technology Initiative
FY 1999 Budget Request
B/A
($000)

Life Sciences	$ 5,000
Environmental Processes	6,000
Total	$11,000

The Biological and Environmental Research (BER) program has the opportunity to take advantage of the unique research capabilities within the Environmental Processes subprogram and to determine which natural systems of forest, other plant, and marine microorganisms can be induced to increase their natural carbon sequestration capabilities. This will help to position the Department and the Nation to build new energy efficient technologies that capitalize on Nature's own processes. Additionally, through its pre-eminent role in the Human Genome Program and its development of the complementary Microbial Genome Program within the Life Science subprogram, the BER program is ideally placed to support research that will focus on the production of genetic information on methane-producing and hydrogen-producing microorganisms that can be exploited in the development of useful and efficient non-fossil fuel sources. Where appropriate, these efforts will be coordinated with activities within the U.S. Global Change Research Program. When combined with complementary activities within the Basic Energy Sciences program, this initiative will lead to the comprehensive carbon management research program described, above.

Funding of Contractor Security Clearances

In FY 1999, the Department will divide the responsibility for obtaining and maintaining security clearances. The Office of Security Affairs, which has been responsible for funding all Federal and contractor employee clearances, will pay only for clearances of Federal employees, both at headquarters and the field. Program organizations will be responsible for contractor clearances, using program funds. This change in policy will enable program managers to make the decisions as to how many and what level clearances are necessary for effective program execution. In this way, it is hoped that any backlog of essential clearances which are impeding program success can be cleared up by those managers most directly involved. The Office of Energy Research is budgeting $101,000 for estimated contractor clearances in FY 1999 within this decision unit.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

PROGRAM FUNDING PROFILE
(Dollars in thousands)

Subprogram	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation	
Life Sciences	$143,546		$165,537		-$343	a/	$165,194	
Environmental Processes	109,055		108,626		-226	a/	108,400	
Environmental Remediation	34,850		66,435		-138	a/	66,297	
Medical Applications and Measurement Science	56,609		66,112		-136	a/	65,976	
Subtotal	344,060		406,710		-843	a/	405,867	
Construction	36,113		0		0		0	
Subtotal, Biological and Environmental Research	380,173		406,710		-843	a/	405,867	
Adjustment	-6,702	b/	-4,360	c/	0		-4,360	c/
Adjustment	0		-843	a/	843	a/	0	
TOTAL, BER	$373,471	d/	$401,507		$0		$401,507	

a/ Share of Science general reduction for contractor training.

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

c/ Share of Science general reduction for use of prior year balances assigned to this program. Total general reduction is applied at the appropriation level.

d/ Excludes $8,118,000 which has been transfered to the SBIR program and $484,000 which has been transferred to the STTR program.

Public Law Authorization:

Pub. Law 94-91, DOE Organization Act

FY 1999 Budget Request
$162,017
119,237
67,435
43,911
392,600
0
392,600
0
0
$392,600

BIOLOGICAL AND ENVIRONMENTAL RESEARCH
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation
Albuquerque Operations Office				
Los Alamos National Laboratory	$23,807	$17,681	$0	$17,681
National Renewable Energy Laboratory	0	250	0	250
Sandia National Laboratory	2,819	3,564	0	3,564
Chicago Operations Office				
Ames Laboratory	649	786	0	786
Argonne National Laboratory (East)	10,546	9,803	0	9,803
Brookhaven National Laboratory	26,293	22,977	0	22,977
Fermi National Accelerator Laboratory	2,200	0	0	0
Idaho Operations Office				
Idaho National Environmental Engineering Lab.	2,338	2,011	0	2,011
Oakland Operations Office				
Lawrence Berkeley National Laboratory	40,517	29,587	0	29,587
Lawrence Livermore National Laboratory	24,592	18,189	0	18,189
Stanford Linear Accelerator Facility (SSRL)	2,846	2,250	0	2,250
Oak Ridge Operations Office				
Oak Ridge Institute for Science & Education	5,613	3,702	0	3,702
Oak Ridge National Laboratory	22,924	21,689	0	21,689

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation	
Richland Operations Office								
Pacific Northwest National Laboratory	89,101		72,687		0		72,687	
All Other Sites a/	125,928		201,534		-843	b/	200,691	
Subtotal	380,173		406,710		-843	b/	405,867	
Adjustment	-6,702	c/	-4,360	d/	0		-4,360	d/
Adjustment	0		-843	b/	843	b/	0	
TOTAL	$373,471	e/	$401,507		$0		$401,507	

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

b/ Share of Science general reduction for contractor training.

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

d/ Share of Science general reduction for use of prior year balances assigned to this program. Total general reduction is applie
the appropriation level.

e/ Excludes $8,118,000 which was transferred to the SBIR program and $484,000 which was transferred to the STTR program.

FY 1999 Budget Request
$18,162
0
3,219
604
8,433
22,687
0
1,650
28,412
16,730
2,350
3,420
19,390

FY 1999 Budget Request
70,465
197,078
392,600
0
0
$392,600

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BIOLOGICAL AND ENVIRONMENTAL RESEARCH

LIFE SCIENCES
(Tabular dollars in thousands, narrative in whole dollars)

I. <u>Mission Supporting Goals and Objectives</u>:

Research is focused on utilizing unique DOE resources and facilities to develop fundamental biological information and advanced technologies for understanding and mitigating the potential health effects of energy development, energy use, and waste cleanup. Research is conducted in five areas: structural biology, cellular biology, molecular biology, human genome, and health effects. The research:

- Integrates information and technologies from genome, structural biology, and molecular biology research with human health research to understand the complex relationships between genes, the proteins they encode, and the biological functions of these proteins in the context of the whole organism.

- Develops new biotechnologies, including those derived from microbial genome research, for bioremediation applications, and for the mitigation of potential health effects resulting from energy development, energy use, and waste cleanup.

- Supports DOE research at national user facilities for scientists to determine the molecular structure of enzymes, antibodies, and other important biological molecules. Computational structural biology research combines computer science, structural biology, and genome research to predict the functions of biological molecules.

- Develops and applies new technologies and resources to map and determine the sequence of the subunits of DNA found in a typical human cell, for analyzing and interpreting DNA sequence data, and for studying the ethical, legal, and social implications (ELSI) of information and data resulting from the genome program, especially issues of privacy, intellectual property, and education. Program emphasis is on high throughput, production sequencing of human DNA, rapid entry of data into public databases, and identifying the functions for a portion of the 100,000 genes that make up the human genome.

- Develops new molecular-based tools for health surveillance, biological dosimetry, and individual susceptibility determination to understand and characterize the risks to human health from exposures to low levels of radiation and chemicals both at home and at work. An emphasis is placed on research that utilizes the unique resources and tools developed in the Department's human genome, structural biology, and cellular and molecular biology programs.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

LIFE SCIENCES

I. Mission Supporting Goals and Objectives (cont'd):

Climate Change Technology Initiative

The Life Sciences subprogram's support of microbial genome research also underpins the climate change technology initiative.

II. Funding Schedule:

Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Structural Biology	$ 25,912	$ 28,105	$ 28,145	$+ 40	+ 0.1%
Molecular and Cellular Biology . .	19,256	29,312	24,771	- 4,541	-15.5%
Human Genome	77,989	84,915	85,329	+ 414	+ 0.5%
Health Effects	20,389	18,797	19,801	+ 1,004	+ 5.3%
SBIR/STTR	0	4,065	3,971	- 94	- 2.3%
Total, Life Sciences	$143,546	$165,194	$162,017	$- 3,177	- 1.9%

III. Performance Summary - Accomplishments:

	FY 1997	FY 1998	FY 1999
Life Sciences			
-Structural biology supports research at national user facilities to determine the molecular structure of important biological molecules to assist in rational drug design, improved biomaterials, and efficient removal of environmental contaminants. The program performs computational structural biology research aimed at enhancing our understanding of the structure-function relationship of biological macromolecules. Capital equipment funds are provided for the development of instrumentation for the user stations at the Department's synchrotrons and neutron sources and to purchase new generation detectors and related instrumentation for existing experimental stations at the Department's facilities. Education	$25,912	$28,105	$28,145

activities for improving

III. Performance Summary - Accomplishments:	**FY 1997**	**FY 1998**	**FY 1999**
science education for students and faculty in America's schools, colleges and universities are also funded in this program.			
-Molecular biology research develops information and resources to address Departmental biotechnology needs including applications in energy development, energy use, and waste cleanup. Program efforts include determining the sequence and evolutionary relationships of industrially and environmentally important microbes, developing tools to determine the relationship between DNA sequence, protein structure and protein function, and developing approaches to modify the structure of proteins to improve their function. Capital equipment funds provide for structural molecular biology beamline instrumentation. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	11,651	12,175	12,092
-The microbial genome program has made significant investments in the technology that enables genome sequencing at rates previously unattainable. Capitalizing on these investments, the genomes of microbes that produce methane and hydrogen will be sequenced. This will enable the identification of the key genetic components of the organisms that regulate these gases. Once we identify and understand more fully how the enzymes and organisms operate, we will be able to evaluate the potential use of either the microorganisms or the relevant enzymes to produce methane or hydrogen from either fossil fuels or other carbonaceous sources, including biomass or perhaps even some kinds of waste products. For instance, recently discovered "extremophile" organisms could be used to engineer biological entities that could ingest a feedstock like methane, sequester the carbon dioxide,	0	0	5,000

and give off hydrogen. This effort is part of the Climate Change Technology Initiative.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

LIFE SCIENCES

III. Performance Summary - Accomplishments:	FY 1997	FY 1998	FY 1999
-Funding for Northeast Regional Cancer Institute in Scranton, Pennsylvania per Congressional direction for FY 1998.	0	9,709	0
-Cellular biology research develops information and resources that exploit and integrate developments in the Department's genome, structural biology, and health effects programs. Program efforts include determination of the relationship between the expression of large numbers of genes in cells or tissues, development and use of model systems to determine the function of known or unknown human genes, and development of methods capable of efficiently determining the function of or the relationship between very large numbers of genes. Capital equipment funds support cellular biology research providing upgrades of flow cytometers and development of equipment needed to meet research goals. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	7,605	7,428	7,679
-Genome research develops and uses resources and technologies for high-throughput human DNA sequencing, mapping and analysis, and studies genome-associated ethical, legal, and social issues. The Joint Genome Institute is fully operational and focused on high throughput, production sequencing of human DNA, side-by-side comparisons of different sequencing strategies and of interchangeable modules in the sequencing production line, and on the integration of	77,989	84,915	85,329

sequencing with analyses that annotate the sequence, i.e., reveal the biological content of the sequence data produced. The Program goal is to sequence the entire human genome which includes 3 billion base sequences, by the year 2005. DOE plans to accomplish a significant portion of the U.S. effort with the

III. Performance Summary - Accomplishments:

balance to be completed by NIH. Other efforts include physical mapping of the human genome, development of a set of analyses that reveal the biological informational content of the sequence data produced, more rapid entry of DNA sequence into public data bases, research into instrumentation for new applications of genomics beyond the year 2005, development of user- friendly interoperable databases for DNA map and sequence data, development and distribution of educational programs on genome research and associated societal issues, and support of judges workshops on the use of genetic evidence. Capital equipment funding provides instrumentation for high throughput production sequencing and computer hardware to support the human genome data bases. A table follows displaying both DOE and NIH genome funding. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.

U.S. HUMAN GENOME PROJECT FUNDING
(Dollars in millions)

	Prior Years	FY 1997	FY 1998	FY 1999

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

LIFE SCIENCES

DOE Total Funding (includes construction)	$ 378.4	$ 78.9	$ 84.9	$ 85.3
NIH Funding	1,044.4	190.0	218.0	TBD
Total U.S. Funding	$1,422.8	$268.9	$302.9	TBD

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
-Health effects research develops and uses information and tools for health surveillance and biodosimetry. Program efforts include identification and characterization of polymorphisms in genes, including DNA repair genes and genes associated with immune function, that may increase individual health risk, and integration of rapid DNA screening technologies with information on genes that may increase health risk from radiation or chemicals, e.g., beryllium. Capital equipment funds provide items such as cage washers, centrifuges, themocyclers, laminar flow hoods, DNA sequencers, photoimagers, and computer hardware for confocal microscopes in support of health effects research. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.	20,389	18,797	19,801
SBIR/STTR In FY 1997, $3,544,000 and $206,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirements for the continuation of these programs.	0	4,065	3,971
TOTAL Life Sciences	$143,546	$165,194	$162,017

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

LIFE SCIENCES

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

LIFE SCIENCES

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

-Continue Structural Biology program at FY 1998 level.	$ +40,000
-Net decrease to Molecular and Cellular Biology is attributable to:	
- One-time funding of a Congressionally directed project at the Northeast Regional Cancer Institute in FY 1998.	-9,709,000
- Increase to support ER Climate Change Technology Initiative.	+5,000,000
- Increase to Molecular and Celluar Biology research.	+168,000
-Increase in Human Genome funding will allow continued progress in high throughput, production sequencing of human DNA.	+414,000
-The increase in Health Effects Research will partially restore funding to the FY 1997 level.	+1,004,000
-Change in SBIR/STTR due to decrease in operating budget.	-94,000
Total Funding Change, Life Sciences	$-3,177,000

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

ENVIRONMENTAL PROCESSES
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

Research is focused on understanding the basic chemical, physical, and biological processes of the Earth's atmosphere, land, and oceans and how these processes may be affected by energy production and use, primarily the emission of carbon dioxide from fossil fuel combustion. A major part of the research is designed to provide the data that will enable an objective assessment of the potential for, and consequences of, global warming. The program is comprehensive with an emphasis on understanding the radiation balance from the surface of the Earth to the top of the atmosphere (including the role of clouds) and on enhancing the quantitative models necessary to predict possible climate change at the global and regional scales. An additional focus is on programs designed to assess the potential impacts of climate change on terrestrial systems. There are four contributing areas to this research program: Climate and Hydrology, Atmospheric Chemistry and Carbon Cycle, Ecological Processes, and Human Interactions. The National Institute for Global and Environmental Change (NIGEC) is included within these four areas. The Environmental Processes subprogram, with the exception of carbon management activities, funds DOE's contribution to the U.S. Global Change Research Program that was codified by Congress in the Global Change Research Act of 1990. This program includes research needed to develop biotechnological and bioengineering approaches to enhancing the sequestration and recycling of carbon from fossil fuels and thereby reduce the levels of atmospheric carbon dioxide.

Climate Change Technology Initiative

The Atmospheric Chemistry and Carbon Cycle category supports basic research that promotes an understanding of the role that the terrestrial biosphere and human activities play on the state and quality of the global climate. Capitalizing on activities in support of the U.S. Global Change Research Program, science for the Climate Change Technology Initiative will seek the understanding necessary to exploit the biosphere’s natural processes for use in sequestration of atmospheric carbon dioxide including the roles of marine microorganisms in ocean carbon sequestration.

II. Funding Schedule:

Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Climate and Hydrology	$ 64,663	$ 61,748	$ 64,136	$+ 2,388	+3.9%
Atmospheric Chemistry and Carbon Cycle	22,806	22,568	30,879	+ 8,311	+36.8%
Ecological Processes	12,635	12,321	12,011	- 310	-2.5%
Human Interactions	8,951	8,984	9,158	+ 174	+1.9%
SBIR/STTR	0	2,779	3,053	+ 274	+9.9%
Total, Environmental Processes	$109,055	$108,400	$119,237	$+10,837	+10.0%

III. Performance Summary - Accomplishments

	FY 1997	FY 1998	FY 1999
Climate and Hydrology			
-Climate models on massively-parallel super computers are used to simulate climate change, predict climate, and evaluate model uncertainties due to changes in atmospheric concentrations of greenhouse gases on decade-to-century timescales. New generation coupled atmosphere-ocean general circulation models (GCMs) have been developed and will be used to perform simulations of possible climate response to increasing atmospheric concentrations of greenhouse gases. These simulations will be significantly improved over earlier studies because they will be better verified, have realistic estimates of natural climate variability on decadal and longer time scales, and produce information that can be used to estimate regional impacts in much greater detail. Work will continue on developing more accurate and computationally efficient models, as well as improving the observational data bases and methods necessary to test and verify the capacity of	$23,494	$22,781	$24,132

climate models to predict decadal to multi-century climate variability

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
and climate change. New research will be undertaken in advanced simulation and applied to climate prediction. This research will include capitalizing on emerging large scale computer technology. The models will run faster and more efficiently allowing quicker model evaluation against data and alternative modeling approaches.			
-Under the Atmospheric Radiation Measurement (ARM) Program 40,004 and the ARM Unmanned Aerial Vehicle (UAV) Program, research aimed at determining the role of clouds in climate change continues to provide new data to the scientific community. The effort to resolve a potentially critical difference between the results of extensive analysis of experimental data and model calculations of short wave absorption will be completed. Operation of the ARM Southern Great Plains (SGP) facility continues, including at least five intensive observational periods. Following its installation, the second atmospheric radiation and cloud station (ARCS) in the Tropical Western Pacific (TWP, first site in Papua New Guinea, second site in Nauru) will begin to yield data; collaborations with Australia and Japan in TWP will commence. Operation of the first polar ARCS (PARCS) in Barrow, AK will begin to yield important climatological data; the second PARCS will be redeployed from the arctic ocean to Atqasuk, AK. A combined UAV/manned aircraft mission over SGP will provide essential data on the radiation budget in cloudy atmosphere to be correlated with measurements of cloud characteristics. Capital equipment funds support the development and maintenance of state-of-the-art equipment		41,169	38,967

at the three ARM sites. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

ENVIRONMENTAL PROCESSES

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
Activities in these areas include research performed through the National Institute of Global Environmental Change (NIGEC).			
Atmospheric Chemistry and Carbon Cycle			
-Research provides atmospheric chemistry data necessary to understand pollutant transport and tropospheric ozone. Analysis of data measured during the prototype megacity (Mexico City, Mexico) air quality study will be completed; meteorological studies affecting pollutant transport will be initiated. The Atmospheric Science program will focus on research needs identified through the North American Research Strategy for Tropospheric Ozone (NARSTO) program, including both ozone and small airborne particulates, and on aerosols. Tools of molecular biology are used to explore linkages between carbon and nitrogen cycles in marine microbes and their relationship to global environmental change processes. Partnerships will be achieved among institutions with the tradition of research in ocean sciences and the emerging research institutions, especially those that have traditionally served under represented minorities, leading to an increased diversification of the scientific work force. Continue measurements of carbon dioxide fluxes between the atmosphere and major terrestrial ecosystems and utilize flux data to test and improve terrestrial carbon process models. Initiate fundamental research to improve understanding of the role microorganisms may play in carbon sequestration (fixation). Continue modeling of terrestrial carbon processes and the potential of terrestrial ecosystems to sequester atmospheric	22,806	22,568	24,879

carbon dioxide. Activities in these areas include research performed through the National Institute for Global Environmental Change (NIGEC). Capital equipment funds in FY 1997 supported field instruments such as those used to measure carbon dioxide fluxes and ozone precursors. Education activities for improving science

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
education for students and faculty in America's schools, colleges and universities are also funded in this program.			
-The December 1997 Kyoto accords include allowances for the role of natural carbon sinks, such as forested areas, in achieving targeted reductions of greenhouse gas emissions. In support of the role of such natural carbon sinks, research activities will focus on the determination of which natural systems of plants, interacting with the components of their native environments, can be induced to increase their net utilization of atmospheric carbon dioxide. Research will include identifying and then optimizing the most important biochemical mechanisms and pathways used by these plants for capture of atmospheric carbon dioxide. This effort is part of the Climate Change Technology Initiative.	0	0	4,000
-One of the major uncertainties of the ocean carbon cycle is the biological role of marine microorganisms in carbon fixation and sequestration. Research activities will include identification of the key pathways by which marine microorganisms enhance carbon flow from the atmosphere to the oceans and ways that these pathways might be enhanced, the mechanisms and role of these microorganisms in sequestering carbon, and their role in carbon transfer from the ocean surface to the deep ocean. This effort is part of the Climate Change Technology Initiative.	0	0	2,000
Ecological Processes			

-Continue experiments to quantify responses of selected temperate forest, 12,635 12,321
12,011
grassland, arid land ecosystems, and agroecosystems to natural and

III.	**Performance Summary - Accomplishments**	**FY 1997**	**FY 1998**	**FY 1999**

human-induced changes in atmospheric composition and climate. Complete initial analysis of (1) forest ecosystem responses to the combined effects of elevated carbon dioxide and ozone, (2) the interactive effects of biodiversity, elevated carbon dioxide and soil nitrogen on a grassland ecosystem, (3) the response of a deciduous forest ecosystem to changes in total precipitation, and the response of a sorghum
agroecosystem to elevated carbon dioxide. Improve understanding of the processes regulating the exchange of water and carbon dioxide between the atmosphere and terrestrial ecosystems.

Continue activities focused on developing a predictive understanding of the interactions and feedbacks between the atmosphere and terrestrial ecosystems. Activities in these areas include research performed through the National Institute for Global Environmental Change (NIGEC). Capital equipment funds were used in FY 1997 to purchase field and laboratory instruments needed to measure biological and ecological responses to the experimental treatments and to quantify natural and experimentally- induced changes in environmental conditions.

Human Interactions

	FY 1997	FY 1998	FY 1999
-Integrated Assessment (IA) framework will be developed, tested, and used to identify priority research needs. IA studies will include a focus on technology innovation and its diffusion into society. The Information and	8,951	8,984	9,158

Integration Program will continue to store, evaluate, and quality-assure a broad range of environmental data relevant to global environmental change research and to disseminate these data to the broad research community; this includes serving as the Quality Systems Science Center for the tri-lateral (United States,

III.	**Performance Summary - Accomplishments**	**FY 1997**	**FY 1998**	**FY 1999**	
	Mexico, Canada) North American Research Strategy for Tropospheric Ozone. Initiate a new education and research program that develops research manpower in environmental process uncertainties. There will be continued support for the inclusion of minority institutions in research-oriented programs. Research performed through the National Institute of Global Environmental Change (NIGEC) includes activities in these areas. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.				
	SBIR/STTR In FY 1997, $2,522,000 and $152,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirements for the continuation of these programs.	0	2,779	3,053	
	TOTAL Environmental Processes		$109,055	$108,400	$119,237

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

ENVIRONMENTAL PROCESSES

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

-Increase to Climate and Hydrology will continue research at approximately the FY 1998 level with increases to Atmospheric Research Measurement and Modeling and will support new activities in advanced simulation.		$+2,388,000
-Increase to Atmospheric Chemistry and Carbon Cycle is attributable to:		
- Support for the ER Climate Change Technology Initiative.	+6,000,000	
- Additional funding for the continuation of modeling of terrestrial +2,210,000 carbon processes.		
-Beginning in FY 1999, this program will budget $38,000 for estimated cost of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+101,000	
-Slight decrease in Ecological Processes will continue programs at FY 1998 level.	-310,000	
Slight increase in Human Interactions will continue programs at FY 1998 level.		+174,000
Change in SBIR/STTR due to increase in operating budget.	+274,000	
Total Change, Environmental Processes	$+10,837,000	

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

ENVIRONMENTAL REMEDIATION
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

The research is primarily focused on gaining a better understanding of the fundamental biological, chemical, geological, and physical processes that must be marshaled for the development and advancement of new, effective, and efficient processes for the remediation and restoration of the Nation's nuclear weapons production sites. Priorities of this research include bioremediation, operation of the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), and the fundamental research in support of the Department's cleanup and environmental missions. Bioremediation activities are centered on the Natural and Accelerated Bioremediation Research (NABIR) program, a basic research program focused on determining the conditions under which bioremediation will be a reliable, efficient, and cost-effective technique. This subprogram also includes basic research in support of pollution prevention and sustainable technology development. It also includes integrated assessment research focused on the technology innovation and diffusion of new technologies for sustainable development. Clean-up research is a research effort to develop information on physical, chemical, and biological processes required for developing advanced, cost-effective technologies and strategies to remediate contaminated environments. Facility operations supports the operation of the EMSL national user facility for basic research that will underpin safe and cost-effective environmental remediation methods and technologies and other environmental priorities.

II. Funding Schedule:

Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Bioremediation Research . .	$20,429	$27,969	$28,039	$+ 70	+0.2%
Clean-Up Research	5,434	7,726	7,746	+ 20	+0.2%
Facility Operations	8,987	29,053	30,072	+1,019	+3.5%
SBIR/STTR	0	1,549	1,578	+ 29	+1.9%
Total, Environmental Remediation	$34,850	$66,297	$67,435	$+1,138	+1.7%

ENVIRONMENTAL REMEDIATION

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
Bioremediation Research			
-Conduct research activities identified in the 10-year plan on bioremediation bioremediation, the Natural and Accelerated Bioremediation Research (NABIR) program. Continue the process of establishing the first NABIR field research center, that will be sited after the completion of the NEPA process. Long-term research, including aspects of the microbial genome program, necessary to identify key microbial communities, biotransformation pathways, and biogeochemical processes to enhance the utility of bioremediation and begin to develop strategies to represent these processes in predictive models. Further development of the program on Bioremediation and Its Societal Implications and Concerns (parallel to the Ethical, Legal, and Social Implications program within the Human Genome Program). New understanding gained of the role of microbes in immobilization (or mobilization) of radionuclides and metals in the subsurface. Identification of key microbial communities for bioremediation and of the impact of spatial heterogeneity on subsurface remediation. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	$14,522	$22,004	$22,059
-General Plant Projects (GPP) funding is for minor new construction, other capital alterations and additions, and for buildings and utility systems. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. This subprogram includes landlord GPP funding for Pacific Northwest National Laboratory (PNNL) and for Oak Ridge Institute for Science and Education (ORISE). The total estimated cost of each GPP project will not exceed $5,000,000.	4,650	4,798	4,811

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
-General Purpose Equipment (GPE) funding for general purpose equipment for PNNL and ORISE.	1,257	1,167	1,169
Clean-Up Research			
-Link fundamental research on the physical, chemical, and geological studies of contaminant transport with related activities in the Office of Science and Technology within the Office of Environmental Management. Acquire data at the William R. Wiley Environmental Molecular Sciences Laboratory and implement results in development of new understandings and technologies necessary to advance environmental remediation. Develop assessment and modeling tools useful for understanding the diffusion of new, sustainable technologies into the economic base.	5,434	7,726	7,746
Facility Operations: William R. Wiley Environmental Molecular Sciences Laboratory (EMSL)			
-EMSL becomes fully operational as a national user facility in FY 1998. Operating funds provide essential maintenance of instruments and associated support facilities at the Laboratory, and technical and ES&H support needed to ensure access to and application of EMSL capabilities by the user community. Includes capital equipment funding to support instrument modifications needed by collaborators and external users of the facility and to maintain the spectroscopic and computer equipment at state-of-the-art.	8,987	29,053	30,072

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

ENVIRONMENTAL REMEDIATION

III. Performance Summary - Accomplishments	**FY 1997**	**FY 1998**	**FY 1999**
SBIR/STTR In FY 1997, $677,000 and $43,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1998 amounts are the estimated requirements for the continuation of these programs.	0	1,549	1,578
TOTAL Environmental Remediation	$34,850	$66,297	$67,435

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

-The Environmental Remediation research program is continued at the FY 1998 level with an increase to Facility Operations.	$+1,109,000
-Change in SBIR/STTR due to increase in operating budget.	+ 29,000
Total Change, Environmental Remediation	$+1,138,000

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

MEDICAL APPLICATIONS AND MEASUREMENT SCIENCE
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

The medical applications subprogram supports research to develop beneficial applications of nuclear and other energy-related technologies for medical diagnosis and treatment. The research develops applications of radiotracer agents for medical research using recent advances in instrumentation as well as in genomics and computational, molecular, and structural biology. A major emphasis is placed on non-invasive diagnostic tools, including imaging technologies such as positron emission tomography. The research in this activity is conducted in five specific areas: Radiopharmaceuticals, Instrumentation, Clinical Feasibility, Boron Neutron Capture Therapy (BNCT), and Molecular Nuclear Medicine.

The measurement science subprogram focuses on research in analytical chemistry to develop new instrumentation, to meet the needs of environmental and life sciences research of the Biological and Environmental Research program and other departmental units. Emphasis is placed on using the advanced technologies developed in the Department's National Laboratories for environmental and biomedical research.
A high priority is given to basic research in instrumentation that will meet needs of the Department’s environmental clean-up program.

II. Funding Schedule:

Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Medical Applications	$49,922	$58,421	$36,925	$-21,496	-36.8%
Measurement Science	6,687	5,797	5,849	+ 52	+ 0.9%
SBIR/STTR	0	1,758	1,137	- 621	-35.3%
Total, Medical Applications & Measurement Science	$56,609	$65,976	$43,911	$-22,065	-33.4%

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

MEDICAL APPLICATIONS AND MEASUREMENT SCIENCE

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
Medical Applications			
-Complete Phase I/Phase II human clinical trials of boron neutron capture therapy (BNCT) at Brookhaven National Laboratory, Massachusetts Institute of Technology and Ohio State University and follow up successful trials with additional clinical trials at higher drug and radiation dosages. Continue to develop collaboration with the National Cancer Institute with latter responsible for advanced clinical trials and DOE responsible for basic research and compound evaluation for BNCT. Capital equipment funds are provided to improve reactor facilities used for early clinical trials of BNCT and to develop new accelerator-based facilities for this purpose.	$10,917	$12,348	$10,031
-Develop new approaches to radiopharmaceutical design and synthesis using genome sequencing information, combinatorial chemistry and computational modeling concepts. Initiate major effort to gain understanding of role of functional genomics in health and disease through development of new concepts in the use of multiple radioisotope tracers to study physiological processes. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.	19,809	17,151	20,334
-Multimodal imaging systems for studies of human brain function in normal and diseased states lead to new applications of imaging and laser technology for medical practice. Capital equipment funds are provided in support of	5,038	5,339	6,199

research into new imaging techniques in nuclear medicine and for instrumentation needed for development of new detectors for medical isotopes. Education

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.			
-Complete research on phase-out of new radioisotopes for nuclear medicine applications.	0	2,800	911
-Funding for Indiana School of Medicine and Oregon Health Sciences University, as included in Congressional direction for FY 1997. Funding for these projects is completed in FY 1997.	12,585	0	0
-Funding for the Medical University of South Carolina, Loma Linda, Rochester Center, Englewood Hospital in New Jersey, Highlands University of New Mexico, University of Nevada, Las Vegas, and University of California, Davis, as included in Congressional direction for FY 1998. Funding for these projects is completed in FY 1998.	0	21,806	0
<u>Measurement Science</u>			
-Continue research on laser instrumentation for environmental and life sciences applications. Follow up successful projects in the EM/ER Pilot Collaborative Research program to develop instrumentation for analytical chemistry applications at the Department’s environmental cleanup sites. Capital equipment funds are provided for components needed for research into new instrumentation.	5,307	5,797	5,849

III. Performance Summary - Accomplishments	FY 1997	FY 1998	FY 1999
-Facility modifications and improvements are necessary to ensure continued safe operation and reliability of accelerators, reactors, and other existing BER-related facilities. This program is being discontinued after FY 1997.	0	1,380	0
SBIR/STTR In FY 1997, $1,375,000 and $83,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirements for the continuation of these programs.	0	1,758	1,137
TOTAL Medical Applications and Measurement Science	$56,609	$65,976	$43,911

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

-Decrease in Medical Applications is attributable to:

- The completion of Congressionally directed projects. $-21,806,000
- Remaining research within the program continues approximately at the FY 1998 level with the exception of the radioisotope development program which has become mature and will be phased out in FY 1999. The availability of existing well-characterized radioisotopes allows this shift in priorities and increased support for the radiopharmaceutical program. +310,000

-Measurement Sciences continues at the FY 1998 level. +52,000

-SBIR/STTR decrease due to reduction in research funding.

-621,000

Total Medical Applications and Measurement Science $-22,065,000

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

CONSTRUCTION
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives:

Construction is needed to support research under the Biological and Environmental Research program. Cutting-edge basic research requires that state-of-the-art facilities be built or existing facilities modified to meet unique BER requirements.

II. Funding Schedule:

Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Construction	$36,113	$ 0	$ 0	$ 0	-------
Total	$36,113	$ 0	$ 0	$ 0	-------

III. Performance Summary- Accomplishments

	FY 1997	FY 1998	FY 1999
-Completed funding for construction of the Environmental Molecular $0 Sciences Laboratory at PNNL in FY 1997.		$35,113	$0
-Completed funding for construction of the Human Genome Laboratory at LBNL in FY 1997.	1,000	0	0
TOTAL Construction	$36,113	$0	$0

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

None.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH
CAPITAL OPERATING EXPENSES AND CONSTRUCTION SUMMARY
(Dollars in thousands)

	FY 1997	FY 1998	FY 1999	$ Change	% Change
Capital Operating Expenses					
General Plant Projects (total)......................................	$4,650	$4,811	$4,811	$0	----
Facility Modifications and Improvements (total).........	1,380	0	0	0	----
Capital Equipment (total)...	17,189	18,763	20,150	1,387	7.4%

Construction Project Summary (both Operating and Construction Funded)

Project No.	Project Title	TEC	Previous Appropriated	FY 1997 Appropriated	FY 1998 Appropriated	FY 1999 Request	Unapprop. Balance
94-E-339	Human Genome Laboratory, LBNL	$24,634	$23,634	$1,000	$0	$0	$0
91-EM-100	Environmental Molecular Sciences Lab.,	207,900	172,787	35,113	0	0	0
Total Biological and Environmental Research		XXXXXX	$196,421	$36,113	$0	$0	$0

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
SCIENCE
(Tabular dollars in thousands, Narrative in whole dollars)

BASIC ENERGY SCIENCES

PROGRAM MISSION

The MISSION of the Basic Energy Sciences (BES) program is to foster and support fundamental research in the natural sciences and engineering leading to new and improved energy technologies and to understanding and mitigating the environmental impacts of energy technologies. As part of its mission, BES plans, constructs, and operates major scientific user facilities to serve researchers at universities, national laboratories, and industrial laboratories.

The GOALS of the BES program are:

1. To maintain U.S. world leadership in those areas of the natural sciences and engineering that are relevant to energy resources, production, conversion, and efficiency and to the mitigation of the adverse impacts of energy production and use;

2. To foster and support the discovery, dissemination, and integration of the results of fundamental, innovative research in these areas;

3. To provide world-class scientific user facilities for the Nation; and

4. To act as a steward of human resources, essential scientific disciplines, institutions, and premier scientific user facilities.

The OBJECTIVES related to these goals are:

1. Obtain major new fundamental knowledge. -- Foster and support fundamental, innovative, peer-reviewed research to create new scientific and engineering knowledge in areas important to the BES mission, i.e., in materials sciences, chemical sciences, geosciences, plant and microbial biosciences, and engineering sciences.

2. Support the missions of the Department of Energy (DOE). -- Promote the transfer of the results of basic research to contribute to DOE missions in areas of energy efficiency, renewable energy resources, improved use of fossil fuels, reduced environmental impacts of energy production and use, science-based stockpile stewardship, and future fusion energy sources by using established management practices to link BES staff and BES-supported principal investigators with their counterparts in the energy technology offices and in industry. Such practices include, for example, cofunding and collocating basic research programs supported by BES with applied research programs supported by the technology offices at the DOE laboratories and the initiation in FY 1999 of the Partnerships for Academic-Industrial Research (PAIR) Program, which will link basic researchers in academia with those in industry.

3. Plan, construct, and operate premier national scientific user facilities to serve researchers at universities, national laboratories, and industrial laboratories, thus enabling the acquisition of new scientific knowledge. These scientific facilities include synchrotron radiation light sources, high-flux neutron sources, electron-beam microcharacterization centers, and specialized facilities such as the Combustion Research Facility. In addition, to encourage the use of these facilities in areas important to BES activities and also in areas that extend beyond the scope of BES activities, such as structural biology, environmental science, medical imaging, rational drug design, micromachining, and industrial technologies.

4. Establish and maintain stable, essential research communities, institutions, and scientific user facilities. -- Steward important research communities and institutions to respond quickly and appropriately to mission need and scientific opportunity. For example, BES serves as the Nation's primary or sole supporter of such important subdisciplines as heavy element chemistry, natural and artificial solar energy conversion, catalysis, organometallic chemistry, combustion related science, separations science, neutron science, radiation chemistry, and radiation effects in materials.

PROGRAM MISSION - BASIC ENERGY SCIENCES - (Cont'd)

PERFORMANCE MEASURES:

BES is prototypical of a large, diverse, and robust basic research program that exists within a mission agency. BES measures performance in four areas that together characterize this special role. The first three areas relate to the fundamental tenets or principles of BES, which correspond directly to the goals described above. These tenets are: (1) excellence in basic research [Goal 1], (2) relevance to the comprehensive energy mission of the agency [Goal 2]; and (3) stewardship of research performers, essential scientific disciplines, institutions, and scientific user facilities [Goals 3 and 4]. Combining and sustaining these tenets are the management challenge of BES. The fourth area to be evaluated, therefore, is program management.

Activities in these four areas are measured in a number of ways, which separate naturally into four categories: (1) peer review, (2) indicators or metrics (i.e., things that can be counted), (3) customer evaluation and stakeholder input, and (4) qualitative assessments, which might include historical retrospectives and annual program highlights.

A number of activities that might be considered essential or "foundation" performance measurement activities are already in place in BES; indeed, some have been ongoing for many years. These include, for example, peer review of research programs and customer surveys of the scientific user facilities. However, literally dozens of other activities and indicators can be envisioned for inclusion in the matrix. An important management challenge is choosing a few significant items to target for special attention. Different activities and indicators may be targeted in successive years. In this way, a balanced system of performance measurement will evolve. For the next few years, BES will select a few activities each year that address different aspects of performance measurement and that, taken together with ongoing activities, will strengthen performance measurement.

During FY 1997, BES began two activities designed to strengthen and formalize performance measurement in the future. These were (1) codification of the peer review process for research at the DOE laboratories using a process analogous to that described in 10 CFR 605 for the university grant program and (2) development of a major new survey tool for the scientific user facilities in collaboration with the facility directors and the facility user coordinators. In addition, BES conducted a number of other activities related to performance and to the management of basic research programs including (3) initiation of a Basic Energy Sciences Advisory Committee (BESAC) review of the BES synchrotron radiation light sources; (4) initiation of a BESAC assessment of neutron science following the events at the High Flux Beam Reactor at Brookhaven National Laboratory; (5) project management reviews of two ongoing construction projects -- the joint ER/Defense Programs enhancement of the Los Alamos Neutron Science Center short pulse spallation source and the Conceptual Design Report of the

Spallation Neutron Source; (6) sponsorship of a number of workshops to assess the frontiers of research in areas of interest to BES; (7) development of new ways to increase the number of Small Business Innovation Research (SBIR) topics promoted by BES; (8) initiation of a pilot study to assess the culture that promotes excellence in basic research at the DOE laboratories; (9) continuation of a grant to assess the impacts on industry of basic research; and (10) publication of several overview brochures aimed at general audiences providing historical retrospectives, program highlights, and descriptions of the impacts of basic research on U.S. industry.

During FY 1998, BES will (1) institute the formalized peer review process for activities at the DOE laboratories using the process developed in FY 1997, (2) establish baselines for all performance indicators for each scientific user facility using the survey tool established in FY 1997, and (3) begin peer review of the operating scientific user facilities. In addition, in order to formalize other processes for implementation in FY 1999, BES will in FY 1998 (4) determine a set of performance indicators that will be collected annually from investigators in the grant program and the DOE laboratory system; and (5) review the implementation of the criteria of the merit review system.

In FY 1999, BES will initiate construction of the Spallation Neutron Source, which will be a world-class facility used to provide beams of neutrons to probe and understand the physical, chemical, and biological properties of materials at an atomic level. In addition, (1) the development and upgrade of scientific user facilities will be kept on schedule and within cost, not to exceed 110 percent of estimates; (2) the operating time lost at scientific user facilities due to unscheduled downtime will be less than 10 percent of the total scheduled possible operating time, on average; (3) all research projects will undergo regular peer review and merit evaluation based on procedures set down in 10CFR 605 for the extramural grant program and in a modification of 10CFR 605 for the laboratory programs and scientific user facilities;
(4) new projects will be selected by peer review and merit evaluation; and (5) work performed by investigators in universities and DOE laboratories will continue to be recognized as outstanding through the receipt of major prizes and awards.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

The BES program is one of the Nation's major sponsors of fundamental research in broad areas of materials sciences, chemical sciences, geosciences, biosciences, and engineering sciences. The program encompasses more than 2,400 researchers in 200 institutions and several of the Nation's premier user facilities. Presented below are program accomplishments from FY 1997 including selected prizes, awards, and honors bestowed on BES principal investigators during that period and selected highlights from the scientific programs. The selected program highlights are representative of the broad range of studies supported in the BES program. These highlights demonstrate the discovery of new knowledge, the rapidity with which such new knowledge can often be incorporated into the commercial sector, and the great potential of new knowledge for future impacts in energy production and use. Following that are discussions of scientific facilities, two

FY 1999 initiatives that will be funded with existing funds using the normal turnover in proposals, and a new program in carbon emissions management.

PROGRAM MISSION - BASIC ENERGY SCIENCES - (Cont'd)

Prizes, Awards, and Honors

- Annually, principal investigators funded by BES win dozens of major prizes and awards sponsored by professional societies and by others; in addition, many are elected to fellowship in organizations such as the National Academy of Sciences, the National Academy of Engineering, and the major scientific professional societies. Paramount among the honors in FY 1997 were Nobel Prizes. The Nobel Prize in Chemistry for 1996 was awarded to Richard E. Smalley (Rice University), Robert F. Curl (Rice University), and Sir Harold Kroto (University of Sussex) for their discovery of buckminsterfullerene, C_{60}. Richard Smalley was supported by BES for the work that led to the discovery of C_{60}, and Robert Curl has long been supported by BES for work in infrared spectroscopy. The Nobel Prize in Chemistry for 1997 was awarded to three biochemists, Paul D. Boyer (University of California at Los Angeles), John E. Walker (Medical Research Council Laboratory of Molecular Biology of Cambridge, England) and Jens C. Skou (Aarhus University in Denmark). Drs. Boyer and Walker were cited for their elucidation of the enzymatic mechanism underlying the synthesis of adenosine triphosphate (ATP). Dr. Boyer's work was supported in part by the BES Energy Biosciences subprogram and its predecessor organizations from 1963 until his retirement in 1993. These are the third and fourth Nobel Prizes awarded to BES principal investigators in the past four years.

Other selected major prizes and awards include:

From ACTA Metallurgica -- the Gold Medal

From the American Ceramic Society -- the James I. Mueller Memorial Award; the Edward Orton, Jr. Memorial Lecture; the George W. Morey Award

From the American Chemical Society -- the Arthur W. Adamson Award for Distinguished Service in the Advancement of Surface Chemistry; the Award for Distinguished Service in the Advancement of Inorganic Chemistry; the Award in Analytical Chemistry; the Award in Spectrochemical Analysis; the Award in the Chemistry of Materials; the Berlinger Award; the E. V. Murphree Award in Industrial and Engineering Chemistry; the Henry Award; the James Van Lanen Award for Distinguished Service to the Biochemical Technology Division; the Ralph K. Iler Award in the Chemistry of Colloidal Materials; the Remsen Award; the Award in Chromotography; the Irving Langmuir Award in Chemical Physics

From the American Crystallographic Association -- the Bertram E. Warren Award

From the American Physical Society -- the Arthur L. Schawlow Prize in Laser Science; the Award for Outstanding Doctoral Thesis Research in Atomic, Molecular, or Optical Physics; the High Polymer Physics Prize; the Oliver E. Buckley Prize in Condensed Matter Physics; Nottingham Prize for Outstanding Graduate Thesis in the Surface Science; the Earl K. Plyer Prize in Molecular Spectroscopy

From the American Society for Mass Spectrometry -- the Biemann Award in Mass Spectrometry

From the American Society of Plant Physiologists -- the Charles Albert Shull Award; the Martin Gibbs Medal; the Dennis Robert Hoagland Award

From the American Vacuum Society -- the Peter Mark Award; the George T. Hanyo Award; the Medard W. Welch Award

From the American Welding Society -- the Charles H. Jennings Memorial Award

From the ASM International -- the Henry Marion Howe Medal

From the Australian Society of Electron Microscopy -- the President’s Award

From the Electrochemical Society -- the Edward Goodrich Acheson Medal; the Olin Palladium Award

From the Geological Society of America -- the Arthur L. Day Medal for Outstanding Contributions to Geosciences Research; the Distinguished Service Award in Hydrogeology; the O. E. Meinzer Award for Hydrogeological Research

From the Institute of Electrical and Electronic Engineers -- the Magnetics Society Distinguished Lecturer; the Quantum Electronics Award

From the Institute of Materials -- the Elegant Work Prize

From the Inter-American Photochemical Society -- the Award in Photochemistry

From the International Society of Electrochemistry -- Prix Jacques Tacussel Award

From the International Union of Pure and Applied Chemistry -- the Rossini Lectureship Award

PROGRAM MISSION - BASIC ENERGY SCIENCES - (Cont’d)

From the International Union of Pure and Applied Physics -- the Magnetism Award

From the Materials Research Society -- the von Hippel Award

From the Mineralogical Society of America -- the Mineralogical Society of America Award; the Harley Award

From the Minerals, Metals, and Materials Society (TMS) -- the Educator Award; the Leadership Award; the Structural Materials Distinguished Materials Scientist/Engineer Award; the Robert Lansing Hardy Award

From the North American Catalysis Society -- the Paul H. Emmett Award

From the Optical Society of America -- the Adolph Lomb Medal

From the Royal Society of Chemistry -- the Centenary Lectureship; the Structural Chemistry Award

From the Society of Analytical Chemistry -- the Robert Boyle Award

From the Society of Electroanalytical Chemistry -- the Charles N. Reilley Award

From the Society of Polymer Science (Japan) -- the Distinguished Service in Advancement of Polymer Science Award

Finally, two principal investigators received the President's National Medal of Science; two received the E. O. Lawrence Award; ten were inducted into the National Academy of Sciences; and five were inducted into the National Academy of Engineering.

Selected FY 1997 Scientific Highlights/Accomplishments

- <u>The 1997 Nobel Prize in Chemistry</u>. Dr. Paul D. Boyer shared in the 1997 Nobel Prize in Chemistry for "elucidation of the enzymatic mechanism underlying the synthesis of adenosine triphosphate (ATP)." The energy cycle of all biological organisms involves the central molecule, ATP. The energy captured from photosynthesis or released from respiration is converted into ATP where it is used for maintenance of cells, synthesis of cellular components, and other energy-requiring processes such as movement. ATP is frequently referred to as the "energy currency" of the cell. The enzyme responsible for the synthesis is ATP synthase. Dr. Boyer's work examined the detailed chemical reactions involved in this synthesis and the roles specific parts of the ATP synthase molecule played in the overall synthesis. Dr. Boyer's work on the synthesis of ATP was supported in part by the Division of Energy Biosciences of the Office of Basic Energy Sciences and its predecessor organizations from 1963 until 1993 under a project entitled "Energy Capture and Use in Plants and Bacteria" to the University of California at Los Angeles.

- The Advanced Photon Source (APS) Completes Its First Year of Operation. As the floor of the APS became crowded with experimental hutches, new results emerged that took advantage of the very high brightness of this new light source and that could not have been done elsewhere. While much of the work at the APS and the other BES synchrotron radiation light sources has been and will continue to be in the area of materials sciences and condensed matter physics, many studies are also being done in the areas of biological, plant, environmental, and geosciences. For example,

  - A new structural determination and biochemical analysis of the human fragile histidine triad (FHIT) protein has been performed. The FHIT protein derives from a fragile site on human chromosome 3 that is commonly disrupted in association with cancers. The understanding of this tumor suppressor protein will focus on a diverse human HIT family member in search of their in vivo function throughout biology.

  - The first experiments were conducted with a newly constructed beamline for geosciences/soil/environmental research. Molecular-scale observations (made possible by the high brightness of the APS) enable new understanding of local structural and chemical changes that govern the mechanisms of mineral-fluid interactions. For example, the molecular form or speciation of environmental contaminants, such as chromium, arsenic, lead, uranium or plutonium, determines their toxicity and bioavailability.

  - Over 90% of the world's plants, including essentially all crops, make use of symbiotic associations with fungi. X-ray imaging studies performed on these systems using an x-ray microprobe have provided detailed information on the elemental distribution in plant roots and associated fungi. These images, with unprecedented spatial resolution, will be a key to understanding the symbiosis between the plant roots and fungi.

- New Sensor Provides Instant Litmus Test for Pathogens. A new class of colorimetric sensor materials has been invented that makes it possible to instantaneously and inexpensively detect a wide range of biological toxins and common disease-causing organisms. Building on earlier discoveries, researchers have developed a thin film consisting of receptor molecules attached to a film of linked diacetylene molecules. The film transmits blue light. The surface receptor molecules are designed to very selectively bind specific pathogens causing the film molecules to reorganize and the film to turn red. Pathogens thus far detected with good sensitivity include an influenza virus, cholera toxin, botulism toxin, and the toxin produced by the bacteria responsible for 200 deaths per year in the US alone, as noted by the recent contamination of fruit drinks and fast food hamburgers. Existing tests for all of these pathogens require at least a 24 hour culture. After further development, the sensors can be placed on plastic, paper, or glass and incorporated into inexpensive packaging and portable detection devices.

- Joint Program Results in a New "Smart" Window. Windows with reduced transmission have been shown to be energy savers by reflecting some of the heat from solar radiation. However, such windows have fixed transmission that also reduces visible light. On a cloudy day a building or home equipped with such windows may not have adequate natural lighting. Research jointly supported by BES and the Department’s Energy Efficiency program has led to the initial development of a self-powered "smart" window that can control its own transparency. Integration of two technologies, electrochromic windows and dye-sensitized solar cells, yields a smart window that darkens, reversibly, when exposed to sunlight.

- Powder Process Produces Cheaper Stronger Permanent Magnets. A collaborative team from two laboratories is a recipient of a prestigious R&D 100 Award for the processing of nanocrystalline composite powder for high-strength, permanent magnets. The permanent magnet industry is a very large global industry worth 3.2 billion dollars in 1995 and is predicted to reach 10 billion dollars by 2010. The high magnetic strength of the prize-winning neodynium-iron-boron 'super magnets' results from matching the crystallite size formed on cooling the alloy from the melt to the size of the magnetic domains. The previously used rapid cooling process that creates the fine-grained polycrystalline material is too expensive for many commercial magnet applications. It was discovered that adding titanium and carbon to the molten alloy allows a spray atomization process to create appropriately sized particles that can be consolidated into magnetic compacts.

- Fast-Transport Predicted in Subsurface Fluids. Underground flow properties of fluids containing two or more components (oil(s)/water) are a major issue for environmental remediation. New experimental work documents how upward and downward flow of different fluids can be driven by differences in their density and their tendency to diffuse. Such transport occurs much more rapidly than has been predicted by earlier models. This new research developed innovative experimental methods to test the earlier predictions, and successfully measured and modeled the effects of multiphase flow in simple porous materials.   This work is a significant step towards developing improved models to make better predictions for complex and highly variable natural subsurface environments.

- Breakthrough in Processing of Aerogel Films. A breakthrough in the processing of ceramic aerogel films won a prestigious award of the American Chemical Society and was cited as an important discovery by the Wall Street Journal. This breakthrough overcame the sixty year barrier to the large scale commercial utilization of these films. Aerogel films have a foam-like structure, exceptional lightness and transparency, and are ideal insulating materials for double-paned windows and other uses. When freshly formed from a liquid, the film can be easy torn until it has been hardened. Older processes required a toxic liquid and high pressure and temperature to dry the films. Employing a new understanding of film drying and chemical treatment of the surfaces of the pores in the film, a non-toxic, low-pressure and temperature process was developed to keep the film flexible and resilient as it formed.

- Silicon in Biology. Silicon is an element that is a principal component of glass, computer chips, coatings and numerous consumer products. There are only a few biological systems that metabolize this element. Silicon is metabolized by some simple animals, by algae to make the equivalent of glass houses, and by some higher plants (the rough feel of corn leaves comes from chards of silicates in the leaves). Recently a gene was identified that encodes a protein that is involved in binding and transporting silicon into a cell. This discovery will extend our understanding of how silicon is taken up and processed by biological systems which may lead to applications such as the mining of silicon from seawater and the manufacture of silicon-containing products.

- Cool Sounds. Air conditioning from your favorite music? Not quite yet. However, sound, or acoustic energy, has now been used to make refrigerating and heating units. These devices, called thermoacoustic refrigerators, or thermoacoustic engines when operated in a heating mode, have no moving parts and use sound waves in air or helium to transfer heat. Operation of these devices has been based upon a standing acoustic wave in a closed system, limiting their usage. Now, a radically new concept has been devised in which the air or helium would flow slowly through the device during operation. This concept would allow for heating and cooling of buildings and for other industrial air conditioning applications with an economic advantage over current technology through the elimination of the bulky heat exchangers on building roofs. First results from a test system operating as a refrigerator using helium or air have confirmed the concept. Further developments of this concept are under way.

- New Graphite Nanofibers Store Hydrogen. A new nano-phase graphitic material capable of absorbing three grams of hydrogen for each gram of carbon has been discovered by researchers studying catalyst deactivation. The origins of this material are found in studies of metal particle fracturing that occurs during Fischer-Tropsch catalysis. The graphitic microstructure of the fibers is such as to allow hydrogen to fit within the interplanar space between aligned graphitic planes. The development of synthetic routes to these new nanomaterials have been awarded a patent. Although it is not yet understood how these nanofibers absorb such a large volume of hydrogen (about 32 liters of hydrogen per gram at ambient conditions), the discovery is potentially very significant to hydrogen storage technology and perhaps also to storage of other small gases.

- Slick and Sticky. Pencil-shaped organic molecules called "rod-coils," designed and synthesized to have half of the molecule rigid and the other half flexible, were discovered to exhibit unusual and important clustering mechanisms on several size scales. Aggregates of these molecules self-assemble into mushroom-shaped clusters with the rigid ends forming the stems and the flexible coils forming the caps. At the next level of organization, the mushroom clusters pack side by side into layered sheets to form, ultimately, a thick film. Because the building-block molecules are all oriented in the same direction, the film's properties mirror those of the individual molecules, resulting in a film whose bottom surface is sticky and top surface is slippery. Such a film has many potential applications, for example as an anti-ice coating on an airplane wing or an anti-blood-clot lining for artificial blood vessels. This new molecular organizational technique is being explored to make films with other properties by replacing the slippery and sticky groups capping the rodcoils with compounds that perform other functions, such as conducting electricity or changing their size in response to an electrical pulse.

- Controlling Natural Energy Resources through Plant Genetic Engineering. Cellulose is the most prevalent biological compound on earth. It is the principal component of all plants, wood, paper and cotton. When considered globally, cellulose constitutes an enormous supply of chemical energy, all of it renewable. Recently, several plants have been manipulated to make significantly less cellulose. This modification is important because it may now permit identification of the factors that control the synthesis and deposition of cellulose and related compounds. This development may permit the genetic engineering of plants to produce either more cellulose, or plants that produce larger amounts of other chemicals such as liquid fuels and plastics.

- New Process Forms Diamond-Like Boron Nitride Films. A process to grow diamond-like boron nitride films, the second hardest material known, has been discovered based on a new understanding of how hard nitride films are formed. Like diamond, films of boron nitride can be grown from hot gases and plasmas without the use of high pressures. However, it was recently discovered that irradiation of boron nitride films with low-energy ion beams will produce films of boron nitride that contain the hard, diamond-like form rather than the soft graphite-like form. This new process to form ultra-hard boron nitride films could revolutionize the tool industry, because, unlike diamond, boron nitride does not react with iron or steel; therefore, boron nitride is an ideal material for cutting tools.

- "Green" Separation Process for Hanford Wastes. The radioactive components in the Hanford waste tanks comprise a mere 1/100th of a percent of the millions of gallons of contaminated waste in storage. Thus, highly selective removal of the radioactive components could significantly reduce the volume of waste which will require very costly processing and long-term storage. Fundamental studies of technetium extraction in the 1980s, followed by more recent investigations of the structural and thermodynamic aspects of the extraction of alkali metal salts with crown ethers has led to a new technetium extraction process. The crown ether binds sodium ions already present in the waste, and then extracts technetium as much as four orders of magnitude better than others ions in the waste, such as nitrate, which are present at much higher concentrations. The crown ether complex is readily decomposed by contact with water to release the extracted technetium thereby affording a convenient, safe, and economical stripping method. The crown ether is then recycled thus minimizing secondary waste production.

- New Metallocene Catalysts Lead to Commercial Applications. The new family of metallocene polymerization catalysts, in which polymerization occurs principally at a single type of metal center with a well-defined coordination environment, are a substantial advance over the prior heterogeneous polymerization catalysts. Recent advances on two fronts -- strained early transition metals and non-coordinating counterions -- have resulted in new commercial applications by Dow Chemical and by Exxon Chemical. The remarkable stereospecificity features of these new catalysts have not only led to a variety of new, advanced polymer products over a wide range of densities, but they also provide the ability to "turn a microscope on" the underlying molecular mechanisms, thus leading to continually improved catalysts and products. The new polymers produced from these catalysts are found in wide-ranging applications from food wrapping to the plastic front end front bumper combinations on automobiles. The impact of these new products can be imagined from the Dow Insite process which produces plastics with a market of about $2,000,000,000 per year at Dow's Texas plant.

- A Microscopic Understanding of Materials Joining Enables the Intelligent Processing of Materials. Welding is a critical fabrication technology used extensively in a wide variety of industries such as energy, automotive, construction, aerospace, shipbuilding, and electronics. Weld failures are among the most common reason for unscheduled outages in power plants with the cost of replacement power often exceeding $1,000,000 per day. Recent advances in materials joining science have improved our understanding of the welding process and welded materials. With the help of massively parallel computers, complex physical models that link both macro- and microscopic scale phenomena during the melting and solidification of a weld have been developed. Using such models it is now possible to visualize directly the solidified weld microstructure for a given set of processing conditions. The resulting knowledge has been transferred to industry thereby allowing the intelligent processing of defect-free, structurally sound and reliable welds.

- Magnetic Refrigeration to Eliminate Harmful Freon. Conventional air conditioning of domestic and commercial buildings, and cooling in food processing and other industrial plants requires enormous quantities of electricity and uses huge amounts of environmentally harmful chlorofluorocarbons (CFCs). Magnetic refrigeration uses the magneto-caloric effect, the ability of a magnetic material to raise its temperature upon application of a magnetic field and to lower it upon removal of that field. For many years the alloys showing this effect operated only at impractically low temperatures. New understanding of thermal and magnetic behavior uncovered a gadolinium-silicon-germanium alloy that cools efficiently near room temperature. Refrigerator devices based on magneto-caloric material could cut energy costs and eliminate ozone-depleting CFCs.

- Bioproduction of Natural Gas**.** The few microorganisms that possess the ability to produce methane (natural gas) have been studied for a number of years in the hope of using these organisms to produce a renewable energy source. Last year the genome of a methane-producing bacterium was sequenced which showed the uniqueness of these organisms. It is now thought that these bacteria are among the first life forms ever developed on earth. Recently, procedures have been developed which will permit the genes of methane-producing bacteria to be manipulated. This development will allow scientists to determine the nature and properties of these organisms and their unusual metabolism.

- Materials Failure in a Radiation Environment. The safe storage of nuclear materials and radioactive wastes is a major challenge for the post cold-war generation. The long term effects of radiation on the physical integrity of these materials and their containers is still poorly understood. Recent work using simultaneous electron microscopy and ion irradiation experiments shows that the impact of just a single high energy ion on the surface of a material has a much greater effect than previously realized and disrupts tens of thousands of atoms near the surface of the material. The impact causes local melting, displacement of many atoms beneath the surface, and the formation of surface craters and holes. This work should lead to a correct understanding of how materials are damaged by radiation and will help explain and predict the behavior of materials used for waste storage and other applications.

Scientific Facilities Utilization

The BES program request includes $317,012,000 to maintain support of the scientific user facilities. This funding includes increases for the synchrotron radiation light sources and for the neutron scattering facilities to adjust for increased cost-of-living expenses. In addition, in accord with the highest recommendations of the Basic Energy Sciences Advisory Committee Panel on Synchrotron Radiation Sources and Science (the Birgeneau Panel), additional funds are provided to the National Synchrotron Light Source for increased support for users and to the light source community for instrumentation and beamline construction at the light sources; the latter funds will be allocated via peer review. Research and development on the Spallation Neutron Source (SNS) is also increased and included in facility operations. Prior to

FY 1999, SNS research and development was funded in Materials Sciences Research. Finally, increased research activities are planned for the Combustion Research Facility, which will complete construction of Phase II in FY 1999. These increases were made possible because, in FY 1999, all funds associated with the SNS were added as an increment above the base program. Research communities that have benefitted from the BES supported Scientific Facilities Initiative include materials sciences, chemical sciences, earth and geosciences, environmental sciences, structural biology, superconductor technology, medical research, and industrial technology development. More detailed description of funding for specific facilities are given in the subprogram narratives and in the section entitled "Major User Facilities."

Spallation Neutron Source (SNS) Project

FY 1999 funding of $157,000,000 is requested for the Spallation Neutron Source (SNS) Project to begin Title I design activities, initiate subcontracts and long-lead procurements, and continue critical research and development work necessary to reduce technical and schedule risks. The importance of neutron science for fundamental discoveries and technological development is universally acknowledged. The scientific justification and need for a new neutron source and instrumentation in the U.S. have been thoroughly established by numerous studies by the scientific community since the 1970s. These include the 1984 National Research Council study "Major Facilities for Materials Research and Related Disciplines" (the Seitz-Eastman Report), which recommended the immediate start of the design of both a steady-state source and an accelerator-based pulsed spallation source. More recently, the 1993 DOE Basic Energy Sciences Advisory Committee (BESAC) report "Neutron Sources for America's Future" (the Kohn Panel Report) again included construction of a new pulsed spallation source with SNS capabilities among its highest priorities. This conclusion was even more strongly reaffirmed by the 1996 BESAC Report (the Russell Panel Report), which recommended the construction of a 1 MW spallation source that could be upgraded to significantly higher powers in the future. The purpose of the SNS Project is to provide a next-generation short-pulse spallation neutron source for neutron scattering and related research in broad areas of the physical, chemical, materials, biological, and medical sciences. The SNS will be a national facility with an open user policy attractive to scientists from universities, industries, and federal laboratories. It is anticipated that the facility will be used by 1,000-2,000 scientists and engineers each year and that it will meet the national need for neutron science capabilities well into the next century. The conceptual design of the SNS -- which was an interlaboratory effort involving Lawrence Berkeley National Laboratory in the ion source, Los Alamos National Laboratory in the linear accelerator, Brookhaven National Laboratory in the accumulator ring, and Argonne National Laboratory in targets and moderators -- was completed in June of 1997. The design conforms to the recommendations of the Russell Panel Report. The power will be in the 1 megawatt range or about six times that of the highest currently available worldwide, and the design will allow for significantly higher powers at a later stage. The design will further include moderators for neutrons with appropriate spectral and temporal characteristics in the epithermal, thermal, and cold energy ranges. There will be the potential for at least three target areas and for 30 to 40 instruments. Agreements are in place with Rutherford Appleton Laboratory (England) and the European Spallation Source project to allow joint research and development. Furthermore, a Working Group on Neutron Sources has been established under the Megascience Forum of the Organization for Economic Cooperation and Development. A Steering Committee has been formed, consisting of distinguished members of the neutron science community, to provide input on instrumentation and on user needs. Finally, key management positions have been filled and the development of the project Cost Schedule Control System is proceeding as planned. Additional information on the SNS project is provided in the SNS construction project data sheet, project number 99-E-334.

Neutron Science Activities

Facility Enhancements

BES will continue to support the ongoing enhancements of existing reactor and spallation neutron sources and will proceed with the construction of the Spallation Neutron Source (SNS). (1) Fabrication of instrumentation will continue for the short-pulse spallation source at the Manuel Lujan Jr. Neutron Scattering Center at the Los Alamos Neutron Science Center (LANSCE). This instrumentation enhancement project was undertaken concurrently with an accelerator enhancement project funded by the Department's Office of Defense Programs. Together, these enhancements will result in a state-of-the-art, short-pulse spallation source facility for neutron scattering, radiography, and science-based stockpile stewardship. (2) The beryllium reflector at the High Flux Isotope Reactor at Oak Ridge National Laboratory is scheduled to be changed in FY 1999. This is a scheduled maintenance operation, that addresses the normal lifetime limitations of the beryllium reflector. The reflector will exceed its projected operating life in November 1999. At the time of the beryllium reflector replacement, certain improvements will be made to the beam tubes and monochromators. These improvements will significantly increase the thermal neutron flux to the instruments. This work was initiated in FY 1998 and will be completed in FY 2000.

FY 1999 Initiatives

- **The Partnerships for Academic-Industrial Research (PAIR) Program will be initiated at a funding level of $1,500,000.** This program is designed to encourage and facilitate research partnerships between academic researchers, their students, and industrial researchers. Funding for the PAIR program will be derived from normal turnover of university and DOE laboratory programs. The BES program, through support of basic research that is collocated with applied research at the DOE laboratories, has had considerable opportunity to observe that both basic and applied researchers contribute to problem definition, discovery, and understanding and that the transition from discovery to development and deployment is not a linear process. The PAIR program seeks to encourage similar interactions between basic and applied researchers in academia and industry. The PAIR program will be initiated in FY 1999 as an experiment to strengthen the linkages between academic and industrial researchers during a time when industry is restructuring its own research programs to address focused corporate needs.

Additionally, the PAIR program is intended to encourage universities to consider novel research activities and to encourage faculty participation in nontraditional partnerships, which may have been discouraged in the past. The PAIR program encompasses the entire range of research supported by the BES program. Grants will be awarded on the basis of competitive peer review to university researchers for support of work that is jointly defined by the academic and industrial research partners and that supports a student or postdoctoral fellow from the university who will spend time in the industrial setting.

- **A program in Complex and Collective Phenomena will be initiated at a funding level of $3,000,000.** Much of the research supported by the BES program and its predecessor organizations during the past 50 years has been devoted to solving very difficult problems in idealized, simple systems. The challenge now is to use that knowledge to understand complex systems. This initiative will support work at the frontiers of basic research. Work is intended to be revolutionary rather than evolutionary, and it is expected that it may involve multidisciplinary and/or interdisciplinary efforts. Further it is expected to bridge the gap between an atomic level understanding (reductionist view) and a continuum mechanics understanding (classical view) of complex and collective phenomena. Funding for the initiative will be derived from normal turnover of university and DOE laboratory programs. Awards will be made on the basis of competitive peer review to university and DOE laboratory researchers. The initiative is open to the entire range of disciplines supported by the BES program. Specific examples of work that might be funded under this initiative are given in the sections describing the BES subprograms.

Some important categories of studies that might be included within the initiative in Complex and Collective Phenomena are:

- *Materials that are beyond binary; that lack stochiometry; that are far from equilibrium; that have little or no symmetry or low dimensionality.* Often properties and behaviors that we desire exist only in "non-ideal compounds," i.e., those that are made from more than a few elements, made in non-stoichiometric combinations, made far from equilibrium; or made in one or two dimensions. As examples, high-temperature superconductors are complex compounds of four or more elements that are not stoichiometric with respect to oxygen; the glassy metal state, which has many desirable properties, has no long range order or symmetry; and many interesting and useful properties exist in atomic and molecular arrangements that have only one or two dimensions, such as is found in thin films, membranes, and quantum dots. These classes of materials, which will dominate the next generation of energy technologies, pose new challenges and opportunities because of their complexity.

- *Functional synthesis.* Although chemists routinely synthesize molecules to desired elemental composition and structure, the ability to *predict* structure/function relationships remains elusive. Because function can be exquisitely sensitive to even minor changes in both composition and structure and because the number of combinations is virtually boundless, we are unable to predict what combinations of elements and arrangements of atoms give rise to desired properties such as superconductivity, magnetism, ductility, toughness, strength, resistance, catalytic function, or enzymatic function.

- *The control of entropy.* To a scientist, entropy has a precise mathematical definition; however, to a nonscientist, entropy can be viewed as synonymous with disorder. A standard maxim in physics is that "the entropy of the universe tends to increase," i.e., things become increasingly disordered with time. Interestingly, most of our energy now comes from fossil fuels that were derived from photosynthesis -- the ability of plants to reduce entropy locally by absorbing sunlight and converting carbon dioxide to lower-entropy hydrocarbons, polysaccharides, and other compounds. However, even though photosynthesis has been studied for decades, we still do not completely understand it nor have we been able to duplicate or improve on it. This one example of the control of entropy -- the ability to mimic the functions of plants -- remains one of the outstanding challenges in the natural sciences.

- *Phenomena beyond the independent particle approximation.* Phenomena beyond the independent particle model -- that by their nature are collective -- challenge our understanding of the natural world and require major advances in theory, modeling, computing, and experiment. Collective phenomena include widely diverse phenomena in the gas and condensed phases, including Bose-Einstein condensation, high-temperature superconductivity, and electron correlation.

- *Scaling in space and time.* Research in chemistry, materials, geosciences, and biosciences covers lengths from the atomic scale to the cellular scale to the meter scale and times from femtoseconds to millennia. We understand single atoms, molecules, and pure crystals fairly well; but, when we go beyond these simple systems to larger more complex systems, our understanding is limited. Understanding phenomena over wide time scales is also important -- from femtoseconds in spectroscopy to decades in the regulatory system of plants to thousands of years in radioactive waste disposal.

Climate Change Technology Initiative

Overview

The FY 1999 budget contains two carbon related programs, each of which cut across several agencies. The first is the Climate Change Technology Initiative (CCTI). That part of the CCTI that is within the Office of Energy Research is a joint activity between the Biological and Environmental Research (BER) and Basic Energy Sciences (BES) programs. The second program is the U.S. Global Change Research Program (US/GCRP) that spans eleven agencies and is coordinated through the National Science and Technology Council's Committee on Environment and Natural Resources. Within DOE, the BER program plays the lead role in US/GCRP activities. Although the two programs, CCTI and US/GCRP, are synergistic, they are different. US/GCRP research focuses on developing the fundamental understanding of the comprehensive climate system and the global and regional adaptations to it. The CCTI focuses on the underpinning science that will enable mitigation of climate change while maintaining a robust National economy.

Eighty-five percent of our Nation's energy results from the burning of fossil fuels, a process that adds carbon to the atmosphere -- principally in the form of carbon dioxide -- from the sequestered fossil reservoir. Because of the potential environmental impacts of increases in atmospheric carbon dioxide, carbon management has become an international concern and has become a focus of the Climate Change Technology Initiative. A comprehensive research and development program that meets the needs of the Climate Change Technology Initiative addresses the diverse aspects of this problem. The Office of Energy Research is well positioned to make significant contributions to the many solutions needed for this problem, as it is set to build on the fundamental discoveries of its core programs and extend them to the new discoveries needed to make carbon management practical and efficient. Energy Research core programs include research on both carbon and non-carbon energy sources and on both carbon sequestration and carbon recycling. These core activities can now be exploited in the generation of the carbon management science that will underpin the technologies of the future. The theme of efficiency in energy production and use must span the entire range of research activities. Research on carbon energy sources, and their impacts, is a focal point of interagency activity through the U.S. Global Change Research Program (USGCRP). Research on non-carbon energy sources is also a focal point of intra-agency activities and is led by the DOE Office of Energy Efficiency and Renewable Energy. The DOE Office of Energy Research, through activities in both the Basic Energy Sciences (BES) program and the Biological and Environmental Research (BER) program, supports research that underpins both efforts.

A research program in carbon management would include:

(1) science for efficient technologies,
(2) fundamental science underpinning advances in all low/no carbon energy sources, and
(3) sequestration science.

Energy Research has long-standing programs in fundamental research that already impact the three categories. Additional resources of $16,000,000 in the BES program, provided specifically for carbon management science in the Climate Change Technology Initiative, will be a natural extension of the complementary, ongoing work in several programs in Energy Research, and it will build on the foundation of excellent and relevant research already underway. Focus areas will be those that build on strengths of the current Energy Research programs and that promise maximum impact in the area of carbon management.

Immediate Impacts of Expanded Effort in Climate Change Technology

Additional Energy Research effort will not only address an immediate societal problem, but it will also have a major effect on many scientific disciplines by advancing the state of knowledge and by training students in areas of research that are important to carbon management. For example, biochemistry, molecular and cellular biology, structural biology, and genome science will be impacted, because the production of fuels and chemicals by plants and microorganisms and the interconversion of greenhouse gases requires a better understanding of metabolism, of the structure and function of sub-cellular components, and of enzymes. Similarly, the state-of-the-art in biochemistry, molecular biology, and ecology will be impacted. All of these biological processes are important in understanding the role of marine microorganisms in sequestering carbon. Improvements in combustion to reduce carbon emissions require a fundamental understanding in chemical dynamics and theoretical chemistry and physics. Conversion of sunlight to energy requires an understanding in many areas of science, including photochemistry, photosynthesis, metabolism, and solid state physics. The search for increased efficiency in energy production and use requires fundamental knowledge in ceramics, metals, polymers, solid state chemistry, and condensed matter physics for materials that can withstand higher temperatures, have lower coefficients of friction, and are stronger and lighter. Enhanced recovery of fuel resources and of disposal of carbon dioxide requires a fundamental understanding of geometric, structural, and hydrologic properties of reservoirs and of multiphase, nonlinear transport of fluids in porous and fractured structures. Cross-cutting programs in nano- and meso-phase materials involve research at the forefront of materials science, chemistry, engineering, surface science, and semiconductor physics.

The new research efforts supporting advances in low/no carbon energy technologies, as well as existing activities, will be closely coordinated with DOE's technology programs and will provide the knowledge base for the development of advanced technologies to reduce carbon dioxide emissions. Many of the activities will impact the Office of Energy Efficiency and Renewable Energy (EE) by providing options for increasing efficiency in automobiles by reducing weight; for increasing efficiency in the use of electricity by increasing the efficiency of electric motors and generators with better magnets; for increasing efficiency in the transmission of electricity by using superconductors; and for reducing energy consumption in manufacturing with improved sensors, controls, and processes. Much of this research program will provide the knowledge base needed to increase the use of renewable resources with research aimed at understanding the metabolism of carbon dioxide and the metabolic pathways to the production of methane and other biofuels. Other aspects of the research program impact the Office of Fossil Energy (FE) by providing a foundation for effective and safe underground sequestration, new materials, a better understanding of combustion, and improved catalysts.

Funding will be provided for areas of research in carbon cycle management including appropriate areas that will be jointly identified and implemented by the Biological and Environmental Research and Basic Energy Sciences programs. Solicitations will be used for individual research projects. Additionally, proposal notifications may be developed jointly with the DOE energy technology programs with the intention of establishing multi-disciplinary centers at universities and national laboratories that will use the full capabilities of the institutions for a research program in carbon cycle management encompassing, for example, topics in the following areas: integration and assessment; separations; efficiency; clean fuels; bioenergy; storage and conversion; enhanced natural terrestrial cycles; and enhanced use of major scientific user facilities to support carbon management research.

Interagency Environment

The ER program in fundamental science supporting energy technologies will be closely coordinated with, and synergistic to, the activities in its sister agencies (e.g., NASA, NSF, NOAA, USDA, DOI, and EPA) within the USGCRP. Through its leadership role in decade to century climate prediction, ER has developed the research capability for comprehensive and large scale modeling of carbon dioxide impacts on climate, on ecology, and on ocean sciences, and this expertise is augmented by complementary activities in the other agencies. Similarly, the network of carbon flux measurements and ecological experiments that ER has developed serve as a backdrop to those of many other agencies, and the state-of-the-art can thus be pushed ahead more rapidly by capitalizing on the more rapidly growing base of knowledge. ER also has a leadership role within the USGCRP on consequence evaluation of increased greenhouse gases in global climate change, including integrated assessments that address both scientific and societal (including economic) impacts of carbon management. Finally, through its pre-eminent role in the Human Genome Program and its development of the complementary Microbial Genome Program, the ER program is ideally placed to support research that will focus on the application of genetic information of microorganisms to increase metabolic efficiency related to both carbon dioxide and methane production or consumption, and will thus underpin the related activities to be undertaken by both Energy Research and the National Science Foundation LexEN (Life in Extreme Environments) program.

BES Activities

Climate Change Technology Initiative
FY 1999 Budget Request
B/A
($000)

Materials Sciences	$ 3,500
Chemical Sciences	4,500
Engineering and Geosciences	3,000
Energy Biosciences	5,000
Total	$16,000

As noted above, an inclusive climate change technology research and development program must address diverse aspects of the problem including (1) carbon recycling, (2) improved efficiency in the use of fossil carbon energy sources, (3) new and improved non-carbon energy sources, and (4) carbon dioxide sequestration. The BES program has long supported fundamental research that impacts these categories and has particularly strong programs related to the first three. A comprehensive program in issues relating specifically to carbon management, therefore, finds a natural home with the scientific communities supported by BES.

Focus areas will be those that promise the maximum impact in the area of carbon management and that build on strengths of current BES programs. In the Materials Sciences subprogram, research will focus on three areas: high temperature materials for more efficient combustion, magnetic materials that reduce energy loss during use, and semiconductor materials for solar energy conversion. In the Chemical Sciences subprogram, research will emphasize atomic and molecular level understanding of chemical processes to enable predictive capability. A major component of the research will aim at reducing emissions of carbon dioxide through fundamental understanding of the chemistries associated with combustion, catalysis, photochemical energy conversion, electrical energy storage, electrochemical interfaces, and molecular specific separation from complex mixtures. In the Engineering and Geosciences subprogram, research will emphasize those areas of geophysics and geomechanics that will impact carbon dioxide sequestration in subsurface geologic formations. The program will focus on three areas where improved understanding is needed to evaluate the potential for deep underground sequestration: (1) understanding the mechanical stability of porous and fractured reservoirs/aquifers, (2) understanding multiphase fluid flow within the aquifers, and (3) understanding the geochemical reactivity within the reservoirs/aquifers. Finally, in the Energy Biosciences subprogram, research will emphasize the biological process of photosynthesis, which is central to global carbon cycling.

Included among this work, which is interdisciplinary in its nature, will be research activities for new and improved catalysts for more efficient production of fuels and chemicals and for the conversion of biomass to fuels; lower cost and more efficient photovoltaic devices to convert sunlight to electricity; higher capacity batteries to store electrical energy more effectively; fuel cells to use alternative fuels; lightweight materials to improve mileage in automobiles; high-temperature materials to increase energy efficiency in energy production and manufacturing processes; biological production of fuels to recycle carbon and reduce the use of fossil fuels; and more efficient electric generation, transmission, and use through the use of superconductors and improved magnets. Specific areas of research are described in greater detail in the narratives for the individual subprograms. The new BES research program will be closely related to DOE's technology programs and will provide the knowledge base for the development of advanced technologies to reduce CO_2 emissions. When combined with the complimentary activities within Biological and Environmental Research program, this initiative will lead to the comprehensive carbon management research program described above.

Fundamental Research Relating to Solar and Renewable Energy Resources

Included in this request are funds in the amount of $47,905,000 that potentially impact solar and renewable energy resource production and use in the categories of "biomass," "wind energy," "photovoltaics," "hydrogen," and "other (solar photoconversion)." These funds support multidisciplinary, basic research in the BES Materials Sciences, Chemical Sciences, and Energy Biosciences subprograms. These multidisciplinary research activities are also relevant to a number of other areas that impact energy. Funding totalling $6,300,000 in this category also addresses the Climate Change Technology Initiative. Indeed, the nature of most of the BES programs is to provide the results of basic research that impact a wide variety of applications. For example, research in the area of biomass focuses on understanding, at the mechanistic level, the biology of plants, algae, and non-medical microbes. While the majority of fundamental research on plants and non-medical microbes is directly related to biomass or renewables, the research also directly impacts many other disciplines and technologies including agricultural food production, plant-derived pharmaceuticals, textile fibers, wood and wood byproducts, environmental restoration, and fermentation technologies. Similarly, research in solar photoconversion focuses on the detailed nature of how molecules in the photo excited state transfer electrons (and thus energy); this work impacts numerous technologies in addition to solar and renewable energy programs including sensors, molecular photonics, photodegradation of hazardous wastes, photoassisted synthesis of chemicals, new analytical techniques (or methodologies), soil science, biological electron transfer, and carbon dioxide photoreduction. As a final example, research in photovoltaics focuses primarily on semiconductor physics and the synthesis of semiconductor materials. These materials are also used in microprocessors, batteries, displays, sensors, electrochromic windows, and semiconductor alloys. BES partners with all appropriate DOE technology offices to make the results of the BES research widely known and used. Furthermore, BES research programs are influenced by the needs of the technology offices. As a result, there have been many joint activities. For example, in photovoltaics, the Office of Energy Efficiency and Renewable Energy (EE) and BES together sponsored a workshop in 1993. Based on this workshop, a jointly funded project was started at NREL that resulted in record-breaking photovoltaic efficiencies. In general, research activities in biomass, wind energy, photovoltaics, hydrogen, and solar photoconversion are coordinated with EE through Coordinating Committees in the Department, through ad hoc meetings, through workshops, and through joint funding at universities and at the Department's laboratories. In November, 1997, more than 30 program staff from the Office of Energy Research (ER) -- primarily from BES -- and from EE Offices of Utility Technologies and Transportation Technologies met to discuss programs in the areas noted above. The EE programs involved include those of photovoltaic energy systems, solar thermal, hydrogen technologies, wind technologies, biomass power, and biofuels (transportation). Follow on one-on-one meetings between program managers of both offices are now being held for preliminary identification of research needs and gaps. Similar to the early photovoltaic energy systems coordination activities, it is envisioned that joint-sponsored workshops with invited specific experts will then be held to further define priority research opportunities for both offices.

Funding of Contractor Security Clearances

In FY 1999, the Department will divide the responsibility for obtaining and maintaining security clearances. The Office of Security Affairs, which has been responsible for funding all Federal and contractor employee clearances, will pay only for clearances of Federal employees, both at headquarters and the field. Program organizations will be responsible for contractor clearances, using program funds. This change in policy will enable program managers to make the decisions as to how many and what level clearances are necessary for effective program execution. In this way, it is hoped that any backlog of essential clearances which are impeding program success can be cleared up by those managers most directly involved. The Office of Energy Research is budgeting $346,000 for estimated contractor clearances in FY 1999 within this decision unit.

BASIC ENERGY SCIENCES
PROGRAM FUNDING PROFILE
(Dollars in thousands)

	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Budget Request
Research									
Materials Sciences.............................	#######		$391,595		-$549	a/	$391,046		$417,216
Chemical Sciences.............................	194,537		200,933		-280	a/	200,653		209,582
Engineering and Geosciences.............	40,933		41,251		-57	a/	41,194		44,413
Energy Biosciences............................	27,283		27,461		-39	a/	27,422		32,489
Subtotal, Research............................	631,221		661,240		-925	a/	660,315		703,700
Construction.......................................	11,500		7,000		0		7,000		132,400
Subtotal, Basic Energy Sciences..........	642,721		668,240		-925	a/	667,315		836,100
Adjustment...	-9,731	b/	-4,780	c/	0		-4,780	c/	0
Adjustment...	0		-925	a/	925	a/	0		0
Total, Basic Energy Sciences...............	#######	d/	$662,535		$0		$662,535		$836,100

a/ Share of Science general reduction for contractor training.

b/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned ($9,404,000), and FY 1997 emergency flood supplemental rescission ($327,000). The total general reductior at the appropriation level.

c/ Share of Science general reduction for use of prior year balances assigned to this program. The total general ı at the appropriation level.

d/ Excludes $13,916,000 which has been transferred to the SBIR program and $833,000 which has been transfer STTR program.

Public Law Authorizations:

Public Law 95-91, DOE Organization Act

BASIC ENERGY SCIENCES
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriations	FY 1999 Budget Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$20,654	$23,482	$0	$23,482	$24,489
National Renewable Energy Laboratory	4,160	4,440	0	4,440	4,402
Sandia National Laboratories	30,168	28,419	0	28,419	25,378
Chicago Operations Office					
Ames Laboratory	17,498	17,996	0	17,996	16,609
Argonne National Laboratory	137,340	139,239	0	139,239	145,387
Brookhaven National Laboratory	81,843	75,023	0	75,023	77,311
Idaho Operations Office					
Idaho National Environmental Engineering	3,217	3,708	0	3,708	3,752
Oakland Operations Office					
Lawrence Berkeley National Laboratory	62,470	60,732	0	60,732	61,081
Lawrence Livermore National Laboratory	6,570	5,601	0	5,601	5,602
Stanford Linear Accelerator Center	20,562	21,279	0	21,279	21,853
Oak Ridge Operations Office					
Oak Ridge Institute for Science and Educati	1,504	999	0	999	724
Oak Ridge National Laboratory	89,481	109,431	0	109,431	244,295

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriations		FY 1999 Budget Request
Richland Operations Office									
Pacific Northwest National Laboratory	12,640		12,718		0		12,718		12,708
All Other Sites a/	154,614		165,173		-925	b/	164,248		192,509
Subtotal	642,721	c/	668,240		-925	b/	667,315		836,100
Adjustment	-9,731	d/	-4,780	e/	0		-4,780	e/	0
Adjustment	0		-925	b/	925	b/	0		0
TOTAL	$632,990		$662,535		$0		$662,535		$836,100

a/ Funding provided to universities, industry, other Federal agencies and other miscellaneous contractors.
b/ Share of Science general reduction for contractor training.
c/ Excludes $13,916,000 which was transferred to the SBIR program and $833,000 which was transferred to the STTR program.
d/ Share of Energy Supply Research and Development general reduction for use of prior year balances assigned to this program ($9,404,000) and FY 1997 emergency flood supplemental rescission ($327,000). The total general reduction is applied at the appropriation level.
e/ Share of Science general reduction for use of prior year balances assigned to this program. The total reduction is applied at the appropriation level.

BASIC ENERGY SCIENCES
MATERIALS SCIENCES
(Tabular dollars in thousands, narrative in whole dollars)

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

Climate Change Technology Initiative. Research routes to improved carbon management in support of the Climate Change Technology Initiative include: reducing fuel consumption (and consequently emissions) via higher temperature operation through the use of improved heat and corrosion resistant alloys; reducing energy losses in motors via improved magnetic materials; and displacing fossil fuels with higher-efficiency photovoltaic cells.

Research in Complex and Collective Phenomena. It is now apparent that materials with increased complexity in their composition, atomic structure, and arrangements have created opportunities for the development of new materials with much improved properties and behavior. Research under this initiative will focus on new classes of magnetic materials and their behavior in thin films and layered arrangements; new classes of alloys; and an increased understanding of mechanical behavior between the atomic scale and the macroscopic continuum model.

II. **Funding Schedule:**

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Materials Sciences Research	$169,212	$195,860	$189,066	$- 6,794	- 3.5%
Facilities Operations	191,950	185,915	218,246	+32,331	+17.4%
SBIR/STTR	0	9,271	9,904	+ 633	+ 6.8%
Congressional Direction	7,306	0	0	0	------
Total, Materials Sciences	$368,468	$391,046	$417,216	$+26,170	$+ 6.7%

BASIC ENERGY SCIENCES
MATERIALS SCIENCES

III. **Performance Summary- Accomplishments:**	**FY 1997**	**FY 1998**	**FY 1999**
Materials Sciences Research			
-Basic research is conducted on synthesis and processing; theory and modeling; atomic scale structural characterization; and mechanical and physical behavior. The purpose of this research is to understand the relationship among the synthesis, processing, microscopic structure and the mechanical and physical behavior of materials. This research includes topics in lattice defects; diffusion and transport; phase transformations; magnetic, superconducting, semiconducting and alloy ordering behaviors; radiation damage; corrosion; deformation and fracture; and microstructural and microchemical characterizations by means of electron beams, neutron beams, and x-rays. Within this category of research, new work in complex and collective phenomena is expected to be funded at approximately $650,000. Capital equipment is required for items such as high-temperature components for electron microscopes, atomic probes, crystals, x-ray detectors, spectrometers, tomographic instruments, and computer controls. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.		$68,168	$72,264$75,390
-Basic research on the physical properties of materials, largely in the area of condensed matter physics, is conducted to determine the positions and movements of atoms in solids and liquids and the effects of these on the electronic states. This activity encompasses experiments in neutron and x-ray scattering; experiments to determine transport properties of solids, such as electrical and thermal conductivity, superconductivity, magnetism, and	64,682	65,260	68,430

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
experiments on the effects of light and other radiation on materials. There are also theoretical investigations and computer simulations to gain understanding of the experiments and to model the behavior of materials. Within this category of research, new work in a complex and collective phenomena is expected to be funded at approximately $650,000. Capital equipment is required for items such as high field magnets, neutron and x-ray beam lines and instrumentation, detectors, energy filters, and magneto-optical instrumentation. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.			
-Research on the chemical properties of materials is conducted to understand the effects of chemical reactivity on the behavior of materials and to synthesize new chemical compounds and structures from which better materials can be made. This activity includes research in solid state chemistry, surface chemistry, polymer chemistry, crystallography, synthetic chemistry, and colloid chemistry. Within this category of research, new work in complex and collective phenomena is expected to be funded at approximately $200,000. Capital equipment is required for items such as spectrometers, reflectometers, computer workstations for simulations and modeling, and instrumentation to study surfaces at the atomic scale. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.	21,616	24,021	25,131

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999

BASIC ENERGY SCIENCES
MATERIALS SCIENCES

EPSCoR DISTRIBUTION OF FUNDS BY STATE
(Dollars in thousands)

	FY 1997 Actual	FY 1998 Estimate	FY 1999 Estimate
Alabama	$ 750	$ 725	$ 725
Kentucky	750	725	725
Louisiana	659	725	**
Maine	600	725	**
Montana	750	725	**
Nevada	750	725	725
Puerto Rico	750	725	725
South Carolina	550	725	725
Wyoming	730	725	725
Other*	514	290	2,465
Totals	$6,803	$6,815	$6,815

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

** The funding commitments for awards to Louisiana, Maine, and Montana expire in FY 1998. The uncommitted funds in FY 1999 will be competed among all EPSCoR states that do not have an active award to begin new "initiation" awards. (Eligible states are Arkansas, Idaho, Kansas, Louisiana, Maine, Mississippi, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, Vermont, and West Virginia.) In addition to the normal initiation awards, which support cluster activities statewide, some funds may be used to support individual grants to scientists from EPSCOR states.

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
-The Experimental Program to Stimulate Competitive Research (EPSCoR) provides financial assistance to states that historically have received relatively less Federal research funding. The EPSCoR program was included in the BES program at the direction of Congress in FY 1996.	6,803	6,815	6,815
-Los Alamos Neutron Science Center (LANSCE) instrumentation enhancement. This project is a major item of equipment with a total estimated cost of $20,500,000 that will provide enhanced instrumentation at the LANSCE and will be implemented concurrently with an accelerator upgrade funded by the Office of Defense Programs.	0	4,500	4,500
-Extension of HB-2 beam tube at the High Flux Isotope Reactor. This project, a major item of equipment with a total estimated cost of $5,900,000, will provide beam access for six thermal neutron scattering instruments. Beam guides and optimized geometry will provide a neutron flux at the instrument positions 2-3 times higher than currently available.	0	0	3,500
-Replacement of High Flux Isotope Reactor Monochrometer Drums.	0	0	1,800
-Conceptual design of the Spallation Neutron Source (SNS) was completed in FY 1997. FY 1998 funding will support continued Pre-Title I research and development on the SNS. In FY 1999, SNS research funding in support of construction is reflected in the facility operations section of this budget.	7,943	23,000	0

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
-Basic research in carbon management for the Climate Change Technology Initiative will focus on three areas: high temperature materials, magnetic materials, and semiconductor materials. (1) A major goal in a carbon management program is the derivation of materials that can withstand higher temperatures for more efficient combustion and for improved properties in applications. Research will focus on attaining an atomic-level understanding and a predictive capability for bulk metallic glasses, which have the potential to make significant contributions in corrosion and wear resistance in fossil fueled power plants, and on structural ceramics, which will be used in high temperature applications such as engine components. Additional work will focus on a fundamental understanding of the surface physics and chemistry of oxide layers, which is expected to produce alloys and coatings that have improved corrosion resistance at high temperatures. (2) A second goal is the derivation of magnetic materials to reduce energy loss during use. Research on the microstructure of permanent magnetic materials to understand the optimum grain structure is expected to result in stronger magnets, and research in the processing of magnetic materials is expected to optimize magnetic properties. Taken together, research in magnetic materials is critical to energy efficiency, since electric motors consume about two-thirds of U.S. electric power. (3) A final goal in the areas of materials sciences is the development of new semiconductor materials for solar energy conversion stressing very innovative studies in nanoscale and mesoscale physics that might lead to breakthrough advances. The focus would be to improve the efficiency of the conversion of light to electricity. For example, research in the physics of quantum confinement might lead to new nanoscale structures that can be tuned to absorb the full spectrum of	0	0	3,500

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
sunlight, which, when coupled to electron transport structures, would provide new ways to convert sunlight to electricity.			
Subtotal Materials Sciences Research	169,212	195,860	189,066
Facilities Operations			
-Operation of national user facilities. The facilities included in Materials Sciences are: National Synchrotron Light Source, High Flux Beam Reactor (currently not operating), Intense Pulsed Neutron Source, Stanford Synchrotron Radiation Laboratory, Manuel Lujan, Jr. Neutron Scattering Center, High Flux Isotope Reactor, Advanced Light Source, and the Advanced Photon Source. Research and development in support of construction of the Spallation Neutron Source is also included. The facility operations budget request, which includes operating funds, capital equipment and Accelerator and Reactor Improvements (AIP) funding under $5,000,000, is described in a consolidated manner later in this budget. AIP funding will support additions and modifications to accelerator and reactor facilities which are supported in the Materials Sciences subprogram. Capital equipment is needed at the facilities for items such as beam monitors, interlock systems, vacuum systems, beamline front end components, monochromators, and power supplies. A summary of the funding for the facilities included in the Materials Sciences subprogram is	191,950	185,915	218,246

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
provided below. Additional funds for facility operations for some of these facilities are included in the Chemical Sciences subprogram of this budget.			
Subtotal Facilities Operations	191,950	185,915	218,246
Facilities			
National Synchrotron Light Source	$ 19,990	$ 23,047	$ 24,422
High Flux Beam Reactor	34,450	22,900	22,900
Intense Pulsed Neutron Source	10,692	11,230	11,920
Stanford Synchrotron Radiation Laboratory	3,650	4,002	4,002
Manuel Lujan, Jr. Neutron Scattering Center	7,343	6,588	7,502
Advanced Light Source	32,877	30,708	31,600
Advanced Photon Source	81,441	82,368	87,300
Spallation Neutron Source	0	0	28,600
High Flux Isotope Reactor	0	3,972	0
Partial Offset to ESRD General Reduction Applied to BES	1,507	1,100	0
Total	$191,950	$185,915	$218,246
SBIR/STTR Funding	0	9,271	9,904
In FY 1997 $7,956,000 and $475,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.			
Subtotal SBIR/STTR Funding	0	9,271	9,904

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
Congressional Direction	7,306	0	0
Funds Rose Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.			
Total Materials Sciences	$368,468	$391,046	$417,216

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Increase research and development funds and provide capital equipment for the SNS in support of the FY 1999 construction start.	$+ 5,600,000
Initiate a program of fundamental research in carbon emissions management for the Climate Change Technology Initiative.	+ 3,500,000
Initiate a program of fundamental research in complex and collective phenomena.	+ 1,500,000
Initiate the Partnerships for Academic Industrial Research (PAIR) program.	+ 750,000
Provide increased support for the major scientific user facilities.	+ 7,703,000
Provide AIP funds for extension of HB-2 beam tube at HFIR for thermal neutron scattering.	+ 3,500,000
Reduce AIP funds following completion of beam tube upgrades at HFIR.	- 3,972,000

Provide capital equipment funds for new monochromator drums at HFIR for thermal neutron scattering.	+ 1,800,000
Increase in research for characterization of materials.	+ 1,956,000
Increase SBIR/STTR funding due to increase in operating expenses.	+ 633,000
Increase for peer reviewed research at the synchrotron radiation light sources.	+ 3,000,000
Beginning in FY 1999, this program will budget $200,000 for the estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+ 200,000
Total Funding Change, Materials Sciences	$+26,170,000

MAJOR ISSUES:

- Neutron science is a critical tool in materials sciences and related disciplines that are crucial to the U.S. knowledge base for advanced technologies, particularly those related to energy technologies. The U.S. currently lags far behind both Europe and Japan in neutron science. Planned new neutron sources in Europe and Japan could increase their lead even further in materials science and related research using neutrons. To maintain a strong U.S. position in the field of neutron science, funds to begin construction of the SNS are required in FY 1999. In addition, funds to continue neutron source enhancements such as the Los Alamos Neutron Science Center (LANSCE) instrumentation enhancement and enhanced thermal neutron flux capacity at the High Flux Isotope Reactor are included in this request.

- On December 21, 1996, the High Flux Beam Reactor (HFBR) was shut down for normal refueling. However, before the reactor was restarted, the announcement was made that a plume of tritium, believed to emanate from the reactor spent fuel pool, was contaminating the ground water south of the reactor. The reactor has remained in standby mode since that time. Because the reactor contains radioactive fluids in the primary cooling system, nearly a full staff is necessary to maintain the reactor and associated equipment in safe operating condition. The HFBR will continue to be maintained in this state while the Department evaluates options for its future. The Basic Energy Sciences Advisory Committee has recommended that the HFBR be restarted. This recommendation, along with input from the new contractor at Brookhaven National Laboratory, input from the local community on Long Island, and the Environmental Impact Statement will be used by the Secretary of Energy in determining the future of the HFBR.

BASIC ENERGY SCIENCES
CHEMICAL SCIENCES
(Tabular dollars in thousand, narrative in whole dollars)

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

Climate Change Techology Initiative. The chemical physics and photochemistry disciplinary areas address fundamental interactions of atoms, molecules and ions with photons and electrons that define the underlying chemical science needed to address carbon management. These areas enable more efficient combustion and new understanding of the photochemical conversion of CO_2 and the direct conversion of solar radiation to electricity. The other major component of the research program is comprised of inorganic chemistry, physical chemistry, organic chemistry, analytical chemistry, separations science, heavy element chemistry and aspects of chemical engineering sciences. The separations science, physical chemistry and inorganic chemistry disciplinary areas provide a better molecular level understanding of homogeneous and heterogeneous reactions occurring at surfaces, interfaces and in bulk media. These disciplinary areas provide the basis for new and improved catalysts for conversion of fuels to carbon dioxide and hydrogen; potentially for carbon dioxide conversion to chemicals, separation of the conversion components; and new electrochemical energy production and storage systems.

Research on Complex and Collective Phenomena. Chemical Sciences research under complex and collective phenomena would fall in the areas of AMO physics with a focus on phenomena beyond the independent particle approximation; improved predictive capability in catalysis; combustion models; and separations systems and processes through advances in understanding scaling in space and time as well as functional synthesis; and improved photochemical processes for solar energy conversion and "green synthesis" through the control of entropy and functional synthesis. The greatest potential technological impact would be in energy efficiency and renewable energy, but impacts would also be realized in environmental management and fossil energy.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Chemical Sciences Research	$124,908	$128,852	$137,515	$+8,663	+6.7%
Facilities Operations	64,221	67,335	67,319	- 16	----
SBIR/STTR	0	4,466	4,748	+ 282	+6.3%
Congressional Direction	5,408	0	0	0	----
Total, Chemical Sciences	$194,537	$200,653	$209,582	$+8,929	+4.4%

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
Chemical Sciences Research			
-The program supports experimental and theoretical research devoted to study of atoms, molecules, ions and light and their interactions- areas that may have broad fundamental impact on much of chemistry. Molecular processes related to combustion of fossil fuels and catalysis as well as the conversion of solar energy to other useful energy forms are also studied. Within this category of research, new work in complex and collective phenomena is expected to be funded at approximately $475,000. Capital equipment is required for such items as mass spectrometers, electronic waveform digitizers, oscilloscopes, detection equipment, optical spectrometers, and vacuum equipment. AIP	$67,171	$68,797	$70,610

III. Performance Summary	FY 1997	FY 1998	FY 1999
funding is also required for additions and modifications to accelerator and reactor facilities supported by the Chemical Sciences subprogram. The total estimated cost of each AIP project will not exceed $5,000,000. The Chemical Sciences subprogram also provides General Purpose Equipment (GPE) and General Plant Projects (GPP) funds, for minor new construction, for other capital alterations and additions, and for improvements to land, buildings, and utility systems at the Ames Laboratory, Argonne National Laboratory, and Oak Ridge National Laboratory as part of Basic Energy Sciences landlord responsibilities for these laboratories. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. The total estimated cost of each GPP project will not exceed $5,000,000. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.			
-The program supports a broad, well-integrated continuum of effort that uses atomic and molecular level information to understand homogeneous and heterogeneous catalysis as well as separations and analysis methodologies including studies of the actinide elements. Certain engineering areas are also supported such as turbulence related to combustion and thermodynamics. Within this category of research, new work in complex and collective phenomena is expected to be funded at approximately $425,000. Capital equipment is required for such items as high resolution area detectors, catalytic reactors, analytical instrumentation, lasers, and optical spectrometers. The Chemical Sciences subprogram also	57,737	60,055	62,405

III. Performance Summary	FY 1997	FY 1998	FY 1999
provides General Purpose Equipment (GPE) and General Plant Projects (GPP) funds, for minor new construction, for other capital alterations and additions, and for improvements to land, buildings, and utility systems at the Ames Laboratory, Argonne National Laboratory, and Oak Ridge National Laboratory as part of Basic Energy Sciences landlord responsibilities for these laboratories. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. The total estimated cost of each GPP project will not exceed $5,000,000. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.			
Basic research in carbon management for the Climate Change Technology Initiative will emphasize atomic and molecular level understanding of chemical processes to enable predictive capability. A major component of the research will aim at reducing emissions of carbon dioxide through fundamental understanding of the chemistries associated with combustion, catalysis, photochemical energy conversion, electrical energy storage, electrochemical interfaces, and molecular specific separation from complex mixtures. In particular, multidisciplinary efforts are required that focus on improved understanding of new and existing chemical and physical separation processes, transport mechanisms, and membrane systems with selective chemical functionality; this work will address issues that are critical to clean and efficient fuels in a reduced green-house-gas economy, such as separation of CO_2 from complex mixtures or new concepts for economical oxygen	0	0	4,500

III. Performance Summary	FY 1997	FY 1998	FY 1999
separation from air for partial oxidation schemes. In addition, work will be initiated using supercritical carbon dioxide as a reagent for the catalytic and photochemical reduction of carbon dioxide to specialty chemicals or hydrocarbons, thus preventing their release into the atmosphere. Examples of these activities are: understanding charge separation and electron transfer processes critical to photochemical reduction of carbon dioxide with water or hydrogen to hydrocarbons; understanding the interactions and dynamics between molecules and catalysts that result in the catalytic process to enable new catalysts for carbon dioxide insertion into chemicals; understanding the complex relationship between chemical reaction dynamics and turbulence that are critical to improving the efficiency of fossil fuel combustion processes.			
Subtotal Chemical Sciences Research	124,908	128,852	137,515
Facilities Operations			
-Operation of national user facilities. The facilities included in Chemical Sciences are: National Synchrotron Light Source, High Flux Isotope Reactor, Radiochemical Engineering Development Center, Stanford Synchrotron Radiation Laboratory, and Combustion Research Facility. The facility operations budget request, which includes operating funds, capital equipment, general plant projects, and AIP funding under $5,000,000, is described in a consolidated manner later in this budget. AIP funding will support additions and modifications to accelerator and reactor facilities which are supported in the Chemical Sciences subprogram. General Plant Project (GPP) funding is also required for minor new construction,	64,221	67,335	67,319

III. Performance Summary	FY 1997	FY 1998	FY 1999
for other capital alterations and additions, and for improvements to land, buildings, and utility systems. The total estimated cost of each GPP project will not exceed $5,000,000. Capital equipment is needed for the facilities for items such as beam monitors, interlock systems, vacuum systems, beamline front end components, monochromators, and power supplies.			
A summary table of the facilities included in this Chemical Sciences subprogram is provided below. Additional funds for facility operations for some of these facilities are included in the Materials Sciences subprogram of this budget. Included in FY 1999 is the second major increment to the HFIR operating budget of $2,360,000. This increment is for the replacement of the beryllium reflector. The reflector replacement includes fabrication of the new reflector, disassembly and reassembly of the reactor and beam room, and associated safety and engineering activities.			
Reflector replacement, which will begin in FY 1998 and will be completed in FY 2000, is a recurring activity that must be performed every 10-12 years. The present reflector will reach its end of life in November 1999.			
Subtotal Facilities Operations	64,221	67,335	67,319

III. Performance Summary

	FY 1997	FY 1998	FY 1999
Facilities			
National Synchrotron Light Source	$ 7,429	$ 7,949	$ 8,190
High Flux Isotope Reactor	27,383	29,798	29,061
Radiochemical Engineering Development Center	6,705	6,705	7,127
Stanford Synchrotron Radiation Laboratory .	16,912	17,277	17,851
Combustion Research Facility	5,256	5,161	5,090
Partial Offset to ESRD General Reduction Applied to BES	536	445	0
Total	$64,221	$67,335	$67,319
SBIR/STTR Funding	0	4,466	4,748
In FY 1997 $4,248,000 and $255,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.			
Subtotal SBIR/STTR Funding	0	4,466	4,748
Congressional Direction	5,408	0	0
Funds Rose-Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.			
Subtotal Congressional Direction	5,408	0	0

Total Chemical Sciences	$194,537	$200,653	$209,582

BASIC ENERGY SCIENCES
CHEMICAL SCIENCES

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

Initiate a program of fundamental research in carbon emissions management for the Climate Change Technology Initiative.	$+4,500,000
Initiate a program of fundamental research in complex and collective phenomena.	+ 900,000
Initiate the Partnerships for Academic Industrial Research (PAIR) program.	+ 450,000
Provide increased support for the major scientific user facilities.	+ 1,223,000
Reduce operating funds to support the beryllium replacement at HFIR.	- 1,239,000
Provide funds for increased research at the CRF.	+ 1,000,000
Increase in research for atomic level understanding of catalysis and chemical processes.	+1,687,000
Increase SBIR/STTR funding due to increase in operating expenses.	+ 282,000
Beginning in FY 1999, this program will budget $126,000 for the estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+126,000
Total Funding Change, Chemical Sciences	$+8,929,000

BASIC ENERGY SCIENCES
ENGINEERING AND GEOSCIENCES
(Tabular dollars in thousands, narrative in whole dollars)

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

Climate Change Technology Initiative. The Geosciences Research program will enhance the scientific underpinning necessary for improving the characterization of subsurface formations and their host potential for carbon dioxide sequestration. Geomechanical studies and research on rock-fluid interactions will support carbon dioxide injection technologies, reservoir storage capacities, and long-term storage stability. Research concerning the physics of multiphase flow in fractured rock systems will provide the basis not only for advancing the predictability of terrestrial carbon dioxide sequestration, but also for providing the basis for improved efficiency of fossil energy and geothermal energy production.

Research on Complex and Collective Phenomena. This research will address: (1) the coupling between geochemical, hydrodynamic, mechanical, and thermal processes in shallow crustal conditions, (2) the effects of heterogeneity and scale on geological structures, transport processes, and properties, and (3) non-linear controls in processing.

II. Funding Schedule

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Engineering Research	$16,691	$16,853	$17,754	$+ 901	+5.3%
Geosciences Research	21,510	23,301	25,534	+2,233	+9.6%
SBIR/STTR	0	1,040	1,125	+ 85	+8.2%
Congressional Direction	2,732	0	0	0	----
Total, Engineering and Geosciences	$40,933	$41,194	$44,413	$+3,219	+7.8%

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
Engineering Research			
-The Engineering Research program supports basic research in selected areas to provide the fundamental scientific base necessary for current engineering practice and to broaden the technical and conceptual base for solving future engineering problems in the energy technologies. Research efforts include single and multiphase flow in reservoirs and pipes, progress in understanding how fracture and fatigue arise in stressed energy structures for early detection and prevention of structure failure, chemical process control to improve production efficiency, instrumentation for environmental sensors, improved understanding of chaotic systems bearing on industrial scale mixing methods, principles underlying environmentally benign manufacturing methods, and continuing support for graduate training fellowships in environmentally sustainable manufacturing. Within this category of research, new work in complex and collective phenomena is expected to be funded at approximately $125,000. Capital equipment is required for items such as instrumentation and diagnostics for experiments on the control of plasma processing of materials and fracture and fatigue in stressed structures. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.	$16,691	$16,853	$17,754
Subtotal Engineering Research	16,691	16,853	17,754

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
Geosciences Research			
The Geosciences Research program supports basic research to improve the level of understanding necessary for advances in, and choices among, current and emerging energy and environmental technologies. Research focuses on fundamental understanding of mineral-fluid interactions to provide a better foundation for oil, gas, and geothermal resource recovery and control of contaminants in groundwater flow; advances in geophysical imaging and interpretation to provide new windows on subsurface structure and properties in the context of energy and environmental technologies; new fundamental thermodynamic and physical property information on rocks, minerals, and geologic fluids for resource recovery and contaminant assessment and monitoring; and extending the pplicability of isotopic tracer methods for evaluation of natural and human-perturbed processes in the geologic environment. Within this category of research, new work in complex and collective phenomena is expected to be funded at approximately $175,000. Capital equipment is required for laboratory and in-situ studies of geologic systems, including facilities for microanalysis (e.g., synchrotron based methods) and facilities for characterizing the thermo-mechanical and transport behavior of rocks. Education activities for improving science education for students and faculty in America’s schools, colleges and universities are also funded in this program.	21,510	23,301	22,534
Basic research in carbon management for the Climate Change Technology Initiative will emphasize those areas of geophysics and geomechanics that will impact carbon dioxide sequestration in subsurface geologic	0	0	3,000

III. Performance Summary- Accomplishments:	**FY 1997**	**FY 1998**	**FY 1999**
formations. A basic research program will focus on three areas where improved understanding is needed to evaluate the potential for deep underground sequestration: (1) understanding the mechanical stability of porous and fractured reservoirs/aquifers, (2) understanding multiphase fluid flow within the aquifers, and (3) understanding the geochemical reactivity within the reservoirs/aquifers. In order to understand the mechanical stability of formations, a better understanding of the stress-strain-poroelasticity- viscoelasticity-thermoelasticity constitutive relationships are necessary as are fracture mechanics models, improved seismic models, and inversion codes to track mechanical stability of rocks at reservoir depths and scales. Fluid flow studies are need to understand mixing, fingering and phase retardation, and fluid-fluid transport at ambient and injection conditions, fluid-fluid-mineral interactions including wetting behavior, and surface tension effects. Better understanding of the geochemical reactivity of reservoirs/aquifers under conditions of flowing and stagnant CO2 rich multiphase fluids and in the presence of multi-component mineral systems will be needed to fully evaluate the reservoirs and adequately model these systems for sequestration potential and safety. Specifically, research will address: (1) geometric, structural, and hydrological reservoir descriptions including rock properties, fluid content, and fluid distribution, (2) changes in reservoir characteristics with drilling and reservoir production including fluid injection, and (3) the physics of multiphase flow in fractured rock systems.			
Subtotal Geosciences Research	21,510	23,301	25,534

BASIC ENERGY SCIENCES
ENGINEERING AND GEOSCIENCES

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
SBIR/STTR Funding	0	1,040	1,125
In FY 1997 $1,017,000 and $61,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.			
Subtotal SBIR/STTR Funding	0	1,040	1,125
Congressional Direction			
Funds Rose-Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.	2,732	0	0
Subtotal Congressional Direction	2,732	0	0
Total Engineering and Geosciences	$40,933	$41,194	$44,413

BASIC ENERGY SCIENCES
ENGINEERING AND GEOSCIENCES

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

Initiate a program of fundamental research in carbon emissions management for the Climate Change Technology Initiative.	$+3,000,000
Initiate a program of fundamental research in complex and collective phenomena.	+ 300,000
Initiate the Partnerships for Academic Industrial Research (PAIR) program.	+ 150,000
Redirection of base program research funds to support initiatives.	- 336,000
Increase SBIR/STTR funding due to increase in operating expenses.	+ 85,000
Beginning in FY 1999, this program will budget $20,000 for the estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+ 20,000
Total Funding Change, Engineering and Geosciences	$ +3,219,000

BASIC ENERGY SCIENCES
ENERGY BIOSCIENCES
(Tabular dollars in thousands, narrative in whole dollars)

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

Climate Change Technology Initiative. The scientific disciplines actively involved in this research are plant science and fermentative microbiology. Biological systems, particularly plants, algae, and microbes, play a major role in the capture and release of atmospheric carbon dioxide. Photosynthetic organisms use sunlight to convert carbon dioxide into more complex organic compounds, while many photosynthetic organisms use the energy in various inorganic and organic compounds to fix carbon dioxide. The biological processes of carbon dioxide fixation offer numerous possibilities leading to the reduction of atmospheric carbon dioxide levels by recycling the carbon or providing fixed carbon for longer term sequestration.

Research in Complex and Collective Phenomena. The interactions between biological macromolecules is responsible for self-assembly and other properties both structural and functional. Studies will be supported to examine both the fundamental nature of these interactions and the resulting effects of the intercommunication.

II. **Funding Schedule:**

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Energy Biosciences	$26,437	$26,711	$31,644	$+4,933	+18.5%
SBIR/STTR	0	711	845	+ 134	+18.8%
Congressional Direction	846	0	0	0	----
Total, Energy Biosciences	$27,283	$27,422	$32,489	$+5,067	+18.5%

BASIC ENERGY SCIENCES
ENERGY BIOSCIENCES

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
-The Energy Biosciences subprogram supports a broad research portfolio of molecular and mechanistic research in the microbial and plant sciences. Efforts to increase the understanding of the molecular interactions between microbial systems and geologic components critical in environmental restoration and the biological modification of inorganic materials are continuing. Research efforts to determine the mechanisms of plant tissue development are being enhanced to more fully understand the formation of the tissues involved in energy storage. A recent advance in this area was the identification of three genes that when mutated led to significant reductions in the cellulase deposited in the cell walls of the model plant, *Arabidopsis thaliana*. Research efforts on the biochemistry and physiology of microbes with the potential for energy use are continuing with special emphasis on the field of microbial physiology, a subdiscipline that is critical to scaling up and deploying new biotechnologies in an industrial setting (e.g., fermentation, pharmaceutical and chemical industries). The recent development of experimental procedures to modify the genes of methane-producing bacteria should greatly facilitate determining the biological roles of genes in these unusual organisms.Within this category of research, new work in complex and collective phenomena is expected to be funded at approximately $300,000. Small capital equipment items are needed to maintain the basic experimental infrastructure required for the advancement of this program's objectives. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.	$26,437	$26,711	$26,644

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
Basic research in carbon management for the Climate Change Technology Initiative will emphasize the biological process of photosynthesis, which is central to global carbon cycling. The current primary focus of the photosynthesis activities is the biophysics and biochemistry of energy capture and structural studies on the photosynthetic apparatus. There are a number of unexplored opportunities that complement this work with studies on the mechanism of photosynthetic carbon fixation and the subsequent metabolism of the fixed carbon. This process is tightly controlled with indications that several levels of regulation exist. Technologies recently developed in the medical community using microarrays of genes may be used to discern the genes responsible for these levels of regulation. An understanding of the complex metabolic and regulatory networks along with other molecular mechanistic studies in metabolism and molecular genetics may lead to new strategies for (1) the replacement of fossil fuels with biologically fixed carbon, including fuels and chemical feedstocks and (2) altering the steady-state levels of carbon fixed in the biosphere. Finally, the fixation mechanisms active in nonphotosynthetic organisms offer the potential to use biobased systems in the context of carbon management through an interconversion of simple carbon containing compounds.	0	0	5,000
<u>SBIR/STTR Funding</u> In FY 1997 $695,000 and $42,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.	0	711	845
Subtotal SBIR/STTR Funding	0	711	845

III. Performance Summary- Accomplishments:	**FY 1997**	**FY 1998**	**FY 1999**
Congressional Direction Funds Rose-Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.	846	0	0
Subtotal Congressional Direction	846	0	0
Total Energy Biosciences	$27,283	$27,422	$32,489

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

Initiate a program of fundamental research in carbon emissions management for the Climate Change Technology Initiative.	$+5,000,000
Initiate a program of fundamental research in complex and collective phenomena.	+ 300,000
Initiate the Partnerships for Academic Industrial Research (PAIR) program.	+ 150,000
Redirection of base program research funds to support initiatives.	- 517,000
Increase SBIR/STTR funding due to increase in operating expenses.	+ 134,000
Total Funding Change, Energy Biosciences	$+5,067,000

BASIC ENERGY SCIENCES
CONSTRUCTION
(Tabular dollars in thousands, narrative in whole dollars)

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

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Construction	$ 11,500	$ 7,000	$132,400	$+125,400	+1,791.4%
Total, Construction	$ 11,500	$ 7,000	$132,400	$+125,400	+1,791.4%

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
-Funding for the Combustion Research Facility, Phase II is completed in FY 1999 as scheduled.	$ 9,000	$7,000	$ 4,000
-Funding for Accelerator and Reactor Improvements and 0 Modifications in excess of $2,000,000 was provided for construction of a liquid hydrogen cold source at the High Flux Isotope Reactor.		2,500	0
-Funding to begin construction of the Spallation Neutron Source Title I design activities and long-lead procurements will begin in FY 1999.	0	0	128,400
Total Construction	$11,500	$ 7,000	$132,400

BASIC ENERGY SCIENCES
CONSTRUCTION

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

The decrease in funding for the construction of the Combustion Research Facility, Phase II project is a scheduled ramp down of effort.	$- 3,000,000
The increase in funding for the Spallation Neutron Source represents the initiation of construction of this facility.	+128,400,000
Total Funding Change, Construction	$+125,400,000

BASIC ENERGY SCIENCES
MAJOR USER FACILITIES
(Tabular dollars in thousands, narrative in whole dollars)

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

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

BASIC ENERGY SCIENCES
MAJOR USER FACILITIES

II. Funding Schedule:

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

Facilities	FY 1997	FY 1998	FY 1999	$Change	%Change
National Synchrotron Light Source	$27,419	$30,996	$32,612	$+1,616	+ 5.2%
High Flux Beam Reactor	34,450	22,900	22,900	0	----
Intense Pulsed Neutron Source	10,692	11,230	11,920	+690	+ 6.1%
High Flux Isotope Reactor	27,383	33,770	29,061	-4,709	-13.9%
Radiochemical Engineering Development Center . .	6,705	6,705	7,127	+422	+ 6.3%
Stanford Synchrotron Radiation Laboratory	20,562	21,279	21,853	+574	+ 2.7%
Manuel Lujan, Jr. Neutron Scattering Center	7,343	6,588	7,502	+914	+13.9%
Combustion Research Facility	5,256	5,161	5,090	-71	- 1.4%
Advanced Light Source	32,877	30,708	31,600	+892	+ 2.9%
Advanced Photon Source	81,441	82,368	87,300	+4,932	+ 6.0%
Spallation Neutron Source	0	0	28,600	+28,600	----
Partial Offset to ESRD General Reduction Applied to BES	2,043	1,545	0	-1,545	0.0%
TOTAL	$256,171	$253,250	$285,565	$+32,315	+12.8%

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
-National Synchrotron Light Source at Brookhaven National Laboratory: This synchrotron provides 79 experimental stations for research using infrared, visible, ultraviolet, and x-ray radiation. The FY 1999 request includes an increase for support of users in accord with the recommendations presented in the Birgeneau Report.	$27,419	$30,996	$32,612

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
-High Flux Beam Reactor at Brookhaven National Laboratory: This high-flux reactor operates at 30 megawatts to provide neutrons for 9 beam tubes and 16 instruments. On December 21, 1996, the High Flux beam Reactor (HFBR) was shut down for normal refueling. However, before the reactor was restarted, the announcement was made that a plume of tritium, believed to emanate from the reactor spend fuel pool, was contaminating the ground water south of the reactor. The reactor has remained in standby mode since that time. Because the reactor contains radioactive fluids in the primary cooling system, nearly a full staff is necessary to maintain the reactor and associated equipment in safe operating condition. The HFBR will continue to be maintained in this state while the Department evaluates options for its future. The funding requested in FY 1999 represents that required to maintain the reactor and to proceed with safety modifications that are required regardless of whether the reactor is restarted or is decommissioned. The level of funding for both FY 1998 and FY 1999 was set by using a formal review of cost, schedule, and technical scope of the required modifications.	34,450	22,900	22,900
- Intense Pulsed Neutron Source at Argonne National Laboratory: This pulsed spallation neutron source operates at 6.7 kilowatts with 12 instruments.	10,692	11,230	11,920
-High Flux Isotope Reactor at Oak Ridge National Laboratory: The HFIR operates at 85 megawatts. A major use of the HFIR is	27,383	33,770	29,061

III.	Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
	neutron-scattering experiments in fundamental studies of materials of interest to solid-state physicists, chemists, biologists, polymer scientists, metallurgists, and colloid scientists. Another purpose of the HFIR is the production of isotopes for research, industrial, and medical applications. Beyond these contributions, the HFIR also provides for a variety of irradiation tests and experiments that benefit from the exceptionally high neutron flux available. There will be a continuation of increased operating support in FY 1999 to take advantage of the new cold source with 3 new experimental stations and to support the scheduled replacement of the beryllium reflector. Also, as noted in the Material Sciences subprogram narrative, major item of equipment funds are provided for extension of HB-2 in order to provide beam access for six thermal neutron scattering instruments.			
	-Radiochemical Engineering Development Center at Oak Ridge National Laboratory: This facility is used to process the isotopes produced in the High Flux Isotope Reactor.	6,705	6,705	7,127
	-Stanford Synchrotron Radiation Laboratory at Stanford University: This synchrotron provides 22 experimental stations for x-ray scattering research with an additional 4 stations under construction.	20,562	21,279	21,853

BASIC ENERGY SCIENCES
MAJOR USER FACILITIES

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
-Manuel Lujan, Jr. Neutron Scattering Center at Los Alamos National National Laboratory: This pulsed spallation neutron source operates at 60 kilowatts with 7 instruments for neutron scattering and is part of the Los Alamos Neutron Science Center, a facility supported jointly by the Office of Basic Energy Sciences and the Office of Defense Programs. Additional neutron scattering instruments will be added to accommodate more users with new capabilities.	7,343	6,588	7,502
-Combustion Research Facility at Sandia National Laboratories/ California: This facility provides lasers for research in chemical dynamics and spectroscopy.	5,256	5,161	5,090
-Advanced Light Source at Lawrence Berkeley National Laboratory: This new, third-generation synchrotron light source provides high-brilliance visible and ultra-violet light and low energy x-rays to 22 experimental stations including 4 that are under construction. Following the receipt of the BESAC Panel Report "Synchrotron Radiation Sources and Science" (the "Birgeneau Report") in November, 1997, BES adjusted the FY 1998 funding for its four synchrotron radiation light sources to address the highest priority recommendations of the Birgeneau Panel. In order to provide funding for at least part of the recommended increases at the National Synchrotron Light Source, the Stanford Synchrotron Radiation Laboratory, and the Advanced Photon Source, it was necessary to reduce FY 1998 support at the Advanced Light Source by $2,500,000. It is important to note, however, that it is not the intention of BES to close the Advanced Light Source or to permanently reduce its operations. Indeed, the	32,877	30,708	31,600

III. Performance Summary- Accomplishments: **FY 1997** **FY 1998** **FY 1999**

most important recommendation of the Birgeneau Panel was that the shutdown of any one of the four BES synchrotron light sources over the next decade would do significant harm to the Nation's science research capabilities and would considerably weaken our international competitive position in this field.

Furthermore, the most important conclusion of the Birgeneau Panel was that over the past 20 years in the United States synchrotron radiation research has evolved from an esoteric endeavor practiced by a small number of scientists primarily from the fields of solid state physics and surface science to a mainstream activity that provides essential information in the materials and chemical sciences, the life sciences, molecular environmental science, the geosciences, nascent technology and defense-related work. The user community at U.S. synchrotron facilities continues to grow exponentially, having reached more than 4,000 on-site users annually in FY 1997. The Birgeneau Report noted that the research carried out at the four BES synchrotron sources is both very broad and often exceptionally deep. Therefore, a high priority of the BES program is to strengthen the scientific program at the Advanced Light Source in order that the facility may evolve into a world-class VUV/soft X-ray light source. To do so, BES is supporting an international workshop in March, 1998, at the Advanced Light Source to determine scientific directions for the facility and a roadmap for achieving the vision. Funding for the Advanced Light Source in FY 1999 represents a modest cost of living increase over the *reduced*

BASIC ENERGY SCIENCES
MAJOR USER FACILITIES

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999	
FY 1998 level; however, it is anticipated that this funding could increase based on successful proposals both from the user community and from the facility itself following the workshop in March, 1998.				
-Advanced Photon Source at Argonne National Laboratory: This new, third-generation synchrotron light source provides high-energy x-rays to at least 20 experimental stations with more under construction.	81,441	82,368	87,300	
-Spallation Neutron Source at Oak Ridge National Laboratory: This next-generation neutron source will have a power in the 1 megawatt range. Continued research and development is necessary to support construction of the SNS. Prior to FY 1999, research and development activities were funded in the Materials Sciences research section of this budget.		0	0	28,600
-Partial Offset to ESRD General Reduction Applied to BES.	2,043	1,545	0	
Total Major User Facilities	$256,171	$253,250	$285,565	

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

Capital Operating Expenses	FY 1997	FY 1998	FY 1999	$ Change	% Change
General Plant Projects (total)...	$8,894	$10,762	$9,275	$-1,487	-13.8%
AIP under $5 million (total)..	7,602	11,109	7,110	-3,999	-36.0%
Capital Equipment (total)..	45,870	49,740	60,097	+10,357	+20.8%

Construction Project Summary (both Operating and Construction Funded)

Project No.	Project Title	TEC	Previous Appropriated	FY 1997 Appropriated	FY 1998 Request	FY 1999 Request	Unapprop. Balance
99-E-334	Spallation Neutron Source, ORNL	########	$0	$0	$0	$128,400	########
97-E-305	Accelerator and Reactor Improvements & Modifications, Various Locations	2,500	0	2,500	0	0	
96-E-300	Combustion Research Facility, Phase II, SNL	26,800	6,800	9,000	7,000	4,000	
Total Basic Energy Sciences		XXXXXX	$6,800	$11,500	$7,000	$132,400	########

Detailed Breakouts	Total CDR Cost	Previous Appropriated	FY 1997 Appropriated	FY 1998 Request	FY 1999 Request	Unapprop. Balance
CDR's - Exceeding $3 million						
1. Spallation Neutron Source - Conceptual Design	$15,478	$7,535	$7,943	$0	$0	$0

Major Items of Equipment (CE $2 million and above)	TEC	Previous Appropriated	FY 1997 Appropriated	FY 1998 Request	FY 1999 Request	Acceptance Date
1. Short Pulse Spallation Upgrade at LANSCE - LANL	20,500	0	0	4,500	4,500	Sept-2001
2. HB-2 Beam Tube Extension at HFIR-ORNL	5,900	0	0	0	3,500	Sept-2000

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST

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

Basic Energy Sciences

1. Title and Location of Project:	Spallation Neutron Source (SNS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No.: 99-E-334 2b. Construction Funded	

	Preliminary Estimate	Title I Baseline a/	Current Baseline Estimate
3a. Date A-E Work Initiated (Title I Design Start Scheduled)	1st Qtr. FY 1999	TBD	TBD
3b. A-E Work (Title I & II) Duration:	60 Months	TBD	TBD
4a. Date physical Construction Starts:	3rd Qtr. FY 2000	TBD	TBD
4b. Date Construction Ends:	4th Qtr. FY 2005	TBD	TBD

	Preliminary Estimate	Title I Baseline a/	Current Baseline Estimate
5. Total Estimated Cost (TEC) --	$1,138,800	TBD	TBD
6. Total Project Cost (TPC) --	$1,332,800	TBD	TBD

a/ To be determined upon completion of Title I design.

1. Title and Location of Project:	Spallation Neutron Source (SNS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No.: 99-E-334 2b. Construction Funded

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Adjustments	Obligations	Costs
1999	$128,400		$128,400	$ 52,500
2000	196,100		196,100	135,200
2001	254,900		254,900	294,000
2002	253,200		253,200	276,100
2003	184,900		184,900	207,300
2004	78,300		78,300	130,700
2005	43,000		43,000	43,000

8. Project Description, Justification, and Scope

The purpose of the Spallation Neutron Source (SNS) Project is to provide a next-generation short-pulse spallation neutron source for neutron scattering and related research in broad areas of the physical, chemical, materials, biological, and medical sciences. The SNS will be a national facility with an open user policy attractive to scientists from universities, industries, and federal laboratories. It is anticipated that the facility will be used by 1,000—2,000 scientists and engineers each year and that it will meet the national need for neutron science capabilities well into the next century.

The importance of neutron science for fundamental discoveries and technological development is universally acknowledged. The scientific justification and need for a new neutron source and instrumentation in the U.S. have been thoroughly established by numerous studies by the scientific community since the 1970s. These include the 1984 National Research Council study *Major Facilities for Materials Research and Related Disciplines* (the Seitz-Eastman Report), which recommended the immediate start of the design of both a steady-state source and an accelerator-based pulsed spallation source. More recently, the 1993 DOE Basic Energy Sciences Advisory Committee (BESAC) report *Neutron Sources for America's Future* (the Kohn Panel Report) again included construction of a new pulsed spallation source with SNS capabilities among its highest priorities. This conclusion was even more strongly reaffirmed by the 1996 BESAC Report (the Russell Panel Report), which recommended the construction of a 1 megawatt (MW) spallation source that could be upgraded to significantly higher powers in the future.

8. Project Description, Justification, and Scope (continued)

Neutron probes are a unique and increasingly indispensable scientific tool. Over the past decade, they have made invaluable contributions to the
understanding and development of many classes of new materials, from high temperature superconductors to fullerenes, a new form of carbon. In addition to creating the new scientific knowledge upon which unforeseen breakthroughs will be based, neutron science is at the core of many technologies that currently improve the health of our citizenry and the safety and effectiveness of our industrial materials.

The information that neutrons provide has wide impacts. For example, chemical companies use neutrons to make better fibers, plastics, and catalysts; drug companies use neutrons to design drugs with higher potency and fewer side effects; and automobile manufacturers use the penetrating power of neutrons to understand how to cast and forge gears and brake discs in order to make cars run better and more safely. Furthermore, research on magnetism using neutrons has led to higher strength magnets for more efficient electric generators and motors and to better magnetic materials for magnetic recording tapes and computer hard drives.

Based on the recommendations of the scientific community obtained via the 1996 Russell Panel Report, the SNS has been designed to operate at an average power on target of about 1 MW. At this power level, the SNS will be the most powerful spallation source in the world--six times that of ISIS at the Rutherford Appleton Laboratory in the United Kingdom. However, the SNS has been deliberately designed to allow for economical upgrading to substantially higher powers once the technology is developed to make this possible. Thus, the SNS will be the nation’s premiere neutron facility for many decades.

The importance of high power, and consequently high neutron flux (i.e., high neutron intensity), cannot be overstated. The properties of neutrons that make them an ideal probe of matter also require that they be generated with high flux. (Neutrons are particles with the mass of the proton, with spin 1/2, and with no electrical charge.) Neutrons interact with nuclei and magnetic fields; both interactions are extremely weak, but they are known with great accuracy. Because they weakly interact with materials, neutrons are highly penetrating and can be used to study bulk phase samples, highly complex samples, and samples confined in thick-walled metal containers. Because they have spin, neutrons have a magnetic moment and can be used to study magnetic structure and magnetic properties of materials. Because their interactions are known with great accuracy, neutron scattering is far more easily interpreted than either photon scattering or electron scattering.

8. Project Description, Justification, and Scope (continued)

However, the same properties that make neutrons an ideal probe of matter also result in their most significant disadvantage. Because neutrons interact only weakly with matter, most neutrons pass through a sample without producing a detectable interaction. Therefore, neutron scattering experiments are said to be extremely "flux limited." This situation is further exacerbated because, unlike photons and charged particles, neutrons
cannot be focused. Therefore, high brilliance (i.e., highly focused) neutron beams are very difficult to make. The combination of weak interaction and inherent low brilliance has driven the quest for high-flux neutron sources. The pursuit of high-flux neutron sources is more than just a desire to perform experiments faster, although that, of course, is an obvious benefit. High flux enables broad classes of experiments that cannot be done with low-flux sources. For example, high flux enables studies of small samples, complex molecules and structures, time-dependent phenomena, and very weak interactions. Put most simply, high flux enables studies of complex materials in real time and in all disciplines--physics, chemistry, materials science, geosciences, and biological and medical sciences.

The SNS will consist of a linac-ring accelerator system that delivers short (microsecond) pulses to a target/moderator system where neutrons are produced by a nuclear reaction process called spallation. The process of neutron production in the SNS consists of the following: negatively charged hydrogen ions are produced in an ion source and are accelerated to 1 giga electron volt (GeV) energy in a linear accelerator (linac); the hydrogen ion beam is injected into an accumulator ring through a stripper foil, which strips the electrons off of the hydrogen ions to produce a
proton beam; the proton beam is collected and bunched into short pulses in the accumulator ring; and, finally, the proton beam is injected into a heavy metal target at a frequency of up to 60 Hz. The intense proton bursts striking the target produce pulsed neutron beams by the spallation process. The high-energy neutrons so produced are moderated (i.e., slowed down) to reduce their energies, typically by using thermal or cold moderators. The "moderated" neutron beams are then used for neutron scattering experiments. Specially designed scientific instruments use these pulsed neutron beams for a wide variety of investigations.

The primary objectives in the design of the site and buildings for the SNS are to provide optimal facilities for the DOE and the scientific community for neutron scattering well into the next century and to address the mix of needs associated with the user community, the operations staff, security, contamination control, noise, etc.

A research and development program is required to ensure technical feasibility and to determine physics design of accelerator and target systems that will meet performance requirements.

8. Project Description, Justification, and Scope (continued)

The objectives stated above will be met by the technical components described earlier (ion source; linac accelerator; accumulator ring; target station with moderators; beam transport systems; and experimental facilities capable of supporting up to 18 neutron scattering beam lines for research instruments) and attendant conventional facilities. Also included on the site will be facilities to support the needs of operations staff, technical support staff, users and capabilities for remote servicing of activated components. An initial suite of approximately 10 neutron scattering instruments is included in the TEC.

The FY 1999 requested budget authority will allow the start of Title I design activities, initiation of subcontracts and long-lead procurements, and continuation of critical research and development work necessary to reduce technical and schedule risks in this project.

1. Title and Location of Project:	Spallation Neutron Source (SNS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No.: 99-E-334 2b. Construction Funded

9. Details of Cost Estimate [a/]

		Item Cost	Total Cost
a.	Design and Management Costs		$ 290,000
	(1) Engineering, design, and inspection at approximately 26% of items c and f below	$ 166,900	
	(2) Construction management at approximately 4% of items c and f below	26,300	
	(3) Project management at approximately 15% of items c and f below	96,800	
b.	Land and land rights		0
c.	Construction costs.		642,700
	(1) Improvements to land (grading, paving, landscaping, and sidewalks)	28,600	
	(2) Buildings	176,700	
	(3) Other structures	600	
	(4) Utilities (electrical, water, steam, and sewer lines)	30,500	
	(5) Technical components	406,300	
d.	Standard Equipment		1,100
e.	Major computer items		12,000
f.	Removal cost less salvage.		0
g.	Design and project liaison, testing, checkout and acceptance		6,700
	Subtotal		$ 952,500
h.	Contingency at approximately 20% of above costs		186,300
	Total line item cost (Section 11.a.1.(a))		$1,138,800
i.	Less: Non-Federal Contribution		0
	Net Federal total estimated cost (TEC)		$1,138,800

[a/] The cost estimate is based on a conceptual design completed in FY 1997. The DOE Headquarters Economic Escalation Indices were used as appropriate over the project cycle.

10. Method of Performance:

The ORNL Management and Operating Contractor will provide overall project management and integration, design and ultimate procurement of the target station, beam transport, and experiment systems, and will subcontract for the services of an Industry Team for design and construction management services. The Industry Team will consist of an Architect-Engineer for the conventional facilities design and a Construction Manager for construction, installation, equipment procurement, testing and preoperational support. Other DOE laboratories will, through intra laboratory agreements, become members of the overall project's management, design and R&D team, particularly in the areas encompassed by the linac, the accumulator ring, instrumentation, and the target. Procurement and construction will be accomplished, to the extent feasible, by fixed-priced subcontracts awarded to industry on the basis of competitive bidding.

1. Title and Location of Project: Spallation Neutron Source (SNS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No.: 99-E-334 2b. Construction Funded

11. Schedule of Project Funding and Other Related Funding Requirements

a. Total project costs	Previous FY Years	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	TOTAL
(1) Total facility costs									
(a) Line Item (Section 9)	$ 0	$ 52,500	$135,200	$294,000	$276,100	$207,300	$130,700	$43,000	$1,138,800
(b) Plant Engineering & Design . . .	0	0	0	0	0	0	0	0	0
(c) Expense-funded equipment . . .	0	0	0	0	0	0	0	0	0
(d) Inventories	0	0	0	0	0	0	0	0	0
Total direct cost (Federal and Non-federal)	0	52,500	135,200	294,000	276,100	207,300	130,700	43,000	1,138,800
(2) Other project costs									
(a) R&D necessary to complete project	21,600	25,700	16,297	11,700	7,800	3,700	2,600	0	89,397
(b) Conceptual design cost	15,303	0	0	0	0	0	0	0	15,303
(c) Decontamination & Decommissioning (D&D)	0	0	0	0	0	0	0	0	0
(d) NEPA Documentation costs . . .	1,500	0	0	0	0	0	0	0	1,500
(e) Other project related costs	0	800	900	1,300	1,900	6,400	16,000	57,400	84,700
(f) Capital equipment not related to construction	100	2,100	700	100	100	0	0	0	3,100
Total other project costs	38,503	28,600	17,897	13,100	9,800	10,100	18,600	57,400	194,000
Total project costs (TPC)	38,503	81,100	153,097	307,100	285,900	217,400	149,300	100,400	1,332,800
(g) Less: Non-federal contribution .	0	0	0	0	0	0	0	0	0
Net Federal total project costs (TPC)	$38,503	$81,100	$153,097	$307,100	$285,900	$217,400	$149,300	$100,400	$1,332,800

11. Schedule of Project Funding and Other Related Funding Requirements (Continued)

b. Related annual funding [a/] (estimated life of project: 40 Years)

(1) Facility operating costs	$21,300
(2) Facility maintenance and repair costs	25,300
(3) Programmatic operating expenses directly related to the facility	22,500
(4) Capital equipment not related to construction but related to the programmatic effort in the facility	2,100
(5) GPP or other construction related to the programmatic effort in the facility	1,000
(6) Utility costs	30,400
(7) Accelerator Improvement Modifications (AIMs)	4,100
Total related annual funding	$ 106,700

[a/] Expressed in FY 2006 dollars, the first full year of operation.

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

a. Total Project Cost

(1) Total facility costs

(a) Line Item (Section 9)

Construction line item costs included in this budget request are for providing Title I and II design, inspection, procurement, and construction of the SNS facility for an estimated cost of $1,138,800,000.

(b) Plant Engineering and Design

No narrative required

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

(c) Expense funded equipment

No narrative required

(d) Inventories

No narrative required

(2) Other project costs

(a) R&D necessary to complete construction

A research and development program at an estimated cost of $89,400,000 is needed to confirm several design bases related primarily to the accelerator systems, the target systems, safety analyses, cold moderator designs, and neutron guides, beam tubes, and instruments. Several of these development tasks require long time durations and the timely coupling of development results into the design is a major factor in detailed task planning.

(b) Conceptual design costs

Costs of $15,303,000 are included for conceptual design and for preparation of the conceptual design documentation prior to the start of Title I design in FY 1999.

(c) Decontamination & Decommissioning

No narrative required

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

(d) NEPA Documentation costs

Estimated costs of $1,500,000 are included to complete the Environmental Impact Statement.

(e) Other project related costs

Estimated costs of $84,697,000 are included to cover pre-operations costs.

(f) Capital equipment not related to construction but related to the programmatic effort in the facility.

Estimated costs of $3,100,000 to provide test facilities and other capital equipment to support the R&D program.

b. Related Annual Funding (estimated life of the facility: 40 years)

Costs shown are the estimated annual operating costs for the facility in FY 2006 dollars, the first full year of operation.

13. Design and Construction of Federal Facilities

All DOE facilities are designed and constructed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations, and DOE Orders. The total estimated cost of the project includes the cost of measures necessary to assure compliance with Executive Order 12088 "Federal Compliance with Pollution Control Standards; Section 19 of the Occupational Safety and Health Act of 1970, the provisions of Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CFR Title 29, Chapter XVII,
Part 1960); and the Architectural Barriers Act, Public Law 90-480, and implementing instructions in 41 CFR 101-19.6. The project will be located in an area not subject to flooding determined in accordance with the Executive Order 11988. This project includes the construction of a new building or building addition, therefore, a review of the GSA Inventory of Federal Scientific laboratories is required.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST

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

Basic Energy Sciences

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

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
3a. Date A-E Work Initiated (Title I Design Start Scheduled)	N/A	N/A	1st Qtr. FY 1998
3b. A-E Work (Title I & II) Duration:	N/A	N/A	12 months
4a. Date physical Construction Starts:	N/A	N/A	4th Qtr. FY 1998
4b. Date Construction Ends:	N/A	N/A	4th Qtr. FY 1999

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate a/
5. Total Estimated Cost (TEC) --	N/A	N/A	$26,800
6. Total Project Cost (TPC) --	N/A	N/A	$30,020

a/ Current Baseline Estimate is the latest baseline which reflects the approved changes to the Title I baseline.

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

7. Financial Schedule: (Federal Funds)

Fiscal Year	Appropriation	Adjustments	Obligations	Costs
Prior Years a/	$ 4,800		$ 4,800	$ 4,205
1995	0		0	4
1996	2,000		2,000	685
1997	9,000		9,000	7,347
1998	7,000		7,000	8,476
1999	4,000		4,000	6,083

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

8. Project Description, Justification and Scope

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

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

The laboratory building addition will be an L-shaped extension to the south and east of the existing building. Construction of the addition will match the existing building in architectural style, materials, and finishes, color, and floor-to-floor heights. The laboratory building

8. Project Description, Justification and Scope (Continued)

addition will provide sixteen new laboratory spaces and two facility laser laboratories. The new facility laser rooms will be connected to serve any Lab in the facility, via the Laser Duct and Periscope System.

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

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

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

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

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

8. Project Description, Justification and Scope (Continued)

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

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

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

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

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

There is a continuing need for the CRF to advance combustion-related science and technology to a higher level. The improvements included in the Phase II project will address this need. For example, special lasers and equipment will be developed to provide the ability to measure quantitatively entire two- and three-dimensional images of a system's physical and chemical properties with better resolution, and far greater

8. Project Description, Justification and Scope (Continued)

speed than is now possible. It is this type of advance in the science of combustion that will allow the pursuit of the increasingly more difficult and complex problems that face our country.

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

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

The normal increase in both the quantity and sophistication of combustion research by Sandia staff, together with the heightened requirements of visiting scientists, have completely saturated the facilities provided under CRF Phase I. During the past ten years the number of scientists who visit the CRF long enough to participate in research has almost tripled. In fiscal year 1993 forty professional staff hosted eighty nine such visits. Many important experiments cannot be carried out in the existing facilities because of a lack of space. Access to the unique capabilities of the CRF (such as the Facility lasers and computer resources) is essential for studying trade-offs between combustion efficiency and the pollution that results from existing and alternative fuels. However, much of the combustion research and diagnostics development

8. Project Description, Justification and Scope (Continued)

work at Sandia is currently being done in facilities that are widely scattered throughout Sandia/CA where the researchers do not have access to these unique capabilities. Additional laboratories will permit the consolidation of these experiments at the CRF, thus providing the necessary access to the unique capabilities at the Facility. It will also provide adequate space and ready access to visiting scientists.

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

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

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

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

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

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

9. <u>Details of Cost Estimate (Continued)</u>

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

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

10. <u>Method of Performance</u>

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

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

11. Schedule of Project Funding and Other Related Funding Requirements

	Prior Years	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Total
a. Total project funding							
1. Total facility costs							
(a) Line item	$4,205	$ 4	$ 685	$ 7,347	$ 8,476	$6,083	$26,800
Total direct cost	4,205	4	685	7,347	8,476	6,083	26,800
2. Other project costs							
(a) Other project costs . .	220	0	0	500	750	750	2,220
(b) Capital equipment . . .	0	0	0	500	250	250	1,000
Total other project costs	220	0	0	1,000	1,000	1,000	3,220
Total project cost (TPC) .	$4,425	$ 4	$ 685	$8,347	$ 9,476	$7,083	$30,020

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

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

a/ Estimated costs in thousands escalated to 1999-year dollars. The related annual funding displayed is related to CRF, Phase II project only. These amounts are in addition to annual funding for the existing CRF operations.

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

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

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

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

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

13. Design and Construction of Federal Facilities

All DOE facilities are designed and constructed in accordance with applicable Public Laws, Executive Orders, OMB Circulars, Federal Property Management Regulations, and DOE Orders. The total estimated cost of the project includes the cost of measures necessary to assure compliance with Executive Order 12088 "Federal Compliance with Pollution Control Standards"; Section 19 of the Occupational Safety and Health Act of 1970, the provisions of Executive Order 12196, and the related Safety and Health provisions for Federal Employees
(CFR Title 29, Chapter XVII, Part 1960); and the Architectural Barriers Act, Public Law 90-480, and implementing instructions in 41 CFR 101-19.6. The project will be located in an area not subject to flooding determined in accordance with the Executive Order 11988. This project includes the construction of a new building or building addition, therefore, a review of the GSA Inventory of Federal Scientific laboratories is required.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
SCIENCE
(Tabular dollars in thousands, Narrative in whole dollars)

COMPUTATIONAL AND TECHNOLOGY RESEARCH

PROGRAM MISSION

The mission of the Computational and Technology Research (CTR) program is to perform long-term computational, technology, and advanced energy projects research in support of the goals of the Office of Energy Research strategic plan, and the mission of the Department of Energy (DOE).

The GOAL of the CTR program is:

To address complex problems important to the mission of the Department of Energy and to the nation, through an integrated program in applied mathematical sciences, high performance computing and communications, information infrastructure, advanced energy projects research, and technology research. Research at the forefront of scientific research is becoming more multidisciplinary and fast-paced, calling for new approaches. The CTR program emphasizes multidisciplinary research, often with federal and private sector partners. The program exploits the capabilities and research skills at universities, national laboratories, and industrial research laboratories. The CTR program funds research that extends from fundamental investigations to technology development. This includes activities such as High Performance Computing and Communications, the National Information Infrastructure, inter-agency development of the Next Generation Internet, and the joint Energy Research-Defense Programs DOE 2000 initiative. The program also explores advanced energy concepts to establish their scientific feasibility. Technology research activities include multi-year collaborations and technical assistance to small business. The program works closely with other Energy Research, Departmental, and other agency programs.

The OBJECTIVES related to these goals are:

1. To CONTRIBUTE TO SUSTAINABLE ENERGY PRODUCTION AND USE - Conduct research that creates scientific and engineering knowledge in support of Department of Energy mission thrusts to accelerate the utilization and development of energy technologies in a safe and environmentally compatible manner.

2. To PROVIDE WORLD CLASS COMPUTING FACILITIES - Provide and operate major user supercomputer facilities including wide area networks needed for DOE research and foster research partnerships with industry and the entire scientific community. These facilities include the National Energy Research Scientific Computing (NERSC) Center at Lawrence Berkeley National Laboratory, the Energy Sciences Network (ESnet), and specialized High Performance Computing Resource Providers (HPCRPs) at Los Alamos National Laboratory, Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, and Argonne National Laboratory. Thousands of scientists and engineers use these facilities to advance knowledge and develop new products, materials, and manufacturing processes.

3. To ENSURE THAT RESEARCH RESULTS ARE WIDELY KNOWN, VALUED AND USED - Promote open communications and the transfer of information and technology among universities, government, and the private sector. Activities include peer-review of research activities, presentation of results at meetings and in peer-reviewed scientific journals, strong coordination and planning with the energy technology offices of the Department, co-location of researchers with partner programs, input from stakeholders, and in-depth workshops and conferences among scientists and engineers with management sponsorship and participation. The national laboratories and universities are unique resources to bring about many of these important interactions.

MAJOR ACTIVITIES:

1. <u>Mathematical, Information, and Computational Sciences</u>:
   Supports forefront, diverse applied mathematical sciences, high performance computing, communications and information infrastructure research that spans the spectrum of activities from strategic fundamental research to technology development and demonstration.

2. <u>Laboratory Technology Research</u>:
   Supports high risk, long-term technology research that advances basic research results to a stage where industry and DOE technology

programs can exploit the technologies for improved energy utilization and efficiency.

PROGRAM MISSION - COMPUTATIONAL AND TECHNOLOGY RESEARCH (Cont'd)

3. Advanced Energy Projects:
   Supports fundamental research to establish the feasibility of novel, high risk/high payoff energy-related concepts that span the Department's energy mission and goals.

SCIENTIFIC FACILITIES UTILIZATION:

The Computational and Technology Research program request includes $26,500,000 in FY 1999 to support the NERSC Center. This investment will provide research time for about 5,000 scientists in universities, Federal agencies, and U.S. companies. It will also leverage both Federally and privately sponsored research, consistent with the Administration's strategy for enhancing the U.S. National science investment. The proposed funding supports the number of users served in FY 1997, and will maintain the quality of service and availability of facility resources to users, including university and government scientists, as well as private companies who rely on unique DOE facilities for their basic research needs. The proposed funding level will also provide for efficient utilization of high technology facilities, which are generally oversubscribed by factors of two to three. Research communities that will benefit from this initiative include structural biology, superconductor technology, medical research and technology development, materials, chemical and plasma sciences, high energy and nuclear physics, and environmental and atmospheric research.

PERFORMANCE MEASURES:

The Computational and Technology Research program performs three different types of activities: operate facilities that provide service for ER and DOE; conduct basic research in areas such as computational science, mathematics, and advanced energy principles; and perform technology research to bridge the gap between basic research and industrial needs.

Facilities Operations: Facilities and infrastructure including the NERSC Center and ESnet are operated to meet user and overall ER program requirements. Facility performance measures include achievement of performance specifications, operating time, throughput, user satisfaction and effective utilization of resources as determined by reports from external review panels, user steering committees, and internal ER program manager committees. The development and upgrade of scientific facilities will be kept on schedule and within cost, not to exceed 110 percent of estimates. The operating time lost at scientific facilities due to unscheduled downtime will be less than 10 percent of the total scheduled possible operating time, on average. A review panel of users will review and judge the operation of the computer facilities and networks to determine that they have successfully met 75 percent of their requirements.

Basic Research: The scientific and technical merit, appropriateness, and quality of the Computational and Technology Research programs are judged by rigorous peer reviews conducted by internationally recognized scientific experts. High quality research is assured based on the results of periodic peer reviews by experts in the field. Other measures of the quality of the research are sustained achievements in advancing knowledge, as indicated by publication of research results in refereed scientific journals and by invited participation at national and international conferences and workshops; and by awards received by CTR supported researchers.

Bridging Technology Gap: The purpose of the Laboratory Technology Research (LTR) subprogram, and a subgoal of the Advanced Energy Projects (AEP) subprogram, is to bridge from basic research to the point where industry and DOE's technology programs can exploit the innovations for energy applications. Accordingly, performance is judged by the number of supported projects and concepts that are subsequently supported or implemented by either industry or DOE's technology programs, and the economic and commercial impact of products and processes resulting from the projects, as indicated, for example by R&D 100 Awards.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- In FY 1997, the DOE 2000 initiative began significant multi-laboratory software development efforts in Advanced Computational Testing and Simulation as well as National Collaboratory technology. In addition, two National Collaboratory pilot project partnerships: the Diesel Combustion Collaboratory and the Materials MicroCharacterization Collaboratory were started in FY 1997.

- The second phase of the Grand Challenge program was initiated in FY 1997 in partnership with all other ER program offices and other DOE program offices. A number of the grand challenge teams will use the technologies developed in DOE 2000.

- The CTR program won 5 of the 36 1997 R&D 100 Awards received by DOE programs. Three of these awards were won by the AEP and LTR subprograms, and two were won by the MICS subprogram.

- The CTR program will complete prototype development of the "virtual lab" approach and implement at least three program trial applications.

- The FY 1999 request also includes funding for the Department's participation in the President's Next Generation Internet (NGI) Initiative. This initiative, which involves a number of Federal agencies, has three goals: (1) promote experimentation with the next generation of networking technologies; (2) develop a next generation network testbed to connect universities and Federal research institutions at rates that demonstrate new networking technologies and support future research; and (3) demonstrate new applications that meet important national goals and missions. This initiative will leverage previous MICS investments in ESnet and other advanced networking technologies.

Funding of Contractor Security Clearances

- In FY 1999, the Department will divide the responsibility for obtaining and maintaining security clearances. The Office of Security Affairs, which has been responsible for funding all Federal and contractor employee clearances, will pay only for clearances of Federal employees, both at headquarters and the field. Program organizations will be responsible for contractor clearances, using program funds. This change in policy will enable program managers to make the decisions as to how many and what level clearances are necessary for effective program execution. In this way, it is hoped that any backlog of essential clearances which are impeding program success can be cleared up by those managers most directly involved. The Office of Energy Research is budgeting $46,000 for estimated contractor clearances in FY 1999 within this decision unit.

COMPUTATIONAL AND TECHNOLOGY RESEARCH
PROGRAM FUNDING PROFILE
(Dollars in thousands)

Subprogram	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Budget Request
Mathematical, Information, and Computational Sciences	$ 114,804		$ 127,490		$ -280	a/	$ 127,210		$ 141,311
Laboratory Technology Research....................................	23,666		15,829		-35	a/	15,794		16,329
Advanced Energy Projects...	11,398		7,588		-16	a/	7,572		3,000
Subtotal, Computational and Technology Research.........	149,868		150,907		(331)	a/	150,576		160,640
Adjustment..	-2,580	b/	-1,713	c/	0		-1,713	c/	0
Adjustment..	0		-331	a/	331	a/	0		0
TOTAL, CTR..	$ 147,288	d/	$ 148,863		$ 0		$ 148,863		$ 160,640

a/ Share of Science general reduction for contractor training.

b/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program ($2,522,00(and FY 1997 emergency flood supplemental rescission ($58,000). The total general reduction is applied at the appropriation level.

c/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.

d/ Excludes $3,430,000 which has been transferred to the SBIR program and $202,000 which has been transferred to the STTR program.

Public Law Authorization:

Public Law: 95-91, DOE Organization Act

COMPUTATIONAL AND TECHNOLOGY RESEARCH
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$15,998	$13,524	$0	$13,524	$12,084
National Renewable Energy Laborator	734	498	0	498	0
Sandia National Laboratories	6,286	5,188	0	5,188	3,344
Chicago Operations Office					
Ames Laboratory	3,867	2,240	0	2,240	1,985
Argonne National Laboratory	17,396	15,324	0	15,324	16,615
Fermi National Accelerator Laboratory	0	0	0	0	0
Brookhaven National Laboratory	4,074	2,284	0	2,284	2,617
Princeton Plasma Physics Laboratory	90	90	0	90	0
Oakland Operations Office					
Lawrence Berkeley National Laborator	48,378	53,678	0	53,678	51,922
Lawrence Livermore National Laborat	1,605	1,979	0	1,979	530
Stanford Linear Accelerator Center	410	410	0	410	200
Oak Ridge Operations Office					
Oak Ridge Inst. for Science and Tech.	27	135	0	135	0
Oak Ridge National Laboratory	18,563	14,891	0	14,891	8,069
Thomas Jefferson National Accelerator Facility	180	190	0	190	180

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Budget Request
Richland Operations Office									
Pacific Northwest National Laboratory	4,529		3,628		0		3,628		3,621
All Other Sites a/	27,731		36,848		-331	b/	36,517		59,473
Subtotal	149,868		150,907		-331	b/	150,576		160,640
Adjustment	-2,580	c/	-1,713	d/	0		-1,713	d/	0
Adjustment	0		-331	b/	331	b/	0		0
TOTAL	$147,288	e/	$148,863		$0		$148,863		$160,640

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

b/ Share of Science general reduction for contractor training.

c/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program ($2,522,000) and FY 1997 emergency flood supplemental rescission ($58,000). The total general reduction is applied at the appropriation level.

d/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.

e/ Excludes $3,430,000 which was transferred to the SBIR program and $202,000 which was transferred to the STTR program.

COMPUTATIONAL AND TECHNOLOGY RESEARCH
MATHEMATICAL, INFORMATION, AND COMPUTATIONAL SCIENCES
(Tabular dollars in thousands, narrative in whole dollars)

I. <u>Mission Supporting Goals and Objectives</u>: The Mathematical, Information, and Computational Sciences (MICS) subprogram is a forefront, diverse program in applied mathematical sciences, high performance computing, communications and information infrastructure that spans the spectrum of activities from strategic fundamental research to technology development and demonstration. The diverse activities supported by this program are integrated to support two major strategic thrusts: (1) the National Collaboratories (NC) thrust that develops tools and capabilities to permit scientists and engineers working at different DOE and other facilities to collaborate on research as easily as if they were in the same building; (2) the Advanced Computational Testing and Simulation (ACTS) thrust that develops an integrated set of algorithms, software tools and infrastructure to enable computer simulation to better complement experiment and theory or to be used in place of experiments when real experiments are too dangerous, expensive, or inaccessible. These two strategic thrusts support the mathematics, computational science, and information technology needs of all DOE technical mission areas (e.g., Fundamental Research, Defense, Energy Efficiency, Fossil Energy, and Environmental programs). The efforts in these areas are closely coordinated with related activities supported by Defense Programs.

The FY 1999 request includes funding for the DOE 2000 initiative. Support for the Advanced Computational Testing and Simulation part of the DOE 2000 initiative will foster advanced computational testing and simulation tools to attack complex technical problems and accelerate applications critical to DOE missions. Support for the National Collaboratory part of the DOE 2000 initiative will develop and test a common technology base that will permit scientists and engineers at various remote sites to simultaneously participate in research at large science facilities. The DOE 2000 initiative is coordinated with parallel research in other agencies through the Committee on Computing, Information, and Communication of the National Science and Technology Council; it extends throughout DOE through partnerships with other DOE programs.

The MICS subprogram also provides supercomputer access and advanced communication capabilities, through the National Energy Research Scientific Computing (NERSC) Center and the Energy Sciences Network (ESnet), to scientific researchers.

The FY 1999 request also includes funding for the Department’s participation in the President’s Next Generation Internet (NGI) Initiative. This initiative, which involves a number of Federal agencies, has three goals: (1) promote experimentation with the next generation of networking technologies; (2) develop a next generation network testbed to connect universities and Federal research institutions at rates that demonstrate new networking technologies and support future research; and (3) demonstrate new applications that meet important national goals and missions. This initiative will leverage previous MICS investments in ESnet and other advanced networking technologies. At this level of funding, DOE's goal one activities will focus on developing and deploying technologies that provide DOE applications greater control and management of the network infrastructure, provide DOE applications greater control and management of the network infrastructure, and provide enhanced network interconnection capabilities to support agency and university collaborations. DOE's participation in goal two is focused on connections to six National Laboratories at 100 times today's Internet and two connections to National Laboratories at 1,000 times today's Internet, as well as enhanced support for some strategic university access to DOE facilities and collaborations. DOE's focus in goal three is the enabling of DOE's applications to utilize goal one technologies immediately in DOE's goal two infrastructure, specifically those applications that require University and Laboratory access to DOE's unique facilities. The National Collaboratory Pilot Projects initiated in FY 1997 would continue as NGI applications.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Mathematical, Computational, and Computer Sciences Research	$ 48,028	$ 50,548	$ 52,232	$+ 1,684	+ 3.3%
Advanced Computation, Communications Research, and Associated Activities. . .	66,776	73,450	85,500	+12,050	+16.4%
SBIR/STTR	0	3,212	3,579	+ 367	+11.4%
Total	$114,804	$ 127,210	$141,311	$+14,101	+11.1%

III. Performance Summary - Accomplishments:

	FY 1997	FY 1998	FY 1999
Mathematical, Computational, and Computer Sciences Research			
-Research supporting advanced computational testing and simulation including applied mathematics research, computer science and software tools research, grand challenge applications, and computational science education programs. Capital equipment supporting research in advanced computational testing and simulation including computers, storage	$45,528	$45,548	$47,232

COMPUTATIONAL AND TECHNOLOGY RESEARCH
MATHEMATICAL, INFORMATION, AND COMPUTATIONAL SCIENCES

III. Performance Summary- Accomplishments:	**FY 1997**	**FY 1998**	**FY 1999**
devices and other peripheral equipment. Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.			
-Support of the joint Energy Research/Defense Programs Research program started in FY 1997 under the DOE 2000 initiative to develop and begin deployment of integrated sets of advanced computational tools including software frameworks, tools for complex geometries and advanced parallel software to accelerate the accomplishment of DOE missions.	2,500	5,000	5,000
Total Mathematical, Computational, and Computer 52,232 Sciences Research		48,028	50,548
<u>Advanced Computation, Communications Research, and Associated Activities</u>			
-Research in support of National Collaboratories: high capability networks, information surety, underlying technologies to support national collaboratories, and underlying technologies to support electricity supply and demand management.	6,859	5,936	4,500
-Research under the DOE 2000 initiative to develop and begin deployment of integrated sets of advanced electronic collaboration tools to accelerate the accomplishment of DOE missions by making it as easy for scientists and engineers to work together across the country as if they were in the same building. This effort includes remote operation of experiments at national user facilities.	6,000	6,000	6,000

III. Performance Summary- Accomplishments:

	FY 1997	FY 1998	FY 1999
-Research in support of the President's Next Generation Internet Initiative to: (1) promote experimentation with the next generation of networking technologies; (2) develop a next generation network testbed to connect universities and Federal research institutions at rates that demonstrate new networking technologies and support future research; and (3) demonstrate new applications that meet important national goals and missions. The funding is part of a coordinated multi-agency program.	0	0	22,000
-Support for the NERSC Center, which provides high performance computing for investigators supported by the Office of Energy Research. The Center serves more than 5,000 users working on about 700 projects, of which about 35% are university based, 60% are in National Laboratories, and 5% are in industry. The NERSC Center provides a spectrum of supercomputers that offers a range of high performance computing resources and associated software support that is a critical element in the success of many ER research programs. These computational resources are integrated by a common high performance file storage system which facilitates interdisciplinary collaborations. Related capital equipment needs are also supported.	19,130	26,500	26,500
-Support for ESnet operations which provide worldwide access to Energy Research facilities, including: advanced light sources; neutron sources; particle accelerators; fusion reactors; spectrometers; High Performance Computing Resource Providers (HPCRPs); and other leading-edge science instruments and facilities. Future upgrades will allow for remote experimentation and remote access to these facilities, as National Collaboratory technologies are developed and deployed. Related capital equipment needs are also supported.	14,787	14,787	14,000

III. Performance Summary- Accomplishments:	FY 1997	FY 1998	FY 1999
-High Performance Computing Resource Providers (HPCRPs) at Los Alamos National Laboratory, Argonne National Laboratory, and Lawrence Berkeley National Laboratory which provide the needed leading edge computational hardware testbeds to support grand challenge and advanced computational testing and simulation research. The HPCRP at Oak Ridge National Laboratory will be supported for only six months in FY 1999. Related capital equipment needs are also supported.	20,000	20,227	12,500
Total Advanced Computation, Communications Research & Associated Activities	66,776	73,450	85,500
SBIR/STTR Funding In FY 1997, $2,537,000 and $149,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.	0	3,212	3,579
Total Mathematical, Information, and Computational Sciences	$114,804	$127,210	$141,311

COMPUTATIONAL AND TECHNOLOGY RESEARCH
MATHEMATICAL, INFORMATION, AND COMPUTATIONAL SCIENCES

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

The increase in Advanced Computational Testing and Simulation Research will enhance the applied mathematics program and basic software research.	$+ 1,644,000
Reduce support for HPCRPs. The ORNL HPCRP will be supported for only six months in FY 1999.	- 7,727,000
Decrease in National Collaboratory research.	- 1,436,000
Initiation of Next Generation Internet funding.	+22,000,000
Decrease in ESnet operations.	- 787,000
Beginning in FY 1999, this program will budget $40,000 for the estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+ 40,000
Increase in SBIR/STTR funding due to increase in operating expenses.	+ 367,000
Total Funding Change, Mathematical, Information, and Computational Sciences	$+14,101,000

COMPUTATIONAL AND TECHNOLOGY RESEARCH
LABORATORY TECHNOLOGY RESEARCH
(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The mission of the Laboratory Technology Research (LTR) subprogram is to support high risk, energy related research that advances science and technology toward innovative applications that could significantly impact the Nation's energy economy. Laboratory Technology Research is a scientific research program that fosters the production of research results motivated by a practical energy payoff, through formal cost-shared collaborations between the Energy Research (ER) multiprogram laboratories and industry.

An important component of the Department's strategic goals is to ensure that the United States maintains its leadership in science and technology. LTR is the lead program in the Office of Energy Research for leveraging science and technology to advance understanding and to promote our country's economic competitiveness through cost-shared partnerships with the private sector.

The multiprogram National Laboratories under the stewardship of the Office of Energy Research conduct breakthrough research in a variety of scientific and technical fields and operate unique scientific facilities for visiting scientists. Viewed as a system, these five laboratories, Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest National Laboratory, offer a comprehensive resource for research collaborations. The major component of the LTR research portfolio consists of investments at these laboratories to conduct research that benefits all major stakeholders - the DOE, the industrial collaborators, and the Nation. These investments are further leveraged by the participation of an industry partner, using Cooperative Research and Development Agreements (CRADAs). Another important component of the LTR program provides rapid access by small business to the research capabilities at the ER multi-program laboratories, using several flexible mechanisms including personnel exchanges and technical consultations with small businesses.

II. **Funding Schedule:**

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Laboratory Technology Research	$ 17,307	$ 12,005	$ 15,897	$+3,892	+ 32.4%
SBIR/STTR	0	419	432	+ 13	+ 3.1%
Congressional Direction	6,359	3,370	0	-3,370	-100.0%
Total	$ 23,666	$ 15,794	$ 16,329	$+ 535	+ 3.4%

LABORATORY TECHNOLOGY RESEARCH

III. Performance Summary - Accomplishments:

	FY 1997	FY 1998	FY 1999
- Maintain support for technology research in areas that advance science and technology towards innovative energy applications through cost-shared partnerships between Office of Energy Research multiprogram laboratories and industry. The program focuses on key initiatives and other high-leverage areas including advanced materials, intelligent processing, and sustainable environments. Provide technical assistance for small businesses through rapid access to the research and development at the multiprogram laboratories.	$ 17,307	$ 12,005	$ 15,897
SBIR/STTR Funding In FY 1997, $608,000 and $36,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.	0	419	432
Congressional Direction Funds the University of Southwestern Louisiana (per FY 1997 Congressional Direction).	6,359	3,370	0
Total Laboratory Technology Research	$ 23,666	$ 15,794	$ 16,329

COMPUTATIONAL AND TECHNOLOGY RESEARCH
LABORATORY TECHNOLOGY RESEARCH

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

Increase support of Technology Research projects, including rapid access projects to enable innovative collaborative research between Energy Research multiprogram laboratories and private industry in areas directed toward the goal of reducing greenhouse gases through efficient energy processes.	$+3,887,000
Decrease support for the University of Southwestern Louisiana project for 3,370,000 which funding was completed in FY 1998.	-
Beginning in FY 1999, this program will budget $5,000 for the estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+ 5,000
Increase in SBIR/STTR funding due to increase in operating expenses.	+ 13,000
Total Funding Change, Laboratory Technology Research	$+ 535,000

COMPUTATIONAL AND TECHNOLOGY RESEARCH
ADVANCED ENERGY PROJECTS
(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The Advanced Energy Projects (AEP) subprogram funds research to establish the feasibility of novel, energy-related concepts that span the Department's energy mission and goals. Funded projects are based on innovative ideas that span multiple scientific and technical disciplines and do not fit into any other DOE program area. A common theme for each project is the initial linkage of new research results to an energy application with a potentially significant payoff. Typically, AEP supports projects up to a level of about $250,000 per year for a period of about 3 years. Projects are selected from proposals submitted by universities and national laboratories. Funding criteria emphasize scientific merit as judged by external peer review.

II. **Funding Schedule:**

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Advanced Energy Projects	$ 11,398	$ 7,373	$ 2,920	$ -4,453	-60.4%
SBIR/STTR	0	199	80	- 119	-59.8%
Total	$ 11,398	$ 7,572	$ 3,000	$ -4,572	-60.4%

III. **Performance Summary - Accomplishments:**

	FY 1997	FY 1998	FY 1999	
- Support for high-risk research at universities and national 2,920 laboratories to establish the feasibility of novel energy related concepts that are at an early stage of scientific definition.		$11,398	$ 7,373	$
SBIR/STTR Funding In FY 1997, $285,000 and $17,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.	0	199	80	
Total Advanced Energy Projects	$ 11,398	$ 7,572	$ 3,000	

COMPUTATIONAL AND TECHNOLOGY RESEARCH
ADVANCED ENERGY PROJECTS

<u>EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999</u>:

Significant decrease in level of research supported. Cancel several existing projects. No new novel, energy related concepts will be initiated.	$-4,454,000
Beginning in FY 1999, this program will budget $1,000 for the estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory.	+ 1,000
Decrease in SBIR/STTR funding due to decrease in operating expenses.	- 119,000
Total Funding Change, Advanced Energy Projects	$ -4,572,000

COMPUTATIONAL AND TECHNOLOGY RESEARCH
CAPITAL OPERATING EXPENSES AND CONSTRUCTION SUMMARY
(Dollars in thousands)

	FY 1997	FY 1998	FY 1999	$ Change	% Change
Capital Operating Expenses					
Capital Equipment (total)...	$6,403	$6,356	$6,275	$-81	-1.3%

	TEC	Previous Appropriated	FY 1997 Appropriated	FY 1998 Request	FY 1999 Request
Major Items of Equipment (CE $2 million and Above)					
1. Archival Systems Upgrade - LBNL	$2,000	$0	$2,000	$0	$0

Acceptance Date
4/97

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
SCIENCE
(Tabular dollars in thousands, Narrative in whole dollars)

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT

PROGRAM MISSION

The Multiprogram Energy Laboratories - Facilities Support (MEL-FS) program provides line item construction funding to support the general purpose infrastructure of the Energy Research's five multiprogram national laboratories. These are: Argonne National Laboratory - East (ANL-E), Brookhaven National Laboratory (BNL), Lawrence Berkeley National Laboratory (LBNL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL). These laboratories have over 1,100 buildings with 14.3 million gross square feet of space and an estimated replacement value of over $9,000,000,000. All facilities at these laboratories are government-owned, contractor-operated (GOCO). Total operating funding for these laboratories is over $3,000,000,000 a year. The Office of Energy Research manages this program to provide a comprehensive, prioritized and equitable approach to its stewardship responsibility for the general purpose support infrastructure of these laboratories. The program also provides funding for Payments in Lieu of Taxes (PILT) as authorized by the Atomic Energy Act of 1954, as amended. These discretionary payments are made to state or local governments where the Department or its predecessor agencies has acquired property previously subject to state or local taxation.

The GOAL of the MEL-FS program is:

To ensure that the support facilities at the multiprogram laboratories can meet the Department's research needs in a safe, environmentally sound, and cost-effective manner primarily by refurbishing or replacing deteriorated, outmoded, unsafe, and inefficient general purpose infrastructure.

The OBJECTIVES related to these goals are:

1. To correct Environment, Safety and Health (ES&H) inadequacies.
2. To reduce risk of operational interruptions due to failed support systems.
3. To provide cost effective operations and reduce maintenance costs.
4. To provide quality space for multiprogram research and support activities.

5. To preserve the government investment in the physical plant of the laboratories.
6. To promote performance-based infrastructure management.

PERFORMANCE MEASURES:

Performance measures related to the MEL-FS program are continuously being refined to ensure that they: 1) incorporate external/internal customers' inputs; 2) drive performance; 3) address the strategic plan; and 4) focus on the effectiveness of the laboratory system. Current performance measures include:

1. Support of line item construction funding to reduce risk, ensure continuity of operations, avoid or reduce costs and increase productivity.

Expectation: Fund highest priority needs based on scoring from Life Cycle Asset Management (LCAM) Cost-Risk-Impact Matrix.

2. Overall condition of laboratory buildings

Expectation: Increase the percentage of facilities rated adequate.

3. Excellence in project management

Expectation: Increase the percentage of projects completed within baseline cost and schedule.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- Progress in Line Item Projects - Six projects are scheduled for physical completion in FY 1998. The three projects scheduled for physical completion in FY 1999 are the Building Services Upgrade, the Central Heating Plant Rehabilitation, Phase I, both at ANL-E, and the Upgrade Steam Plant at ORNL.

- Beginning with FY 1999 this program will fund the Payments In Lieu of Taxes (PILT) for ANL-E and BNL.

- Beginning with FY 1997 this program ceased funding ES&H inadequacies with operating funds consistent with FY 1997 Congressional direction.

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT

PROGRAM FUNDING PROFILE

(Dollars in thousands)

Subprogram	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation	
Multiprogram Energy Laboratories-Facilities Support.......	$ 20,628		$ 21,260		-$13	a/	$ 21,247	
Subtotal Multiprogram Energy Laboratories - Facilities Support..	$ 20,628		$ 21,260		$ (13)	a/	$ 21,247	
Adjustment...	-1,399	b/	-66	c/	0		-66	c/
Adjustment...	0		-13	a/	13	a/	0	
TOTAL, MEL-FS...	$19,229		$21,181		$0	a/	$21,181	

a/ Share of Science general reduction for contractor training.

b/ Share of Energy Supply, Research and Development general reduction assigned to this program ($1,398,000), and FY 1997 emergency supplemental rescission ($1,000). The total general reduction is applied at the appropriation level.

c/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.

Public Law Authorizations:

Public Law 95-91, "Department of Energy Organization Act"

FY 1999 Request
$ 21,260
$ 21,260
0
0
$21,260

y flood

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Request
Chicago Operations Office									
Argonne National Lab (East)	$4,868		$10,892		$0		$10,892		$7,359
Brookhaven National Laboratory	11,132		568		0		568		2,239
Oakland Operations Office									
Lawrence Berkeley National Laborator	0		2,400		0		2,400		4,854
Oak Ridge Operations Office									
Oak Ridge National Laboratory	168		7,400		-13	a/	7,387		6,808
Richland Operations Office									
Pacific Northwest National Laboratory	4,460		0		0		0		0
All Other Sites b/	0		0		0		0		0
Subtotal	20,628		21,260		-13	a/	21,247		21,260
Adjustment	-1,399	c/	-66	d/	0		-66	d/	0
Adjustment	0		-13	a/	13	a/	0		0
TOTAL	$19,229		$21,181		$0	a/	$21,181		$21,260

a/ Share of Science general reduction for contractor training.

b/ Funding provided to industry, other Federal agencies and contractors.

c/ Share of Energy Supply, Research and Development general reduction assigned to this program ($1,398,000), and FY 1997 emergency floo supplemental rescission ($1,000). The total general reduction is applied at the appropriation level.

d/ Share of Science general reduction for use of prior year balances assigned to this program ($66,000). The total general reduction is applied at the appropriation level.

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT

(Tabular dollars in thousands, narrative in whole dollars)

I. **<u>Mission Supporting Goals and Objectives</u>**: This subprogram supports the program's goal to ensure that the multiprogram laboratories' support facilities can meet the Department's research needs primarily by refurbishing or replacing deteriorated, outmoded, unsafe, and inefficient general purpose infrastructure. Facility deficiencies are due to age, obsolescence, extensive use and changing requirements, including Environment, Safety and Health (ES&H) requirements. This subprogram achieves this by funding line item construction projects (i.e., projects with a total estimated cost of $5,000,000 or above) for general purpose facilities. General purpose facilities are general use, service and support facilities such as administrative space, cafeterias, general office/laboratory space, utility systems, sanitary sewers, roads, etc. There are over 1,100 buildings at the five multiprogram laboratories covered by this program. These buildings have over 14.3 million gross square feet of space. Approximately half of the space is considered fully adequate, while the remainder needs rehabilitation or replacement/demolition. The large percentage of inadequate space reflects the age of the facilities (average age of 33 years), changing research needs that require more office space and light laboratory space, environmental, safety and health requirements and obsolete systems.

Capital investment requirements are identified in laboratory Institutional Plans which address needs through the year 2002 based on expected programmatic support. The projected needs through the period total over $425,000,000. Forty one percent of this amount is to rehabilitate or replace buildings; 35% is for utility projects; and 24% for environment, safety and health projects. All projects are first ranked using a prioritization model that takes into account risk, impacts, and mission need. The projects that have environment, safety and health as the principal driver are further prioritized using the Risk Prioritization Model from the DOE ES&H Management Plan process.

In FY 1999, the MELFS program will begin meeting payments in lieu of taxes assistance requirements for communities surrounding Brookhaven and Argonne National Laboratories.

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
General Purpose Facilities . . .	$ 7,128	$10,829	$10,271	$- 558	-5.2%
ES&H	13,500	10,418	9,829	- 589	-5.7%
Infrastructure Support	0	0	1,160	+ 1,160	--%
Total Multiprogram Energy Laboratories-Facilities Support	$20,628	$21,247	$21,260	$+ 13	+.1%

III. Performance Summary - Accomplishments:

	FY 1997	FY 1998	FY 1999
Construction			
- Supports the initiation of three new General Purpose Facility subprojects in FY 1999, as well as the continuation of one FY 1998 subproject under the combined Multiprogram Energy Laboratories Infrastructure Project (MEL-001). The FY 1999 new starts include Electrical Systems Modifications at BNL ($849,000); Rehabilitation of Building 77 at LBNL ($754,000); and the Central Supply Facility at ANL-E ($1,860,000). The FY 1998 subproject is the Upgrade Steam Plant at ORNL ($1,900,000). Also supports the ongoing Roofing Improvements project at ORNL ($4,908,000), Project No. 94-E-363.	$ 7,128	$10,829	$10,271
- Supports the initiation of one new ES&H subproject in FY 1999, the completion of one FY 1998 subproject and the continuation of one FY 1998 subproject under the combined Multiprogram Energy Laboratories Infrastructure Project (MEL-001). The	13,500	10,418	9,829

FY 1999 new start is the Sanitary Systems Modifications, Phase

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT

III. Performance Summary - Accomplishments:	**FY 1997**	**FY 1998**	**FY 1999**
III at BNL ($500,000). The FY 1998 subprojects include the Electrical Systems Rehabilitation, Phase IV at LBNL ($4,100,000) and the Electrical Systems Upgrade, Phase III at ANL ($4,961,000). Also supports the ongoing Building Electrical Service Upgrade, Phase I at ANL ($268,000), Project No. 96-E-333.			
Subtotal Construction	$20,628	$21,247	$20,100
Infrastructure Support			
- Begin meeting payments in lieu of taxes assistance requirements for communities surrounding Brookhaven National Laboratory and Argonne National Laboratory.	$0	$0	$1,160
Total	$20,628	$21,247	$21,260

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

Decrease in funding reflects shift of funds to initiate support of Payments in Lieu of Taxes in FY 1999.	$-1,147,000
Begin funding payments in lieu of taxes in FY 1999.	$+1,160,000
Total Funding Change, Construction	$+13

MULTIPROGRAM ENERGY LABORATORIES - FACILITIES SUPPORT
CAPITAL OPERATING EXPENSES & CONSTRUCTION SUMMARY
(Dollars in thousands)

	FY 1997	FY 1998	FY 1999	$ Change	% Change
Capital Operating Expenses	$0	$0	$0	----	----

Construction Project Summary (Construction Funded)

Project No.	Project Title	TEC	Previous Appropriated	FY 1997 Appropriated	FY 1998 Appropriated	FY 1999 Request	Unapprop. Balance
MEL-001	Multiprogram Energy Laboratories Infrastructure Project	N/A	N/A	N/A	$ 7,259	$14,924	$23,837
96-E-333	Multiprogram Energy Laboratories Upgrades, Various Locations	16,865	4,400	6,924	5,273	268	0
95-E-308	Sanitary System Mods, II, BNL	4,250	2,650	1,032	568	0	0
95-E-307	Fire Safety Improvements, III, ANL-I	3,003	1,285	1,000	718	0	0
95-E-301	Central Heat Plant Rehab, I, ANL-E	9,880	3,938	2,500	3,442	0	0
94-E-363	Roofing Improvements, ORNL	16,000	5,422	0	3,987	4,908	1,683
Total Multiprogram Energy Laboratories - Facilities Support		XXXXX	XXXXX	XXXXX	$21,247	$20,100	$25,520

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
SCIENCE - PLANT AND CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

Multiprogram Energy Laboratories - Facilities Support

1. Title and Location of Project:	Multiprogram Energy Laboratories Infrastructure Project Various Locations	2a. Project No. MEL-001 2b. Construction Funded

SIGNIFICANT CHANGES

- Four new starts in FY 1999 include: Electrical Systems Modifications, Brookhaven National Laboratory; Rehabilitation of Berkeley Lab Engineering Center - Bldg. 77, Lawrence Berkeley National Laboratory; Central Supply Facility, Argonne National Laboratory; and Sanitary Systems Modfications, Phase III, Brookhaven National Laboratory.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
SCIENCE - PLANT AND CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

Multiprogram Energy Laboratories - Facilities Support

1. Title and Location of Project:	Multiprogram Energy Laboratories Infrastructure Project Various Locations	2a. Project No. MEL-001 2b. Construction Funded

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
3a. Date A-E Work Initiated (Title I Design Start Scheduled)	N/A	N/A	Varies by subproject
3b. A-E Work (Title I & II) Duration:	N/A	N/A	6-12 Months
4a. Date physical Construction Starts:	N/A	N/A	See subproject details
4b. Date Construction Ends:	N/A	N/A	See subproject details

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
5. Total Estimated Cost (TEC) --	N/A	N/A	N/A
6. Total Project Cost (TPC) --	N/A	N/A	N/A

1.	Title and Location of Project:	Multiprogram Energy Laboratories Infrastructure Project Various Locations	2a.	Project No. MEL-001 2b. Construction Funded

7. Financial Schedule: (Federal Funds)

Fiscal Year	Appropriation	Obligations	Cost
FY 1998	$ 7,259	$ 7,259	$ 800
FY 1999	14,924	14,924	8,665
FY 2000	17,594	17,594	21,325
FY 2001	6,243	6,243	13,590
FY 2002	0	0	1,640

8. Project Description, Justification and Scope

This project funds two types of subprojects:

- Projects to correct ES&H deficiencies including fire safety improvements, sanitary system upgrades and electrical system replacements; and

- Projects that renovate or replace inefficient and unreliable general purpose facilities (GPF) including general use, service and support facilities such as administrative space, cafeterias, utility systems, and roads.

General Purpose Facility Projects:

a. Subproject 01 - Upgrade Steam Plant, ORNL

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
5,300	----	0	3,400	1,900	0	1st Qtr FY 1998 - 4th Qtr. FY 1999

8. Project Description, Justification and Scope (Continued)

This project will upgrade the ORNL steam plant by adding a new steam boiler of approximately 100,000 pounds per hour capacity and capable of burning both natural gas and fuel oil. The boiler will be procured with all necessary ancillary equipment, such as blowers, feedwater pumps, and controls. Suitable weather protection will be provided.

This project is needed because of the age of the five existing boilers. Three are 46 years old, one is 44 years old, and the fifth is 32 years old. The new boiler capacity will allow decreased firing time on the oldest boilers and will extend their useful life. In addition, the new boiler will improve the efficiency of the steam plant.

b. Subproject 04 - Electrical Systems Modifications, (BNL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
5,730	---	0	0	849	4,881	2nd Qtr FY 1999 - 4th Qtr FY 2000

This project is the first phase of a planned modernization and refurbishment of the Laboratory's electrical infrastructure. The project provides for the replacement of 30 to 50 year old deteriorating underground electrical cables, the addition of underground ductbanks to replace damaged portions and support new cabling, the installation of a new 13.8 kV - 2.4 kV substation to address capacity and operational problems, and the retrofitting/reconditioning of switchgear power circuit breakers.

c. Subproject 05 - Rehabilitation of Berkeley Lab Engineering Center - Bldg. 77, (LBNL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
8,000	---	0	0	754	7,246	2nd Qtr FY 1999 - 2nd Qtr FY 2001

8. Project Description, Justification and Scope (Continued)

This project will rehabilitate Building 77's structural system to restore lateral force resistance and arrest differential foundation settlement, and will modernize architectural, mechanical, and electrical systems. These upgrades will restore this 33 year-old, 68,000 sq.ft. building to acceptable seismic performance; provide environmental controls appropriate to precision fabrication processes; increase the reliability and maintainability of building systems; provide flexibility to meet future challenges; and extend building life by 40 years and building systems by 20 to 25 years.

d. Subproject 06 - Central Supply Facility (ANL-E)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
6,370	---	0	0	1,860	4,510	2nd Qtr FY 1999 - 3rd Qtr FY 2001

This proposed 39,100 sq.ft. Central Supply Facility will provide a highly efficient and cost-effective consolidated (expected reduction of $800,000/year in operating costs) operation to meet the missions of the Materials Group and the Property Group of ANL-East and will eliminate the need for 67,630 square feet of substandard (50 year-old) space. The Materials Group receives, sorts, stores, retrieves, and distributes the majority of all materials and supplies for the Laboratory. The Property Group tags, controls, stores, and distributes excess property and precious metals for the Laboratory. This facility will contain truck docks; receiving and distribution areas; inventory control; general material storage; support and office areas; central mail receiving, sorting, and distribution; DOE records storage; property storage; and exterior hazardous storage.

ES&H PROJECTS:

a. Subproject 02 - Electrical Systems Rehab. Phase IV, (LBNL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
6,500	---	0	2,400	4,100	0	2nd Qtr FY 1998 - 4th Qtr FY 2000

1.	Title and Location of Project:	Multiprogram Energy Laboratories Infrastructure Project Various Locations	2a.	Project No. MEL-001 2b. Construction Funded

The Blackberry Switching Station Replacement Project is the last major planned rehabilitation to the LBNL electrical power system, in order to maintain its reliability and improve its safety. The project will upgrade the existing 12 kV power system and utilize circuit breakers installed in the FY 1987 MEL-FS project improvement to the main Grizzly Substation.

The project will correct existing deficiencies in the power distribution system that serves the Blackberry Canyon Service Area. The improvements will replace the existing electrical system, which consists of aged and underrated electrical equipment, 20 to 30 years old in many instances, that is difficult to maintain and unsafe to operate. It will provide the Laboratory with increased operational flexibility as well as improvements in reliability, maintainability and safety.

b. Subproject 03-Electrical System Upgrade, Phase III, (ANL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
7,620	---	0	1,459	4,961	1,200	2nd Qtr FY 1998 - 1st Qtr FY 2001

The project provides for the upgrade of the main electrical substation at Facility 543 and Facility 549A.

The work consists of the following items: install a new 138 kV overhead steel pole transmission line and upgrade the existing transmission line, relocate an existing transformer, upgrade existing transformers, replace existing 13.2 kV outdoor switchgear, and replace existing oil circuit breaker.

The intended project will accomplish several objectives related to system reliability, personnel safety, environmental hazards, risk reduction and system expansion.

8. Project Description, Justification and Scope (Continued)

c. Subproject 07 - Sanitary System Modifications, Phase III, (BNL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
6,500	- - -	0	0	500	6,000	2nd Qtr FY 1999 - 3rd Qtr FY 2001

The BNL Sanitary System consists of over 20 miles of collection piping which collects sanitary waste from nearly all the BNL facilities. The collection piping transports the waste via gravity piping and lift stations to a sewage treatment plant (STP). This project is the third phase of the upgrade of the Laboratory sanitary waste system. In the first two phases, major operations of the STP were upgraded and approximately 14,000 feet of trunk sewer lines were replaced, repaired, or lined. Phase III will continue this upgrade and will replace or rehabilitate approximately 9,900 feet of existing deteriorated (8 to 20 inch) sewer piping, connect five facilities to the sanitary system by installing 7,500 feet of new sewer pipe, and two new lift stations. This will eliminate non-compliant leaching fields and cess pools, reduce non-contact cooling water flow into the sewage system by 72 million gallons per year by: diverting flow to the storm system; converting water heat exchangers to air cooled condensers; and replacing water cooled equipment in 15 buildings. The STP anaerobic sludge digester will be replaced with an aerobic sludge digester to eliminate high maintenance activity and improve performance, and install liners and modify the under drain piping in the STP sand filter beds.

9. Details of Cost Estimate

Based on preliminary or conceptual design.

10. Method of Performance

Design will be negotiated by architect-engineer contracts or laboratory personnel. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

1.	Title and Location of Project:	Multiprogram Energy Laboratories Infrastructure Project Various Locations	2a.	Project No. MEL-001 2b. Construction Funded

11. Schedule of Project Funding and Other Related Funding Requirements

N/A

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

N/A

13. Design and Construction of Federal Facilities

The total estimated cost of this project includes, where appropriate, the cost of measures necessary to assure compliance with OMB Circular No. A-106, and Executive Order No. 12088, “Federal Compliance with Pollution Control Standards”; Section 19 of the Occupational Safety and Health Act of 1970, the provisions of Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CFR Title 29, Chapter XVII, Part 1960); and the Architectural Barriers Act of 1968.” The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST

SCIENCE - PLANT AND CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

Multiprogram Energy Laboratories - Facilities Support

1. Title and Location of Project:	Multiprogram Energy Laboratories Upgrades Various Locations	2a. 2b.	Project No. 96-E-333 Construction Funded

SIGNIFICANT CHANGES

- TEC for Subproject 02 - Hot Lab Renovation, Bldg. 801 (BNL) was reduced from $7,080,000 to $6,580,000 by a reprogramming action to support Tritium Remediation at Brookhaven National Laboratory in FY 1997.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST

SCIENCE - PLANT AND CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

Multiprogram Energy Laboratories - Facilities Support

1. Title and Location of Project:	Multiprogram Energy Laboratories Upgrades Various Locations	2a. Project No. 96-E-333 2b. Construction Funded

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
3a. Date A-E Work Initiated (Title I Design Start Scheduled)	N/A	N/A	Varies by subproject
3b. A-E Work (Title I & II) Duration:	N/A	N/A	6-12 months
4a. Date physical Construction Starts:	N/A	N/A	See subproject details
4b. Date Construction Ends:	N/A	N/A	See subproject details

	Preliminary Estimate	Title I Baseline	Current Baseline Estimate
5. Total Estimated Cost (TEC) --	N/A	N/A	$16,865
6. Total Project Cost (TPC) --	N/A	N/A	$17,010

1. Title and Location of Project:	Multiprogram Energy Laboratories Upgrades Various Locations	2a. Project No. 96-E-333 2b. Construction Funded

7. Financial Schedule: (Federal Funds)

Fiscal Year	Appropriation	Adjustments	Obligations	Cost
FY 1996	4,400		4,400	675
FY 1997	6,924		6,924	4,435
FY 1998	5,273		5,273	5,965
FY 1999	268		268	4,782
FY 2000	0		0	1,008

8. Project Description, Justification and Scope

This project funds subprojects to correct ES&H deficiencies.

a. Subproject 01 - Building Electrical Service Upgrade, I (ANL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
7,885	7,885	1,144	5,273	268	0	2nd Qtr FY 1997 - 4th Qtr FY 1999

This project will provide the most urgently needed replacement of emergency generators and the upgrade of building's main electrical services (circuit breaker retrofits, bus duct replacement and emergency generator replacements) that are no longer adequate, reliable, efficient, or in accordance with existing electrical codes/standards and environment, safety and health standards.

Failure to fund this project would increase frequency and duration of general maintenance resulting in increased parts and labor costs, negative impact on scientific programs and non-compliance with safety regulations.

8. Project Description, Justification and Scope (Continued)

b. Subproject 02 - Hot Lab Renovation, Bldg 801 (BNL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
6,580	7,080	5,780	0	0	0	2nd Qtr FY 1997 - 4th Qtr FY 1998

This project, in the west side of Building 801 (the Hot Lab), is part of a comprehensive effort to: upgrade the production of radionuclides and radiopharmaceuticals for supply to the pharmaceutical/medical community outside the laboratory; upgrade major research program leading to new and more effective diagnostic and therapeutic agents; comply with DOE Order 5820.2A, which requires that the generation of low-level radioactive waste be reduced; and bring Brookhaven National Laboratory (BNL) into conformance with Federal, state, and local environmental laws and regulatory requirements. The unique location of BNL over an EPA designated "sole-source" aquifer has heightened regulatory concern over potential ground water contamination from BNL facilities.

Failure to fund this project would increase the potential for ground water contamination and non-compliance with safety regulations.

c. Subproject 03 - Sanitary Sewer Restoration Phase I (LBNL)

TEC	Prev.	FY 1997	FY 1998	FY 1999	Outyear	Construction Start - Completion Dates
2,400	2,400	0	0	0	0	3rd Qtr FY 1997 - 4th Qtr FY 1998

Portions of the underground sanitary sewer system will be replaced based upon video camera surveys of site sanitary sewer lines, including approximately 3,480 feet of sanitary sewer lines ranging in diameter from three (3) inches to eight (8) inches. Soil samples will be tested during construction for possible contamination. All excavated material that is contaminated will be either remediated or removed to an authorized hazardous waste site.

Failure to fund this project would increase the potential for ground water contamination, excessive maintenance costs, and non-compliance with safety regulations.

9. Details of Cost Estimate

Based on preliminary or conceptual design.

10. Method of Performance

Design will be by negotiated architect-engineer contracts or laboratory personnel. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bids.

11. Schedule of Project Funding and Other Related Funding Requirements

N/A

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

N/A

13. Design and Construction of Federal Facilities

The total estimated cost of this project includes, where appropriate, the cost of measures necessary to assure compliance with OMB Circular No. A-106, and Executive Order No. 12088, “Federal Compliance with Pollution Control Standards”; Section 19 of the Occupational Safety and Health Act of 1970, the provisions of Executive Order 12196, and the related Safety and Health provisions for Federal Employees (CFR Title 29, Chapter XVII, Part 1960); and the Architectural Barriers Act of 1968.” The project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
SCIENCE
(Tabular dollars in thousands, Narrative in whole dollars)

ENERGY RESEARCH ANALYSES

PROGRAM MISSION

The mission of the Energy Research Analyses (ERA) program is to evaluate the quality and impact of Department of Energy research programs and projects.

The GOAL of the ERA program is to:

Provide Department of Energy program managers and senior managers with objective assessments of research projects and programs in order to evaluate the quality and impact of these efforts, to identify undesirable duplications and gaps, and to provide analysis of key technical issues in support of long range energy research planning, science and technology planning, and technical and performance evaluation of departmental programs and objectives.

The OBJECTIVES related to these goals are:

1. To PROVIDE THE BASIS FOR JUDGMENTS ON THE QUALITY OF RESEARCH AND ITS IMPACT. Using merit review with peer evaluation, provide departmental program managers and their superiors with detailed information about the technical strengths and weaknesses of projects that comprise the research and development (R&D) program as a basis for judgment of the quality of the research and its impact.

2. To PROVIDE INDEPENDENT VIEWS OF FUTURE R&D NEEDS IN AREAS OF INTEREST TO THE DEPARTMENT. Evaluate the status of science and technology areas of potential importance to the Department's mission, and to lay out appropriate fundamental and applied research and development to hasten the advance towards potential energy applications.

PROGRAM MISSION - ENERGY RESEARCH ANALYSES (Cont'd)

3. To DEVELOP STRATEGIC AND PERFORMANCE PLANS. Use advice from outside experts, advisory committees, departmental managers, national laboratory managers, industrial scientists and managers, and officials of other government agencies to formulate strategic and performance plans for the Office of Energy Research and for the Science and Technology business line of the Department.

4. To CONTRIBUTE TO DOE AND INTERAGENCY PROGRAM ANALYSIS AND PLANNING FOR GOVERNMENT SCIENCE AND TECHNOLOGY. Participate in committees, task forces, working groups, and workshops of the Department of Energy and organizations such as the National Science and Technology Council, the National Science Foundation, the National Academy of Sciences, and private sector organizations such as the Industrial Research Institute, and the Electric Power Research Institute.

PERFORMANCE MEASURES:

1. Quality and value of peer review evaluations, as indicated by satisfaction of investigators and program managers and actions taken to improve or replace projects that have significant shortcomings, and to capitalize on the strengths of stronger projects.

2. Satisfaction by customer program managers with assessments of science and technology needs, as indicated by changes or additions to make DOE programs and projects more productive and relevant to DOE missions.

3. Quality and acceptance of strategic and performance plans, as indicated by their use by the Director of the Office of Energy Research and by program offices in multi-year program planning, program management, and in effectively justifying programs.

4. Influence on government science and technology planning and analysis, as indicated by contributions to DOE, interagency, and outside recommendations on science policies and plans.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

1. Independent peer reviews verified the quality and relevance of over 100 DOE projects and tasks in FY 1997. These levels of effort will be scaled down in FY 1998 and FY 1999 to accommodate the reduced funding.

2. A new Office of Energy Research Strategic Plan is being developed in FY 1998 that will be implemented in FY 1999 to guide the Office of Energy Research into the first quarter of the next century.

ENERGY RESEARCH ANALYSES

PROGRAM FUNDING PROFILE
(Dollars in thousands)

	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Budget Request
Research..	$1,955		1,500		-$28	a/	$1,472		$1,000
Subtotal Energy Research Analyses.....	1,955		1,500		-28	a/	1,472		1,000
Adjustment.......................................	-415	b/	-144	c/	0		-144	c/	----
Adjustment.......................................	0		-28	a/	28	a/	0	c/	----
TOTAL..	$1,540	d/	$1,328		$0		$1,328		$1,000

a/ General reduction for contractor training.
b/ Share of Energy Supply, Research and Development general reduction for use of prior year balances ($249,000) and FY 1997 emergency flood supplemental rescission ($166,000). The total general red at the appropriation level.
c/ Share of Science general reduction for use of prior year balances assigned to this program. The total at the appropriation level.
d/ Excludes $43,000 which has been transferred to the SBIR program and $2,000 which has been transf

Public Law Authorizations:
Section 209, Public Law 95-91, DOE Organization Act

ENERGY RESEARCH ANALYSES
PROGRAM FUNDING BY SITE
(Dollars in thousands)

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Budget Request
Albuquerque Operations Office									
Los Alamos National Laboratory	$0		$0		$0		$0		$0
Chicago Operations Office.									
Argonne National Laboratory	0		0		0		0		0
Brookhaven National Laboratory	0		0		0		0		0
Oak Ridge Operations Office									
Oak Ridge National Laboratory	480		600		0		600		0
Oakland Operations Office									
Lawrence Berkeley National Laborat	37		0		0		0		0
Richland Operations Office									
Pacific Northwest National Laborator	250		250		0		250		0
All Other Sites a/	1,188		650		-28	b/	622		1,000
Subtotal	1,955		1,500		-28	b/	1,472		1,000
Adjustment	-415	c/	-144	d/	0		-144	d/	----
Adjustment	0		-28	b/	28	b/	0		----
TOTAL	$1,540	e/	$1,328		$0		$1,328		$1,000

a/ Funding provided to laboratories, universities, industry, other Federal agencies and other miscellaneous contractors.
b/ General reduction for contractor training.
c/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program ($249,000) and FY 1997 emergency flood supplemental rescission ($166,000). The total general reduction is applied at the appropriation level.
d/ Share of Science general reduction for use of prior year balances assigned to this program. The total general reduction is applied at the appropriation level.
e/ Excludes $43,000 which was transferred to the SBIR program and $2,000 which was transferred to the STTR program.

ENERGY RESEARCH ANALYSES
(Tabular dollars in thousands, narrative in whole dollars)

I. **Mission Supporting Goals and Objectives:** The Energy Research Analyses (ERA) program assesses research projects and programs in order to judge the significance of these efforts and to identify undesirable duplications and gaps. Peer reviews of individual research projects using outside experts are performed. Technical assessments to determine the direction of future research and state-of-the-science reviews are also performed. The program also provides analyses in support of long range energy research planning, science and technology planning, and technical evaluation of DOE programs and objectives.

II. **Funding Schedule:**

Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Energy Research Analyses	$ 1,955	$ 1,433	$ 973	$ -460	- 32.1%
SBIR/STTR	0	39	27	-12	- 30.8%
Total	$ 1,955	$ 1,472	$1,000	$ -472	- 32.1%

III. **Performance Summary- Accomplishments**

	FY 1997	FY 1998	FY 1999
-Evaluate the quality and relevance of research projects in Energy Research, Fossil Energy, and Energy Efficiency by independent peer reviews and assess additional technical needs in Energy Research, Fossil Energy, and Energy Efficiency (e.g., advanced composite materials). Evaluate critical planning and policy issues of DOE science and technology through reviews by expert groups outside the Department such as the National Academy of Sciences and the JASON group.	$1,955	$1,433	$973

ENERGY RESEARCH ANALYSES

III.	**Performance Summary- Accomplishments**	**FY 1997**	**FY 1998**	**FY 1999**
	-SBIR/STTR Funding In FY 1997, $43,000 and $2,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.	0	39	27
	Total, Energy Research Analyses	$1,955	$1,472	$1,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 to FY 1999:

Significant decrease in the number of peer reviews conducted.	$-460,000
SBIR and STTR funding is decreased due to a decrease in operating expenses.	$ -12,000
Total Funding Change, Energy Research Analyses	$-472,000

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY
(Tabular dollars in thousands, Narrative in whole dollars)

FUSION ENERGY SCIENCES

PROGRAM MISSION

The Fusion Energy Sciences program is a broad-based, fundamental research effort, producing valuable scientific knowledge and practical benefits in the near term and, in cooperation with our international partners, making substantial progress toward an economically and environmentally attractive energy option in the long term. The mission of the Fusion Energy Sciences program is to:

"Acquire the knowledge base needed for an economically and environmentally attractive fusion energy source."

This is a time of important progress and discovery in fusion research. The Fusion Energy Sciences program is making great progress in understanding turbulent losses of particles and energy across the magnetic field lines that are used to confine fusion fuels. In addition, the program is identifying and exploring innovative approaches to fusion power that may lead to less costly development paths.

Cross-cutting goals of the Fusion Energy Sciences program as developed through stakeholder meetings and endorsed by the Fusion Energy Sciences Advisory Committee are summarized below.

Understand the physics of plasmas, the fourth state of matter. Plasmas comprise most of the visible universe, both stellar and interstellar, and have many practical applications. Progress in plasma physics has been the prime engine driving progress in fusion research, and conversely, fusion energy has been the dominant motivation for plasma physics research.

Identify and explore innovative and cost-effective development paths to fusion energy. There is a continuous spectrum of approaches to fusion, from the tokamak, which is the leading reactor candidate, to other magnetic configurations to inertial confinement using particle beams or lasers. The current fusion program is encouraging both research on tokamak improvements and research on other innovative concepts.

PROGRAM MISSION - FUSION ENERGY SCIENCES (Cont'd)

Explore the science and technology of energy producing plasmas, the next frontier in fusion research, as a partner in an international effort. One of the strongest factors that favors fusion power is the potential for self-sustaining operation. Energy from the fusion reaction of deuterium and tritium is released in two components: 1) most of the energy released is in a form that can be extracted and used for commercial purposes; and 2) the remaining energy released is used to replace the energy losses of the confined plasma and to heat the deuterium and tritium sufficiently to sustain the fuel temperature and maintain the reaction process. When this replacement energy exceeds the energy losses, the fusion plasma is said to be "ignited." Understanding the physics of ignited, or self-heated plasmas and developing the technologies essential for fusion energy are linked goals that are achievable through the cooperative efforts of the world community. The long-term benefits to the United States of being a credible partner in this cooperative effort include ensuring our own scientific and technological integration in the world fusion program and contributing to a major step in the development of fusion as an energy source for a growing world population.

PERFORMANCE MEASURES:

The Fusion Energy Sciences program supports the Department's strategic goal of delivering the scientific and technology innovations critical to meeting the Nation's energy challenges. The performance measures of the Fusion Energy Sciences program fall into four areas: (1) excellence of the science, (2) relevance to the DOE mission and national needs, (3) stewardship of research capabilities, and (4) human resource management.

For FY 1999, specific performance measures are:

1. An independent assessment will judge Fusion Energy Sciences research programs to have high scientific quality.

2. Major operating experimental facilities will have research teams, which have participants from throughout the fusion science community. Assessments of research quality and program relevance will be provided to the performers by program advisory committees (PACs).

3. The National Spherical Torus Experiment (NSTX) project at Princeton Plasma Physics Laboratory (PPPL) will be completed and a national research team organized. The facility will begin experimental operations by the 3rd quarter of FY 1999 and the NSTX Program Advisory Committee (PAC) will provide guidance to PPPL for initial operations.

4. Theory and modeling efforts will result in state-of-the-art computational tools which are used to analyze experimental data and to suggest innovations. Standardized software and hardware configurations will be developed to allow national and international remote collaborations.

5. The Fusion Energy Sciences program will have a broadly based innovative concepts program including world-class experimental facilities integrated with theory and modeling.

6. The Technology program subelement will be restructured in FY 1999 to focus on domestic fusion program needs while maintaining strategic participation in international collaborative activities including appropriate participation in a restructured ITER project following completion of the current Engineering Design Activities.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS

- A major phase of U.S. fusion research ended in April 1997 when the Tokamak Fusion Test Reactor (TFTR) at Princeton Plasma Physics Laboratory (PPPL) was shut down. Recent major accomplishments include: 1) creation of internal plasma thermal barriers that for brief pulses drastically reduce the loss of energy from the plasma core and confine particles and heat at theoretically ideal levels;
  2) confirmation of a new theory of plasma turbulence that explains important aspects of tokamak confinement; 3) discovery of a theoretically-predicted instability in tokamak plasmas that is driven by the fast alpha particles produced by the D-T fusion reactions; and 4) demonstration of operation with a high level of radiated power to lower the peak heat load on internal components. These last two accomplishments have provided valuable information for the design of future D-T fusion power systems--the alpha driven instabilities do not produce significant loss of alpha particles, and operation with a high fraction of radiated power is compatible with high fusion power performance. Over the 15-year lifetime of TFTR, many advances in fusion science and technology were achieved:

  -- Methods to employ tritium safely within a fusion powerplant environment were developed; and a million curies of tritium were safely processed.

  -- Over 10 million watts of fusion power were produced for the first time in a laboratory experiment, and numerous detailed measurements of the fusion reaction products were carried out;

PROGRAM MISSION - FUSION ENERGY SCIENCES (Cont'd)

- -- 1 million amperes of electrical current were self-generated in the interior of the high temperature plasma as predicted by theory; and

- -- 500 million degree Celsius plasmas were produced, far exceeding previous experiments.

- During FY 1997 the International Thermonuclear Experimental Reactor (ITER) Detailed Design Report was prepared by the international Joint Central Team, was reviewed by the four ITER Parties, and was accepted in July 1997 by the ITER Council, the governing board for ITER. Other major planned accomplishments are the scheduled completion of the Final Design Report in December 1997 and the completion of the current Engineering Design Activities (EDA) in July 1998.

- After completing its commitment to the 6-year EDA in FY 1998, and within the overall constraints on funding for Energy Research, the United States will aim to participate in strenghtened international collaboration on major fusion facilities abroad. To the extent that the ITER follow-on activities reflect the necessary restructuring, the U.S. would participate at a more modest level, integrated with other international activities, and in a manner which allows us to best exploit our investment in the EDA. In this case, the United States will continue to host the Joint Work Site in San Diego, and support reduced Joint Central Team and Home Team design efforts to take advantage of continuing ITER design, R&D, and other activities by the other parties. We will work with the ITER parties to attempt to arrange the test of the ITER superconducting model coil in order to confirm the design and establish operating margins to fully benefit from the $40,000,000 we have invested in building a major portion of the coil. The majority of closeout costs associated with those U.S. Joint Central Team members returning to their home institutions and reducing the Home Team design effort will be absorbed in FY 1998; however additional closeout funds will be needed in FY 1999. Since virtually all of the U.S. fusion program technology resources had been redirected to ITER during the EDA, resources in FY 1999 are identified to restore the base technology research effort with a focus on the needs of the U.S. domestic fusion program.

- Previous funding for ITER of $52,579,000 in FY 1998 is accounted for by a $1,496,000 reduction in the total fusion funding, and by a reallocation of the remaining $51,083,000 as follows:

Reallocation of Remaining ITER Program Funding
(B/A in millions)

	Change	
Alcator C-Mod/DIII-D facility operations/research		+6.8
Alternate Concept experiments	+5.8	
Theory	+1.7	
Plasma Technologies		+16.1
Fusion Technologies	+5.5	
Advanced Design	+15.2	
	+51.0	

- A large portion of the reallocated ITER funds has been allocated to the operation of DIII-D and C-MOD in order to ensure that the U.S. continues to have significant technical influence with the international fusion program in future years. Both Europe and Japan have strong tokamak programs in support of ITER. In concert with our international partners, the U.S. intends to contribute to the tokamak database and pursue tokamak improvements through increased operation of DIII-D and C-MOD. Similarly, the theory funding is increased to pursue increased understanding of fusion science. At the same time the funding shifted to alternate concepts will assure that the U.S. continues to play an important role in the evolution of fusion concept development over the longer term.

- Fundamental discovery and analysis have led to a remarkable new understanding of transport barriers, which reduce loss of energy from the core of a tokamak confined plasma. Energy transport refers to the loss of thermal energy (heat) from a fusion plasma. The rate at which heat is lost from the plasma determines the minimum size and cost of future fusion devices, such as ITER or a power plant. In a power plant, the reaction products must be confined well enough to replace energy losses so that the fusion reactions are self-sustaining (ignition) or very nearly so. A transport barrier is essentially an insulation layer in the plasma that significantly reduces the heat loss, resulting in very high central plasma temperatures. It is anticipated that such results will be applicable to other fusion approaches such as the innovative concepts that are the basis of the restructuring of the Fusion Energy Sciences program. These results mean that considerable progress has been achieved in the scientific understanding of the ultimate objective of developing simpler, more economical fusion power systems.

PROGRAM MISSION - FUSION ENERGY SCIENCES (Cont'd)

- A principal Fusion Energy Sciences Advisory Committee recommendation was to increase the U.S. effort in innovative concepts research. This budget increases funding for both the NSTX, an innovative new spherical torus experiment, as well as small-scale innovative concept experiments and plasma science experiments, all of which represents the leading edge of restructuring the fusion program. An important new facility, the NSTX, will begin operation in FY 1999. This proof-of-principle level facility will investigate the physics of the promising spherical torus concept. It will be located at PPPL but will be operated as a national collaborative experiment, with 50-60 scientists from 10-15 institutions expected to participate.

- Announcements of opportunities in plasma science in FY 1997 have resulted in new grants in two areas. Five Plasma Science Junior Faculty Development Program awards were made and new opportunities will be made available in FY 1999. More than 15 new awards in basic plasma science and engineering resulted from the new National Science Foundation (NSF)/DOE Joint Partnership in Plasma Science and Engineering.

- Based on technical peer review of 40 laboratory and university innovative concepts proposals, 3 new university scale experimental programs and 1 theoretical study began in FY 1998. These starts are consistent with the increased emphasis being given to alternative concepts in the restructured Fusion Energy Sciences program.

Funding of Contractor Security Clearances

- In FY 1999, the Department will divide the responsibility for obtaining and maintaining security clearances. The Office of Security Affairs, which has been responsible for funding all Federal and contractor employee clearances, will pay only for clearances of Federal employees, both at headquarters and the field. Program organizations will be responsible for contractor clearances, using program funds. This change in policy will enable program managers to make the decisions as to how many and what level clearances are necessary for effective program execution. In this way, it is hoped that any backlog of essential clearances which are impeding program success can be cleared up by those managers most directly involved. The Office of Energy Research is budgeting $115,000 for estimated contractor clearances in FY 1999 within this decision unit.

FUSION ENERGY SCIENCES
PROGRAM FUNDING PROFILE
(Dollars in thousands)

	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments		FY 1998 Current Appropriation		FY 1999 Request
Subprogram									
Science	$94,750		$100,482		-$689	a/	$99,793		$110,460
Facility Operations	61,379		55,318		-180	a/	55,138		61,000
Technology	62,283		69,300		-1,475	a/	67,825		50,000
Program Direction	8,407		6,900		0	a/	6,900		6,700
Subtotal, Fusion Energy Sciences	226,819		232,000		-2,344	a/	229,656		228,160
Adjustment	0		-2,344	a/	2,344	a/	0		0
Adjustment	-2,069	b/	-668	c/	0		-668	c/	0
TOTAL, FES	$224,750	d/	$228,988		$0		$228,988		$228,160
Full-Time Equivalents	59		49		0		49		49

a/ Share of Energy Supply, Research and Development general reduction for contractor training.

b/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program ($2,069,000) and FY 1997 emergency flood supplemental recissision ($64,000). The total general reduction is applied at the appropriation level.

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

d/ Excludes $5,360,000 which has been transferred to the SBIR program and $321,000 which has been transferred to the STTR program.

Public Law Authorization:

Pub. Law 95-91, DOE Organization Act

FUSION ENERGY SCIENCES
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments a/	FY 1998 Current Appropriation	FY 1999 Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$ 3,643	$ 4,068	-$40	$ 4,028	$ 3,150
Sandia National Laboratories	5,266	5,605	-55	5,550	5,065
Chicago Operations Office					
Ames Laboratory	50	0	0	0	0
Argonne National Laboratory	2,480	2,875	-25	2,850	3,058
Brookhaven National Laboratory	60	50	0	50	0
Princeton Plasma Physics Laboratory	56,653	49,530	-495	49,035	49,495
Idaho Operations Office					
Idaho National Engineering Laboratory	2,360	4,110	-40	4,070	1,200
Oakland Operations Office					
Lawrence Berkeley National Laboratory	11,553	4,240	-40	4,200	4,295
Lawrence Livermore National Laborato	9,064	10,478	-110	10,368	9,200
Stanford Linear Accelerator Center	50	50	0	50	50
Oak Ridge Operations Office					
Oak Ridge Institute for Science & Edu	949	825	0	825	0
Oak Ridge National Laboratory	17,049	17,772	-180	17,592	15,380
Richland Operations Office					
Pacific Northwest Laboratory	1,225	1,345	-15	1,330	1,474

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments a/	FY 1998 Current Appropriation		FY 1999 Request
Savannah River Operations Office								
Savannah River Tech Center	395		452		0	452		0
All Other Sites	116,022		130,600		-1,344	129,256		135,793
Subtotal	226,819		232,000		-2,344	229,656		228,160
Adjustment	0		-2,344	a/	2,344	0		0
Adjustment	-2,069	b/	-668	c/	0	-668	c/	0
TOTAL	$224,750	d/	$228,988		$0	$228,988		$228,160

a/ Share of Energy Supply, Research and Development general reduction for contractor training.

b/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program ($2,069,000 and FY 1997 emergency flood supplemental recission ($64,000). The total general reduction is applied at the appropriation level.

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

d/ Excludes $5,360,000 which has been transferred to the SBIR program and $321,000 which has been transferred to the STTR program.

FUSION ENERGY SCIENCES

SCIENCE

I. **<u>Mission Supporting Goals and Objectives</u>:** The goals of this subprogram are to advance plasma science, and to develop innovative approaches for confining a fusion plasma. This subprogram includes a modest program in basic plasma science; active research programs in both tokamak innovations and in non-tokamak concepts; focused efforts to resolve outstanding physics issues related to ITER and other energy producing plasmas; strong theory and modeling programs; and the creation of improved diagnostics that make possible rigorous testing of the scientific principles of fusion.

Plasma science is the study of the behavior of ionized states of matter–ranging from neon lights to stars–that make up 99 percent of the visible universe. It contributes not only to fusion research, but also to many national science and technology goals, ranging from astrophysics to industrial processing to national security. One objective of the Science subprogram is to broaden the intellectual and institutional base in fundamental plasma physics, and a joint NSF/DOE plasma science partnership made initial awards for research on important topics in plasma science and engineering in FY 1997.

Fusion energy research advances through a balanced combination of large-, medium-, and small-scale experiments, theory, and modeling. The largest component of the Science subprogram is the tokamak research activity, which focuses on gaining a predictive understanding of the behavior of plasmas in near reactor-level conditions where the fusion fuel begins to "burn". Tokamak research is carried out primarily on two major U.S. facilities (Alcator C-Mod at the Massachusetts Institute of Technology (MIT) and DIII-D at General Atomics (GA)), which are operated as national collaborative experiments, and through collaborations on large, state-of-the art facilities abroad. Increased collaboration on facilities such as JET and JT-60 was recommended by the Fusion Energy Science Advisory Committee. They also recommended that "in concert with our international partners, a burning plasma facility should be built at the earliest possible time." This goal is being pursued through the ITER collaboration where we expect to develop a broad range of options.

Research on alternative confinement concepts, both magnetic and inertial, is aimed at identifying approaches that may improve the economical and environmental attractiveness of fusion energy sources. This research is carried out at various levels ranging from the concept exploration stage to the proof-of-principle stage. Small-scale exploratory experiments are carried out primarily at universities, while proof-of-principle experiments, such as the NSTX will be carried out primarily at national laboratories.

The FES Inertial Fusion Energy (IFE) program is exploring an alternate path for fusion energy that would capitalize on the major R&D effort in inertial confinement fusion (ICF) for stockpile stewardship purposes within the Office of Defense Programs. The IFE program depends on the ICF program for experimental research into the physics of target ignition that will be tested in the National Ignition Facility at LLNL. Efforts in IFE focus on developing the most efficient methods for heating and compressing a target pellet to fusion conditions.

PROGRAM MISSION - SCIENCE (Cont'd)

Theory and modeling are important to progress in fusion and plasma science because they provide the capability to analyze existing experiments, produce new ideas to improve performance, and provide a scientific assessment of new ideas. An important component of the theory program is the development and use of computational tools to help understand the physical phenomena that govern confinement of high temperature plasmas. Similarly, the development and improvement of diagnostic tools for analyzing plasma behavior continues to provide new insights regarding fusion plasmas.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change	
Tokamak Experimental Research	$48,711	$48,227	$45,327	-$2,900	-6.0%	
Alternative Concept Experimental Research		16,436	23,545	34,060	+10,515	+44.7%
Theory	25,821	19,270	21,000	+1,730	+9.0%	
General Plasma Science	3,782	5,100	5,900	+800	+15.7%	
SBIR/STTR	0	3,651	4,173	+522	+14.3%	
Total Science	$94,750	$99,793	$ 110,460	+$10,667	+10.7%	

III. Performance Summary - Accomplishments

	FY 1997	FY 1998	FY 1999
TOKAMAK EXPERIMENTAL RESEARCH	$48,711	$48,277	$45,327

Tokamak research focuses on developing the scientific foundations underlying the confinement of energetic plasmas and investigating improvements in tokamaks that could lead to a higher-performance, lower-cost tokamak fusion power plant. Key issues include reducing energy losses, increasing power density, maintaining the stability of a tokamak plasma, handling high heat loads, and optimizing all of the previous issues simultaneously in a high

performance tokamak.

	FY 1997	FY 1998	FY 1999

To meet the challenge posed by the shutdown of the TFTR, U.S. fusion scientists and engineers are redefining their methods for carrying out fusion research. Both of the remaining large tokamak facilities (Alcator C-Mod and DIII-D) are becoming national collaborative experiments. Scientists from many institutions are working together on planning and carrying out experiments, many of them from their home institutions via internet connections.

Recent progress in the tokamak program includes: a basic understanding of how the loss of heat and particles can be dramatically reduced by the formation of barriers within the plasma; the development of operating techniques that reduce heat and particle contact with internal components; and the demonstration of advanced operating modes that can increase the power density of a tokamak plasma.

In addition to operating DIII-D and Alcator C-Mod, the program continues to support some innovative, small-scale tokamak experiments and develop advanced diagnostic instruments for studying high performance plasmas. Much of this work is conducted at leading universities. A competitive initiative to address new plasma diagnostic measurement techniques is planned.

International collaboration in tokamak research will be enhanced to take advantage of the unique experimental facilities that are available in Europe and Japan.

Education activities for improving science education for students and faculty in America's schools, colleges and universities are also funded in this program.

	FY 1997	**FY 1998**	**FY 1999**
ALTERNATIVE CONCEPT EXPERIMENTAL RESEARCH	16,436	23,545	34,060

Research on magnetic confinement configurations other than the conventional tokamak is important both for its intrinsic scientific value and for its potential to discover concepts that would make attractive fusion power sources. Approximately 12 experimental programs, located primarily at universities, are currently supported. Some of those resulted from an FY 1998 innovative concept competition. Increased effort on these programs is planned for FY 1999.

The NSTX, located at PPPL, will begin operation in FY 1999. The NSTX research program will address fusion science issues such as current drive by radio waves, very high power density, and nearly total self-generation of the plasma current that helps to confine the plasma. This program will be organized as a national collaborative experiment. The conversion of a TFTR neutral beam heating system for reuse on NSTX will add significantly to NSTX heating and diagnostics capability when it is completed in FY 2000.

Preparations will begin for a second national proof-of-principle experiment using facilities and infrastructure available at PPPL. This would include national working groups selecting a candidate physics concept from ongoing smaller experiments and beginning pre-conceptual design.

In the area of IFE, research continues on ion beam drive methods and critical supporting technology issues. Steps to improve ion beam efficiency, ion accelerator components, and fusion chamber wall protection methods will be tested.

FUSION ENERGY SCIENCES
SCIENCE

	FY 1997	FY 1998	FY 1999
THEORY	25,821	19,270	21,000

The theory program is an integral part of the Fusion Energy Sciences program and supports its mission in several ways: advancing basic theory of magnetically confined plasmas, producing new ideas to improve performance, supporting planning and interpretation of experiments in existing facilities, and helping to conceive and design future devices. The theory program will continue its advanced computing initiatives to develop new analysis codes and a code library for use by fusion researchers. Special emphasis will be placed on continued development of the tools needed for both national and international remote collaboration activities.

	FY 1997	FY 1998	FY 1999
GENERAL PLASMA SCIENCE	3,782	5,100	5,900

The plasma science program will continue to focus on basic plasma science and engineering research, primarily in the university community. Advances in basic plasma physics will support the Fusion Energy Sciences program as well as other important areas of science and technology. Funding for the Plasma Science Junior Faculty Development Program is increased and the NSF/DOE plasma science and engineering program will continue with modest growth over FY 1998 levels. The program will continue to compile atomic physics data for fusion.

	FY 1997	FY 1998	FY 1999
SBIR/STTR FUNDING	0	3,651	4,173
In FY 1997, $3,630,000 and $218,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.			
Total Science	$94,750	$99,793	$110,460

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Funding for TFTR is decreased primarily by reductions in personnel costs, following completion of the
-$6,415,000
TFTR physics program, placing it in a caretaker status, and redirecting the staff to other fusion research such as fabrication of the NSTX.

The DIII-D research funding is increased by $1,123,000 in order to improve the data analysis capability.
+$3,000,000
An increase in Alcator C-Mod of $1,200,000 supports added diagnostic development and data analysis efforts. An increase of $677,000 in International/other reflects greater support for U.S. scientists conducting experiments on unique foreign facilities, such as JET in Europe and JT-60U in Japan.

Beginning in FY 1999, this program will budget $115,000 for the estimated costs of obtaining and maintaining security clearances for contractor employees under the Chicago Operations Office and the Oak Ridge National Laboratory. +$115,000

Smaller scale tokamak experiments at universities and diagnostic development are increased, in part to
+$400,000

support a competitive initiative in advanced diagnostic development.

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999 (Cont'd):

Support for NSTX is increased to begin research operations.	+$7,220,000
An increase is provided to initiate planning for and preliminary design of a second national proof-of-principle alternative concept using existing facilities ($2,200,000) at PPPL, as well as increased support for innovative concepts, primarily at universities.	+$3,295,000
An increase in fusion theory supports code development for national and international collaborative experiments.	+$1,730,000
Additional funding is provided for increasing the breadth of participation in the basic plasma science initiative that began in FY 1997.	+$800,000
SBIR/STTR funding is increased to provide required funding.	+$522,000
Total Funding Change, Science	+$10,667,000

FUSION ENERGY SCIENCES

FACILITY OPERATIONS

I. <u>Mission Supporting Goals and Objectives</u>: This activity provides for the operation of major experimental facilities that are the essential tools that enable scientists in university, industry, and laboratory based research groups to perform experimental research in fusion energy sciences. This subprogram includes funding for the operation and maintenance of the three major fusion research facilities: NSTX at PPPL, DIII-D at GA, and Alcator C-Mod at MIT. These facilities consist of magnetic plasma confinement devices, plasma heating and current drive systems, diagnostics and instrumentation, experimental areas, computing and computer networking facilities, and other auxiliary systems. It includes the cost of operating personnel, electric power, expendable supplies, replacement parts and subsystems, and inventories. In the case of PPPL, this funding also supports the safe shutdown and caretaking of TFTR, prior to removal from the site. General plant projects (GPP) funding for PPPL will be provided to support minor facility renovations, other capital alterations and additions, and for buildings and utility systems. Capital equipment funding for upgrading the research capability of DIII-D and C-Mod is also included, as are funds for design, fabrication, and installation of NSTX, and for further enhancements to the facility.

The principal objective of the Facility Operations subprogram is to maximize the quantity and quality of data collected for experiments being conducted at fusion energy sciences facilities.

The following table summarizes the scheduled weeks of operations for DIII-D and Alcator C-Mod. With the subsequent table on the next page, this table illustrates how the redirection of TFTR funds allows for increased operations of C-Mod and DIII-D (during FY 1998-1999) and beginning operations of NSTX in FY 1999.

Facility Utilization
(Weeks of Operation)

	FY 1997	FY 1998	FY 1999
DIII-D	8	13	14
Alcator C-Mod	8	11	18
TFTR	8	0 *	0 *
NSTX	0	0	6

*Facility shutdown.

FUSION ENERGY SCIENCES
FACILITY OPERATIONS

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
TFTR	$24,721	$5,090	$3,700	-$1,390	-27.3%
DIII-D	23,486	25,973	29,700	+3,727	+14.3%
Alcator C-Mod	7,540	9,315	10,100	+785	+8.4%
NSTX	5,032	13,860	16,800	+2,940	+21.2%
GPP	600	900	700	-200	-22.2%
Total Facility Operations	$61,379	$55,138	$61,000	+$5,862	+10.6%

III. Performance Summary - Accomplishments

	FY 1997	FY 1998	FY 1999
TFTR	$24,721	$5,090	$3,700

After termination of TFTR operations in FY 1997, these funds provide for maintenance and caretaking of the TFTR facility.

- -- FY 1997 - plasma operation using deuterium and deuterium-tritium fuel for 8 weeks; followed by safe shutdown and caretaking.
- -- FY 1998 - maintained in caretaking condition.
- -- FY 1999 - maintained in caretaking condition.

FUSION ENERGY SCIENCES
FACILITY OPERATIONS

	FY 1997	FY 1998	FY 1999
DIII-D	$23,486	$25,973	$29,700

Provides support for operation, maintenance, and improvement of the DIII-D facility, increasing the power available for DIII-D Electron Cyclotron Heating (ECH) systems and support for other equipment at the GA site.

- -- FY 1997 - plasma operation using hydrogen and deuterium fuel for 8 weeks; plus downtime for upgrades and maintenance.
- -- FY 1998 - plasma operation using hydrogen and deuterium fuel for approximately 13 weeks; plus downtime for upgrades and maintenance.
- -- FY 1999 - plasma operation using hydrogen and deuterium fuel for approximately 14 weeks; plus downtime for significant upgrades to the ECH and divertor systems and maintenance.

	FY 1997	FY 1998	FY 1999
ALCATOR C-MOD	7,540	9,315	10,100

Provides support for operation, maintenance, and improvement of the Alcator C-Mod facility, including adding diagnostic systems, and support for other equipment at the MIT site.

- -- FY 1997 - plasma operation using hydrogen and deuterium fuel for approximately 8 weeks plus downtime for maintenance.
- -- FY 1998 - plasma operation using hydrogen and deuterium fuel for approximately 11 weeks plus downtime for maintenance.
- -- FY 1999 - plasma operation using hydrogen and deuterium fuel for approximately 18 weeks plus downtime for maintenance.

FUSION ENERGY SCIENCES
FACILITY OPERATIONS

	FY 1997	FY 1998	FY 1999
NSTX	5,032	13,860	16,800

Provides for completion of the NSTX project and for operation, maintenance, and improvement of the NSTX facility, supporting equipment at the PPPL site, and for initial operations beginning in late FY 1999. A planned equipment enhancement of NSTX includes adding an existing TFTR neutral beam heating system to the facility. This will enhance the initial capabilities of NSTX by increasing the heating and fueling flexibility, extending the performance of the machine, and providing more options for diagnosing the core plasma.

-- FY 1997 - complete final design and start fabrication of components.
-- FY 1998 - complete component fabrication and start assembly/installation.
-- FY 1999 - complete assembly/installation, start operations; begin mods for an additional neutral beam.

	FY 1997	FY 1998	FY 1999
PPPL GENERAL PLANT PROJECTS	600	900	700

The maintenance of the laboratory physical plant is supported as needed to maintain the laboratory's physical plant (e.g., roof replacement, refurbishing office spaces, resurfacing sidewalks).

	FY 1997	FY 1998	FY 1999
Total Facility Operations	$61,379	$55,138	$61,000

FUSION ENERGY SCIENCES
FACILITY OPERATIONS

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

A decrease for the TFTR at PPPL is due to reduced requirements for caretaking expenses.	-$1,390,000
The increase for DIII-D supports continuation of the upgrade of the DIII-D auxiliary heating systems.	+$3,727,000
The increase for Alcator C-Mod supports increased operations of the facility.	+$785,000
An increase in NSTX is provided for completion of fabrication and initiation of operations, as well as for beginning work on a neutral beam heating system for NSTX.	+$2,940,000
General Plant Projects support at PPPL is decreased.	-$200,000
Total Funding Change, Facility Operations	+$5,862,000

FUSION ENERGY SCIENCES

TECHNOLOGY

I. Mission Supporting Goals and Objectives: Most science-oriented programs, which continue to push the frontiers of human knowledge, require both intellectual resources and experimental facilities with state-of-the-art technological capabilities. The fusion program is a leading example of this dual resource need. The Technology subprogram develops the technological capabilities necessary for advancing both the science of fusion and of fusion energy, two strategic goals of the fusion program. Research, engineering, and advanced design will be performed in the areas of superconducting magnets, advanced heat removal methods, plasma diagnostics and control, plasma heating and fueling, safety, fuel processing and breeding, and high performance materials.

The Technology Program is divided into Fusion Energy Research and Advanced Materials. The largest Engineering Research subprogram element in FY 1998 was research and engineering design with the principal purpose of supporting the ITER program during the last year of the current ITER international agreement. The results of this work were also necessary for the viability of the base technology program. For FY 1999, the U.S. plan is to participate in restructured ITER follow on activities at a more modest level. The previous effort will be almost entirely redirected to support the U.S. domestic fusion program. In addition, an increased effort on technology support of major international facilities such as JET and JT-60 will begin. Much of the redirected effort will be dual-purpose, i.e., it will benefit the U.S. domestic fusion program as well as the restructured ITER. This will include the establishment of new initiatives in critical technology areas. The principal Engineering Research subprogram elements in FY 1999 are plasma and fusion technology research in support of existing domestic fusion facilities as well as technology research necessary to establish the knowledge base needed for an economically and environmentally attractive fusion energy source. Also, support will be provided for advanced design and assessments of critical aspects of integrated fusion systems.

The Materials Research subprogram element consists of research on low-activation materials and will be focused on high performance fusion system materials capable of withstanding long-term exposure to energetic particles and electromagnetic radiation from fusion plasma reactions.

FUSION ENERGY SCIENCES
TECHNOLOGY

II. <u>Funding Schedule</u>:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Engineering Research	$56,336	$58,270	$42,485	-$15,785	- 27.1%
Materials Research	5,947	7,771	6,200	- 1,571	- 20.2%
SBIR/STTR	0	1,784	1,315	- 469	- 26.3%
Total Technology	$62,283	$67,825	$50,000	-$17,825	- 26.3%

III. <u>Performance Summary - Accomplishments</u>	**F**	**FY 1997**	**FY 1998**	**FY 1999**
ENGINEERING RESEARCH		$56,336	$58,270	$42,485

The U.S. plan for future participation in ITER activities is as follows. The current ITER Engineering Design Activities (EDA) will be completed in July 1998, and the expectation is high that the technical product of the EDA, namely, a design and supporting R&D information, would provide a satisfactory technical basis for making decisions to proceed with ITER construction. None of the ITER parties is yet prepared to offer to host the ITER construction project.

and interactions with the

Due to the critical importance of the ITER collaborative activity as a focus for the international effort to develop fusion as an attractive energy source free from greenhouse gas emissions and to accomplish useful science, the ITER Parties propose a 3-year post-EDA period between the end of the current EDA and an international decision on whether to construct ITER. In the U.S. view, the objective of this period will be to re-evaluate the technical objectives, and develop design options with their associated cost estimates to enable decisions on possible future construction by the end of the period. The principal activities of the post-EDA period, which will have a major impact on the construction decision, are site specific adaptations of the current ITER design regulatory authorities in those territories of Parties interested in hosting the ITER facility, namely the European Union, Japan and possibly Canada. As a requirement of our participation, another key task during the transition will be to find lower cost approaches to ITER; we see cost reduction as a key factor in enhancing the probability that ITER is built and, consequently, that U.S. fusion energy science objectives can then be met. A continuing ITER support activity will be collaborative experimental and theoretical fusion science research in existing fusion facilities world-wide. The ITER Director also proposes additional work during the transition, i.e. advance the design of all systems in order to improve the schedule during construction, conduct R&D tests on prototype components developed during the EDA in order to establish operating margins and initiate some new R&D.

After about two years of the transition, the ITER Parties would make an assessment of readiness to proceed with construction, taking into account progress on site specific design adaptations and regulatory interactions and the evaluation of the design options and cost estimates as well as prospects for sharing the cost of ITER construction, operation and decommissioning and for establishing a host site. If the assessment were positive, the Parties would proceed to make arrangements for a new construction Agreement to be signed at the end of the transition. If the assessment were negative, the ITER activities would likely be closed out by the end of the transition.

On the basis of strong favorable reviews from the President's Committee of Advisors on Science and Technology and the Fusion Energy Sciences Advisory Committee, the U.S. proposes to continue to participate in the ITER post-EDA period but at a level reduced from its current level in the EDA as would be appropriate for a Party not offering a candidate construction site.

FY 1997 . . . . **FY 1998** **FY 1999**

The U.S. will participate in several design activities, i.e., support of the ITER Joint Work Site in San Diego, support a minimum number of scientists and engineers at the ITER joint work sites in technical areas where the U.S. has both interest and strong capability, and maintain a small Home Team design effort with a focus on design work associated with advanced modes of ITER operation and with possible lower cost configurations. In this way the U.S. will maintain an overall awareness of ITER follow on activities as a part of an integrated program of enhanced international activities.

Preserved from the ITER R&D and design activities conducted in earlier years will be personnel and facilities for technology

	FY 1997	FY 1998	FY 1999

R&D tasks at laboratories and universities to meet the needs of the U.S. fusion program. Some of these tasks will also benefit ITER and will be considered dual-purpose. These technology R&D tasks will be guided by peer review and community consensus for decisions affecting priorities and strategic planning. Merit review will be used extensively to achieve effective implementation of continuing tasks, and competitive processes will be used to select the most outstanding performers for new tasks.

For the nearer term needs of the fusion program, enabling technology work will be performed to meet the requirements of existing and planned plasma physics experiments, which will allow the program to fully exploit its investments in tokamak and alternate concept experiments. Component development and testing for plasma heating, plasma fueling, and plasma-facing systems, which build upon and extend state-of-the-art capabilities, will allow these experiments to operate at their limits for exploring the frontiers of fusion plasma science. Much of this work will also be applicable to ITER, i.e. dual-purpose.

	FY 1997	FY 1998	FY 1999

Technology support will also be performed in selected areas for the plasma physics experiments of our international partners in order to participate in their facilities and experimental programs. In addition, the extensive fusion safety expertise accumulated in the program will be applied toward achieving high standards in facility operation in FY 1999 and beyond.

For the longer term needs of the fusion program, advanced technology work will be aimed toward the program's mission-related goal of providing the technology knowledge base needed for an attractive fusion energy source. Testing will be conducted on the prototype of a major superconducting magnet component for a burning plasma experiment, which was fabricated jointly by the ITER parties with

U.S. leadership in the largest collaborative task of the ITER R&D effort. This testing will allow the program to capitalize on its substantial investment in magnet technology that is relevant to future U.S. fusion energy systems. In addition, initiatives will be implemented on two critical technology issues; research to establish the feasibility of innovative concepts for handling high surface heat fluxes and neutron wall loadings in burning plasma devices. This research is directed toward high-performance energy handling and extraction approaches that are generic to plasma confinement concepts and that will allow magnetic fusion to achieve its full potential as an attractive energy source.

Advanced design studies will be redirected to begin initiatives identifying an attractive pathway toward fusion energy that is based on (a) concept improvement and innovation in fusion plasma science and technology, (b) greater affordability than previous pathways, and (c) opportunities for applications of fusion energy that are nearer term than electricity generation.

	FY 1997	FY 1998	FY 1999
Efforts will be made to retain those U.S. scientists and engineers who participated in the ITER Joint Central Team and Home Team design activities and who possess the knowledge and skills that are vital to the U.S. domestic fusion program effort.			
Funding will also be needed for closeout costs to deal with ITER personnel who cannot be retained.			
<u>MATERIALS RESEARCH</u>	5,947	7,771	6,200
Materials research is a key element in developing safe, reliable and environmentally attractive fusion systems. Development and testing of vanadium alloys, silicon carbide composite materials and advanced ferritic steels for structural service in the high power zones of fusion power systems will continue. Priorities for this work, including innovative approaches to evaluating materials, will be guided by the results of a Fusion Energy Sciences Advisory Committee review to be conducted during FY 1998. Conceptual design of a fusion materials neutron source facility was completed in FY 1997 by an international team under the auspices of the International Energy Agency (IEA). U.S. involvement in the follow-on design and planning work is continuing at a low level in FY 1998. An initiative in advanced materials science will be implemented for development of computational models for predicting neutron interactive materials performance in fusion energy systems.			

SBIR/STTR FUNDING	**FY 1997**	**FY 1998**	**FY 1999**
In FY 1997 $1,730,000 and $103,000 were transferred to the SBIR and STTR programs, respectively. The FY 1998 and FY 1999 amounts are the estimated requirement for the continuation of these programs.	$0	$1,784	$1,315
Total Technology	$62,283	$67,825	$50,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

With the completing of the current ITER EDA activities in FY 1998, the U.S. role in the ITER transition period will be restructured with an accompanying redistribution of funds.	-$52,579,000
Plasma Technologies research, previously focused on ITER, is redirected to support U.S. fusion program domestic needs, including support for burning plasma physics objectives with initiatives in critical areas, much of which will also be applicable in ITER.	+$16,140,000
Fusion Technologies research, previously focused on ITER, is redirected to support U.S. fusion program domestic needs, including support for burning plasma physics objectives with initiatives in critical areas, much of which will also be applicable to ITER.	+$5,450,000
Advanced Design is increased in scope to support design work related to a restructured ITER and to investigate potential non-electric applications of fusion energy such as hydrogen production, and disposal of nuclear wastes and production of medical isotopes. Total funding for ITER joint baseline design will be $12,000,000.	+$15,204,000
SBIR/STTR funding is reduced due to fusion program reductions.	-$469,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999 (cont'd):

	-$1,571,000
Support for advanced materials development is decreased primarily to reflect the completion of the fabrication of the fusion irradiation fixture originally funded by NE.	+$17,825,000
Total Funding Change, Technology	

FUSION ENERGY SCIENCES

PROGRAM DIRECTION

I. Mission Supporting Goals and Objectives: This subprogram provides the Federal staffing resources and associated funding needed to plan, direct, manage, and administer the highly complex scientific and technical research and development program in fusion energy. The Fusion Energy Sciences program is developing the magnetic and inertial approaches to attaining fusion energy as two separate and distinct programs, coordinating, on inertial fusion, with the Office of Defense Programs. International collaboration is an essential element of the program strategy and requires extensive coordination efforts.

In the request for Fusion Energy Sciences Program Direction, $500,000 has been included in FY 1998 for the Working Capital Fund and $373,000 in FY 1999 to cover the costs of centrally provided goods and services at Headquarters such as supplies, housing, utilities, etc..

II. Funding Table:

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Chicago					
Salary and Benefits	1,028	$910	$0	$910	$926
Travel	120	74	0	74	70
Support Services	0	0	0	0	0
Other Related Expenses	200	190	0	190	139
Total	1,348	$1,174	$0	$1,174	$1,135
Full-Time Equivalents	12	10	0	10	10
Oakland					
Salary and Benefits	174	$184	$0	$184	$189
Travel	14	14	0	14	14
Support Services	0	0	0	0	0
Other Related Expenses	2	2	0	2	2
Total	190	$200	$0	$200	$205
Full-Time Equivalents	2	2	0	2	2

FUSION ENERGY SCIENCES
PROGRAM DIRECTION

II. Funding Table (cont'd):

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Headquarters					
Salary and Benefits	4,783	$4,001	$0	$4,001	$4,084
Travel	250	225	0	225	200
Support Services	980	600	0	600	500
Other Related Expenses	856	700	0	700	576
Total	6,869	$5,526	$0	$5,526	$5,360
Full Time Equivalents	45	37	0	37	37
Total Fusion Energy Sciences					
Salary and Benefits	5,985	5,095	0	5,095	5,199
Travel	384	313	0	313	284
Support Services	980	600	0	600	500
Other Related Expenses	1,058	892	0	892	717
Grand Total	8,407	$6,900	$0	$6,900	$6,700
Full-Time Equivalents	59	49	0	49	49

FUSION ENERGY SCIENCES
PROGRAM DIRECTION

III. <u>Performance Summary</u>:

	FY 1997	FY 1998	FY 1999
Salaries and Benefits:	$5,985	$5,095	$5,199

In FY 1998 and FY 1999, the Fusion Energy Sciences program will operate in a downsized mode as a result of a major reduction in staffing in FY 1998, which is reflected in a substantial decrease in salaries and benefits in that year. Remaining staff will focus on the science and technology of fusion energy rather than on the development of a new energy system, in response to direction from Congress and the recommendations of the Fusion Energy Sciences Advisory Committee regarding reorientation of the Fusion Energy Sciences program.

	FY 1997	FY 1998	FY 1999
Travel:	384	313	284

Further decreases in travel will be attained in FY 1998 and FY 1999 despite anticipated increases in the costs of airfare, lodging, etc. Alternatives to travel, such as teleconferencing, will be pursued where possible. Continued international travel will be required to reap the benefits of international cooperative programs, which comprise an important element of the program’s strategic plan.

	FY 1997	FY 1998	FY 1999
Support Services:	980	600	500

FY 1998 and FY 1999 requests provide the minimum level of support services needed to provide for the program’s mailroom, travel processing, technical support and information systems development needs. Energy Research has the best record in the Department for judicious use of support services contracts.

FUSION ENERGY SCIENCES
PROGRAM DIRECTION

	FY 1997	FY 1998	FY 1999
Other Related Expenses:			
The estimates for FY 1998 and FY 1999 include $500,000 and $373,000, respectively, for the new Headquarters Working Capital Fund. The remaining funds cover computer hardware and software acquisitions for information architecture enhancements to permit network upgrades and corporate systems development, as well as rent and utilities, printing and training for field staff supported in this decision unit.	1,058	892	717
TOTAL PROGRAM DIRECTION	$8,407	$6,900	$6,700

FUSION ENERGY SCIENCES
PROGRAM DIRECTION

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Increase of $104,000 in Salary and Benefits resulting from the impact of general pay increases, promotions, and within grade increases.	$+104,000
Decrease of $29,000 in travel is due to increased use of alternatives to travel and the impact of staff downsizing.	$-29,000
Decrease of $100,000 in support services results from realization of savings associated with the overall downsizing of the Fusion Energy Sciences program.	$-100,000
Decrease of $175,000 for other related expenses is due to savings from FY 1998 downsizing, which are partially offset by the inclusion of training and printing costs for field staff.	$-175,000
Total Funding Change, Program Direction	$-200,000

FUSION ENERGY SCIENCES
PROGRAM DIRECTION

Support Services	FY 1997 ($000)	FY 1998 ($000)	FY 1999 ($000)	FY 1999/ FY 1998 Change ($000)
Technical Support Service				
Feasibility of Design Considerations				
Economic and Environmental Analysis				
Test and Evaluation Studies				
Subtotal				
Management Support Services				
Management Studies				
Training and Education	10	5	5	0
ADP Support	520	245	205	-40
Administrative Support Services	450	350	290	-60
Subtotal	980	600	500	-100
Total Support Services	980	600	500	-100
Use of Prior Year Balances				

FUSION ENERGY SCIENCES
PROGRAM DIRECTION

Other Related Expenses	FY 1997 ($000)	FY 1998 ($000)	FY 1999 ($000)	FY 1999/ FY 1998 Change ($000)
Training			11	+11
Working Capital Fund	600	500	373	-127
Printing and Reproduction			9	+9
Rental Space/Utilities	30	26	26	0
Software Procurement/Maintenance Activities/Capital Acquisitions	428	366	298	-68
Other				
Total Obligational Authority	1,058	892	717	-175
Use of Prior-Year Balances				
Total Budget Authority	1,058	892	717	-175

FUSION ENERGY SCIENCES CAPITAL OPERATING EXPENSES AND CONSTRUCTION SUMMARY
(Tabular dollars in thousands, narrative in whole dollars)

	FY 1997	FY 1998	FY 1999	$ Change	% Change
Capital Operating Expenses					
General Plant Projects (total)	600	900	700	-200	-22.2%
Capital Equipment (total)	6,543	16,097	13,700	-2,397	-14.9%

Major Items of Equipment (CE $2 Million and Above)

	TEC	Previous Approp.	FY 1997 Approp.	FY 1998 Approp.	FY 1999 Request	Acceptance Date
1. DIII-D Upgrade	32,400		15,975	2,250	2,440	2,700
2002						
2. NSTX	21,100	0	3,550	12,080	5,450	1999
3. NSTX - Neutral Beam	6,000	0	0	0	3,450	2000

UNIVERSITY AND SCIENCE EDUCATION

PROGRAM MISSION

The Department of Energy is a major component of the nations scientific and technical community, and one of the largest supporters of science and technology in the Federal Government. The scientific and technical challenges of the Department's science and defense missions demand an adequate supply of scientists, engineers, and technicians. While the Department of Education and the National Science Foundation are the lead Federal agencies for supporting math and science education, the science and technology mission agencies -- including the Department of Energy -- make significant contributions. The Department, at its major national laboratories, has unique physical and intellectual resources available to support the nation's efforts to prepare the next generation of scientists and engineers to meet the challenges of the 21st century. The proposed University and Science Education (USE) program will support activities that utilize these scientific and technical resources to enhance the development of a diverse, well-educated and scientifically literate workforce.

The Department can continue to play a significant role in supporting science, technology, engineering, and math education at its laboratories. It will not duplicate the efforts of other organizations, but will focus its resources in those areas in which it can make unique contributions. By opening its laboratories to students and teachers, giving them hands-on research opportunities, and using it's technical expertise to develop Internet and other technical tools to enhance educational experiences and opportunities, DOE fills an important gap in the nation's efforts in science and math education.

The USE program is responsible for providing leadership and program support necessary to use and leverage the resources of the Department's laboratories to help replenish the overall pool of well-trained, diverse scientists and engineers of the future, and to achieve significant, long-term improvements in their scientific and technological skills.

The GOAL of the University and Science Education Program is:

To ensure that the Department effectively utilizes and leverages the resources of its laboratory-based system to support its mathematics and science education mission.

PROGRAM MISSION - UNIVERSITY AND SCIENCE EDUCATION (Cont'd)

The OBJECTIVES related to this goal are:

1. To provide opportunities and effective mechanisms for students and faculty to participate at the Department's laboratories in hands-on research experiences, with a focus on undergraduates.

2. To encourage increased participation of underrepresented populations in science and engineering through research participation opportunities.

3. To utilize DOE laboratory technical resources, in partnership with other science and technology agencies, to develop Internet-based education technologies.

4. To ensure increased attraction and retention in the educational pipeline by supporting a diversity of students and teachers.

5. To enhance community outreach activities in science, technology, engineering and mathematics education at our R&D facilities and sites.

PERFORMANCE MEASURES:

Performance measures for the University and Science Education program are both qualitative and quantitative. The quality of the program is measured by improvements in the efficiency and effectiveness of the DOE Laboratory Science Education Programs. The program performance measures are:

1. Enhanced opportunities at DOE laboratories to improve students/faculty understanding of science and mathematics.

2. Increased flow of underrepresented students into science and math programs/careers achieved.

3. Cost sharing and leveraging of program resources with other agencies will multiply the program's impact.

4. Success of program activities as measured by evaluation criteria related to student retention, enhancement, and impact of the program on participants' future career decisions.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- Through the National Undergraduate Laboratory Research Fellowship subprogram, (formerly known as the Laboratory Cooperative program), undergraduate students and faculty will spend summers and academic terms working side-by-side with scientists at DOE's national laboratories. In addition to gaining valuable research experience, these participants support DOE scientists in advancing their ongoing research.

- According to the most current Participant Activity Report System (PARS) data, in FY 1995 the demographics of the postsecondary participants in the Department's research participation programs are as follows: 34% female, 66% male. Of this total, approximately 14% were African American, 10% Asian/Pacific Island Americans, 7% Hispanic, 3% Native American, 56% were White Americans and 10% unidentified. This is indicative of the significant impact that the program is having on increasing the participation of non-traditional individuals in research.

- In accordance with Congressional direction in FY 1996, the University and Science Education program has been restructured to concentrate the education effort in the national laboratories. The new activities build upon and enhance our core strength of providing state-of-the-art, real world, hands-on experience to students and faculty, and extend the unique "state-of-the-art" capability of our laboratories in to the educational technology arena.

- No direct funding was appropriated for this program in FY 1997. No funds were requested for this activity in the FY 1998 President's budget. However, a modest amount of Energy Research program funding was provided to maintain a minimum Laboratory Cooperative program in FY 1997, consistent with Congressional report language.

UNIVERSITY AND SCIENCE EDUCATION
PROGRAM FUNDING PROFILE
(Dollars in thousands)

Subprogram	FY 1997 Current Appropriation		FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation
Research Fellowship	$0		$0	$0	$0
Educational Technology	0		0	0	0
Minority Institutional Development	0		0	0	0
Community Outreach	0		0	0	0
Subtotal, University and Science Education	0		0	0	0
Adjustment	-10	a/	0	0	0
Total, USE	-$10		$0	$0	$0

a/ Share of FY 1997 emergency flood supplemental rescission.

Public Law Authorization:
Pub. Law 95-91, DOE Organization Act

FY 1999 Request
$6,000
5,000
2,000
2,000
15,000
0
$15,000

UNIVERSITY AND SCIENCE EDUCATION
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$0	$0	$0	$0	$340
Sandia National Laboratory	0	0	0	0	480
Chicago Operations Office					
Ames Laboratory	0	0	0	0	640
Argonne National Laboratory	0	0	0	0	1,335
Brookhaven National Laboratory	0	0	0	0	985
Fermi National Accelerator Laborat	0	0	0	0	530
Princeton Plasma Physics Laborator	0	0	0	0	530
Golden Field Office					
National Renewable Energy Labora	0	0	0	0	500
Idaho Operations Office					
Idaho National Engineering Laborat	0	0	0	0	520
Oakland Operations Office					
Lawrence Berkeley National Labora	0	0	0	0	937
Lawrence Livermore National Labo	0	0	0	0	240
Stanford Linear Accelerator Center	0	0	0	0	530
Oak Ridge Operations Office					
Thomas Jefferson National Accelera	0	0	0	0	540
Oak Ridge Institute for Science and	0	0	0	0	300
Oak Ridge National Laboratory	0	0	0	0	1,105
Richland Operations Office					
Pacific Northwest National Laborat	0	0	0	0	890
Savannah River Operations Office					
Savannah River Ecology Laboratory	0	0	0	0	100
All other sites a/	0	0	0	0	4,498
Subtotal	0	0	0	0	15,000
Adjustment	-10 b/	0	0	0	0

Field Offices/Sites	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
TOTAL	-$10	$0	$0	$0	$15,000

a/ Funding provided to universities, industry, other federal agencies and contractors.
b/ Share of FY 1997 emergency flood supplemental rescission.

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
SCIENCE
(Tabular dollars in thousands, Narrative in whole dollars)

UNIVERSITY AND SCIENCE EDUCATION

PROGRAM MISSION

The Department of Energy is a major component of the nations scientific and technical community, and one of the largest supporters of science and technology in the Federal Government. The scientific and technical challenges of the Department's science and defense missions demand an adequate supply of scientists, engineers, and technicians. While the Department of Education and the National Science Foundation are the lead Federal agencies for supporting math and science education, the science and technology mission agencies -- including the Department of Energy -- make significant contributions. The Department, at its major national laboratories, has unique physical and intellectual resources available to support the nation's efforts to prepare the next generation of scientists and engineers to meet the challenges of the 21st century. The proposed University and Science Education (USE) program will support activities that utilize these scientific and technical resources to enhance the development of a diverse, well-educated and scientifically literate workforce.

The Department can continue to play a significant role in supporting science, technology, engineering, and math education at its laboratories. It will not duplicate the efforts of other organizations, but will focus its resources in those areas in which it can make unique contributions. By opening its laboratories to students and teachers, giving them hands-on research opportunities, and using it's technical expertise to develop Internet and other technical tools to enhance educational experiences and opportunities, DOE fills an important gap in the nation's efforts in science and math education.

The USE program is responsible for providing leadership and program support necessary to use and leverage the resources of the Department's laboratories to help replenish the overall pool of well-trained, diverse scientists and engineers of the future, and to achieve significant, long-term improvements in their scientific and technological skills.

The GOAL of the University and Science Education Program is:

To ensure that the Department effectively utilizes and leverages the resources of its laboratory-based system to support its mathematics and science education mission.

PROGRAM MISSION - UNIVERSITY AND SCIENCE EDUCATION (Cont'd)

The OBJECTIVES related to this goal are:

1. To provide opportunities and effective mechanisms for students and faculty to participate at the Department's laboratories in hands-on research experiences, with a focus on undergraduates.

2. To encourage increased participation of underrepresented populations in science and engineering through research participation opportunities.

3. To utilize DOE laboratory technical resources, in partnership with other science and technology agencies, to develop Internet-based education technologies.

4. To ensure increased attraction and retention in the educational pipeline by supporting a diversity of students and teachers.

5. To enhance community outreach activities in science, technology, engineering and mathematics education at our R&D facilities and sites.

PERFORMANCE MEASURES:

Performance measures for the University and Science Education program are both qualitative and quantitative. The quality of the program is measured by improvements in the efficiency and effectiveness of the DOE Laboratory Science Education Programs. The program performance measures are:

1. Enhanced opportunities at DOE laboratories to improve students/faculty understanding of science and mathematics.

2. Increased flow of underrepresented students into science and math programs/careers achieved.

3. Cost sharing and leveraging of program resources with other agencies will multiply the program's impact.

4. Success of program activities as measured by evaluation criteria related to student retention, enhancement, and impact of the program on participants' future career decisions.

PROGRAM MISSION - UNIVERSITY AND SCIENCE EDUCATION (Cont'd)

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- Through the National Undergraduate Laboratory Research Fellowship subprogram, (formerly known as the Laboratory Cooperative program), undergraduate students and faculty will spend summers and academic terms working side-by-side with scientists at DOE's national laboratories. In addition to gaining valuable research experience, these participants support DOE scientists in advancing their ongoing research.

- According to the most current Participant Activity Report System (PARS) data, in FY 1995 the demographics of the postsecondary participants in the Department's research participation programs are as follows: 34% female, 66% male. Of this total, approximately 14% were African American, 10% Asian/Pacific Island Americans, 7% Hispanic, 3% Native American, 56% were White Americans and 10% unidentified. This is indicative of the significant impact that the program is having on increasing the participation of non-traditional individuals in research.

- In accordance with Congressional direction in FY 1996, the University and Science Education program has been restructured to concentrate the education effort in the national laboratories. The new activities build upon and enhance our core strength of providing state-of-the-art, real world, hands-on experience to students and faculty, and extend the unique "state-of-the-art" capability of our laboratories in to the educational technology arena.

- No direct funding was appropriated for this program in FY 1997. No funds were requested for this activity in the FY 1998 President's budget. However, a modest amount of Energy Research program funding was provided to maintain a minimum Laboratory Cooperative program in FY 1997, consistent with Congressional report language.

UNIVERSITY AND SCIENCE EDUCATION
(Tabular dollars in thousands, narrative in whole dollars)

I. **<u>Mission Supporting Goals and Objectives</u>:** Activities supported by the University and Science Education program help ensure the effective utilization of DOE's laboratory system in support of the Department's mathematics and science education mission by enhancing the capabilities of faculty and students through hands-on research experiences at DOE national laboratories; increasing the diversity of the scientific workforce; utilizing laboratory resources to contribute to improved science education instruction and providing the necessary infrastructure for the Department's laboratory-based science education programs.

Research Fellowship

The National Undergraduate Laboratory Research Fellowship subprogram is the Department's primary vehicle for providing access to its national laboratories, by faculty and students, from every state and region in the United States. The program provides participants, from both small colleges (including predominantly minority institutions) and large universities, with access to state-of-the-art scientific equipment, techniques and ideas that enable them to further develop their critical thinking and analytical skills. The laboratory-based institutional support provided by this subprogram ensures effective participant placement across all of DOE's research and technical program areas and monitors the quality of their research experiences. Minority students and faculty are particularly sought out and encouraged to participate in the program. From the many thousands of applications the program receives annually, it is clear that DOE's research participation appointments are highly regarded and that these opportunities, along with industry internships and appointments at research centers of other federal agencies, play an important role in the science education program of the country. Program support ranges from 8 weeks to a full semester.

Educational Technology

The Educational Technology subprogram supports development of Internet based education technologies for students and faculty. Utilizing DOE's extensive experience and expertise in the area of computational and communications technology, the Department in partnership with NASA, the National Science Foundation and the Department of Education will focus its efforts on developing tools and materials, consistent with National Academy of Science Education Standards, that will help students and teachers take advantage of the capabilities of the Internet. An example of this is developing tutorials in energy sciences using rubics, visualization, simulation and modeling.

I. Mission Supporting Goals and Objectives (Cont'd):

Minority Institutional Development

One principle purpose of the Department's educational initiative is to encourage development of a more diverse science and technology workforce. Historically a major source of minority talent has been predominately minority institutions. Activities under this subprogram will support collaborative efforts between these institutions and the National laboratories to enhance their mathematics, science and technology programs. Also supported under this subprogram will be collaborations between these universities, associations, federal agencies and National laboratories to develop a framework to ensure these diverse interests are aware of the tools, technologies and research opportunities that are available. Consortia, cost-shares and partnerships will be the main mechanisms for accomplishing this goal.

Community Outreach

Activities under the Community Outreach subprogram support the Department's efforts to continue reaching out to the communities in which its laboratories and facilities are located. This outreach will continue to include education-related activities highlighted by the volunteer efforts of DOE and Laboratory employees, such as online mentoring (in collaboration with organizations such as the National Science Teachers Association), school visits and learning workshops. These efforts are intended to enhance DOE's efforts to continue to meet its goal of being a good corporate citizen.

UNIVERSITY AND SCIENCE EDUCATION

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Research Fellowship	$0 *	$0 *	$ 6,000	$+ 6,000	--%
Educational Technology	0	0	5,000	+ 5,000	--%
Minority Institutional Development	0	0	2,000	+ 2,000	--%
Community Outreach	0	0	2,000	+ 2,000	--%
Total University and Science Education	$0	$0	$15,000	$+15,000	--%

* A modest program was supported using program funds in accordance with direction in congressional report language.

III. Performance Summary-Accomplishments

	FY 1997	FY 1998	FY 1999
Research Fellowship			
No activities were supported by the University and Science Education program in FY 1997 and FY 1998 under this category. In FY 1999 this program will provide summer and semester research participation activities to address the research needs of the large, predominately undergraduate, college and university community.	$0	$0	$5,800
SBIR/STTR Funding			
No activities were supported by the University and Science Education program in FY 1997 and FY 1998 under this category. The FY 1999 amount is the estimated requirement for the continuation of these programs.	0	0	200
Total Research Fellowship	$0	$0	$6,000

III. Performance Summary-Accomplishments (Cont'd):

	FY 1997	FY 1998	FY 1999
Educational Technology			
No activities were supported by the University and Science Education program in FY 1997 and FY 1998 under this category. In FY 1999 this program will apply the Department's extensive experience and expertise in the area of computational and computer networking technology -- in partnership with NASA, the NSF and the Department of Education -- to developing tools and materials that will help students and teachers take advantage of the capabilities of the Internet.	$0	$0	$4,802
SBIR/STTR Funding			
No activities were supported by the University and Science Education program in FY 1997 and FY 1998 under this category. The FY 1999 amount is the estimated requirement for the continuation of these programs.	0	0	198
Total Educational Technology	$0	$0	$5,000
Minority Institutional Development			
No activities were supported by the University and Science Education program in FY 1997 and FY 1998 under this category. In FY 1999 this program will support efforts designed to address the special needs of the predominantly non-research minority college and university community, including collaborative initiatives with the National Science Foundation to support programs to encourage members of nontraditional groups to pursue energy-related scientific and technical careers.	0	0	2,000

III. **Performance Summary-Accomplishments (Cont'd):**	**FY 1997**	**FY 1998**	**FY 1999**
Community Outreach			
No activities were supported by the University and Science Education program in FY 1997 and FY 1998 under this category. In FY 1999 this program will support the Department's efforts to continue reaching out to the communities in which its laboratories and facilities are located.	0	0	2,000
This includes education-related activities intended to enhance DOE's efforts to continue to meet its goal of being a good corporate citizen.			
Total University and Science Education	$ 0	$ 0	$15,000

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

This program was terminated in FY 1997 by Congress and therefore no funds were requested for it in the FY 1998 President's budget. The FY 1999 request is to support a revitalized educational initiative restructured in accordance with Congressional instructions, responsive to its concerns, consistent with Presidential initiatives (such as the Call to Action for American Education, and Expanding Access to Internet-Based Educational Resources for Children, Teachers, and Parents), and concentrated in the national laboratories. The refocused initiative builds upon and enhances the Departments' core strength of providing state-of-the-art, hands on experience to students and faculty at the laboratories. Funding is requested for support of:

A National Undergraduate Research Fellowship program to provide summer and semester research participation activities to address the research training needs of the large, predominately undergraduate, college and university community.	$+5,800,000
An Educational Technology program to support development of Internet based education technologies for students and faculty.	+4,802,000

UNIVERSITY AND SCIENCE EDUCATION

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999 (Cont'd):

A Minority Institutional Development program to support collaborative efforts between these institutions and the National laboratories to enhance their mathematics, science and technology programs.	+ 2,000,000
A Community Outreach initiative to support the Department's efforts to continue reaching out to the communities in which its laboratories and facilities are located.	+ 2,000,000
SBIR/STTR assessment.	+ 398,000
Total Funding Changes, University and Science Education	$+15,000,000

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands, Narrative in whole dollars)

TECHNICAL INFORMATION MANAGEMENT

PROGRAM MISSION

The mission of the Technical Information Management program (TIM) is to direct, coordinate, and implement the management and dissemination of scientific and technical information resulting from Department of Energy research and development (R&D) and environmental programs. The program also provides worldwide energy scientific and technical information to the Department of Energy (DOE), United States (U.S.) industry, academia, and the public through interagency and international scientific and technical information exchange agreements.

The Department of Energy makes a multi-billion dollar annual investment in energy- and environment-related R&D activities. The primary and immediate product of this investment is knowledge (or information) - knowledge that will lead to advances in basic science and technology; more efficient uses and conservation of our nation's energy resources; more advanced technologies for environmental protection and remediation; cleaner-burning fuels and better transportation sources. Ultimately, the application of the knowledge created by the Department's R&D contributes to a more competitive economy, a cleaner environment, a more secure national defense - in short, a higher standard of living. At the same time, other industrialized nations are also investing in energy R&D, and the resulting technical information is globally recognized as a valuable commodity that can be exchanged in order to save taxpayer dollars and avoid duplicative research. Without effective and comprehensive technical information management, returns on R&D investments will not be realized, and wasteful duplication of effort will likely result. Requirements for technical information management and dissemination are delineated in the American Technology Preeminence Act; the Paperwork Reduction Act (and implementing guidelines); Department of Energy enabling legislation; and international treaties/agreements with the International Atomic Energy Agency and the International Energy Agency.

The GOAL of the Technical Information Management program is:

To add value to America's investment in energy research and development by facilitating the use of scientific and technical information to advance U.S. interests.

PROGRAM MISSION - TECHNICAL INFORMATION MANAGEMENT (Cont'd)

Specific GOALS include:

- Lead the Department in the collection, organization, preservation, and dissemination of scientific and technical information resulting from the Department's R&D programs; and
- Provide worldwide scientific and technical energy information to the Department, U.S. industry, academia, and the public.

The OBJECTIVES related to these goals are to:

- Increase the number of researchers and citizens served with scientific and technical information at a lower cost per person served;
- Lead/advance the institutionalization of an electronic, decentralized technical information collection that contributes to the development of a National Library of Energy Science and Technology;
- Negotiate and implement agreements for DOE's widespread, electronic access to U.S. science journals;
- Provide more effective mechanisms for public access to global energy-related information; and
- Capitalize on interagency, domestic, and international opportunities to gain access to non-Departmental scientific and technical energy information for U.S. researchers, national security communities, policymakers, academia, and the public.

PERFORMANCE MEASURES:

- Number of persons served with scientific and technical information and reduction in cost per person served;
- Percent of Departmental technical information exchanged electronically;
- Age and timeliness of information acquired and disseminated;
- Reduction in cost for information acquisition and processing;
- Level of partnering and adoption of common standards/practices within the Department and among interagency and international information communities;
- Percent and amount of foreign energy-related information acquired to augment the U.S. collection and promote national competitiveness;
- Amount of information disseminated and number and diversity of customer/market segments reached or "benefitted" by the Department's scientific and technical information collection;
- Percent of special customer projects/services completed on time and within budget; and
- Customer satisfaction with Departmental scientific and technical information products and services.

PROGRAM MISSION - TECHNICAL INFORMATION MANAGEMENT (Cont'd)

Significant ACCOMPLISHMENTS AND PROGRAM SHIFTS:

The Technical Information Management program continues to make progress toward strategic priorities, known collectively as "Bringing Science Information to the Desktop." These priorities are described below:

- Electronic Information Exchange and the Information Bridge through EnergyFiles

  As technology and common standards advance, it becomes more timely and economical to exchange both bibliographic and full-text information in electronic media. While it will be necessary for the Department to maintain a centralized point of coordination for this electronic infrastructure (for policy, standards, archiving, etc.), Departmental elements will realize efficiencies in information technology, management, printing, and publishing as a result of Department-wide electronic exchange. The Information Bridge, which provides access to 40,000 full-text, electronic DOE R&D reports, will continue to enable the user to bypass expensive and time-consuming bibliographic searches and requests for paper reports. The Information Bridge is available through EnergyFiles, a virtual information environment of electronic resources throughout the Department. Distributed information collections throughout the Department will also be electronically interconnected and searchable.

- Enhanced Access to Electronic Science Journals

  The Technical Information Management program is aggressively pursuing agreements for the availability of electronic science journals for the Departmental research community. The program will negotiate licenses with two main science journals in FY 1999, thereby saving the Department the cost of multiple paper-based subscriptions. Electronic journal agreements are estimated to save the Department $8,000,000 annually.

- Archive of Legacy Documents

  The Department's valuable historic collection of scientific and technical information represents billions of dollars of research and development and constitutes much of our nation's energy-related science base. Currently, the vast majority of this legacy collection is in microfiche or paper media rather than in electronic form, which is targeted as the primary means of archival by FY 2000. Interagency standards, cooperation, and agreements are now allowing the use of optical media as an acceptable means of storage. In addition to saving resources, optical media also allow a more user-friendly and cost-effective means of access and retrieval.

PROGRAM MISSION - TECHNICAL INFORMATION MANAGEMENT (Cont'd)

Significant ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- Push Technologies

  The Technical Information Management program will proactively provide information of interest to individual researchers and program managers based on user-defined preferences. This will involve the development of subject- or discipline-based profiles where information about newly added R&D reports or articles will be automatically transmitted to scientists and researchers with similar interests or ongoing projects.

TECHNICAL INFORMATION MANAGEMENT
PROGRAM FUNDING PROFILE
(dollars in thousands)

Subprogram	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments	FY 1998 Current Appropriation		FY 1999 Budget Request
Program Support	$ 2,300		$ 1,600		$0	$ 1,600		$ 2,340
Program Direction	8,700		7,500		0	7,500		7,500
Subtotal	$ 11,000		$ 9,100		$0	$ 9,100		$ 9,840
Construction	1,000		1,000		0	1,000		0
Subtotal, Technical Information Management	$ 12,000		$ 10,100		$0	$ 10,100		$ 9,840
Adjustment	-263	a/	-68	b/	0	-68	b/	0
Total, Technical Information Management	$ 11,737		$ 10,032		$0	$ 10,032		$ 9,840
Full-time equivalents	126		105		0	105		99

a/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program ($163,000) and FY 1997 emergency flood supplemental rescission ($100,000). The total general reduction is applied at the appropriation level.

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

Public Law Authorization:

Public Law: 95-91, DOE Organization Act

TECHNICAL INFORMATION MANAGEMENT
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1997 Current Appropriation		FY 1998 Original Appropriation		FY 1998 Adjustments	FY 1998 Current Appropriation		FY 1999 Budget Request
Oak Ridge Operations Office								
Office of Scientific and Technical Informatio	$12,000		$10,100		$0	$10,100		$9,840
Subtotal...	$12,000		$10,100		$0	$10,100		$9,840
Adjustment..	-263	a/	-68	b/	----	-68	b/	----
TOTAL..	$11,737		$10,032		$0	$10,032		$9,840

a/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program ($163,000) and FY 1997 emergency flood supplemental rescission ($100,000). The total general reduction is applied at the appropriation level.

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

TECHNICAL INFORMATION MANAGEMENT
PROGRAM SUPPORT
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: The Program Support subprogram provides funds for collecting, disseminating, and preserving/protecting appropriate Department of Energy information for the benefit of U.S. educational, industrial, and research communities as well as developing and maintaining systems and technologies to transition from traditional information media to electronic information exchange. This includes funding for the digitization and electronic availability of full-text Departmental R&D reports -- the Information Bridge. Specifically, funding is used to procure software and information technology that will promote distributed, decentralized, electronic processing of research data. Contracts are utilized to develop information systems and to analyze and process domestic and foreign technical information. Resources are also used to develop and maintain classified information processing technology and repository capabilities.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	% Change
Program Support	$2,300	$1,600	$2,340	$+740	+ 46.2%
Total, Program Support	$2,300	$1,600	$2,340	$+740	+ 46.2%

TECHNICAL INFORMATION MANAGEMENT
PROGRAM SUPPORT

III. <u>Performance Summary - Accomplishments</u>:

Program Support	FY 1997	FY 1998	FY 1999
• Implement "Bringing Science Information to the Desktop" initiatives, including electronic science journals, push technologies, and searchable distributed information collections. Streamline collection, management, and dissemination of DOE R&D results by transitioning from predominately paper-based environment to electronic information exchange and locator technology, including the Information Bridge. Capital equipment funding is included for computer hardware to support electronic information exchange efforts. Initiate licenses and access to electronic science journals for the Departmental research community.	$1,700	$1,200	$1,740
• Enhance U.S. economic competitiveness by providing access to foreign technical information by domestic research and industrial communities.	350	200	300
• Protect national security while enabling simplified electronic exchange of and access to classified technical information; implement declassification process in support of continued openness initiatives.	250	200	300
Total, Program Support	$2,300	$1,600	$2,340

TECHNICAL INFORMATION MANAGEMENT
PROGRAM SUPPORT

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Program Support

The increase reflects a strategic investment of additional resources in electronic exchange of scientific and technical information. Following a significant funding reduction in FY 1998, this investment will maintain and operate the Information Bridge which provides DOE R&D report literature full text on-line to the entire DOE complex. The investment will also provide support for electronic full-text access to two major science journals. Push technologies, searchable distributed collections, and machine-translated foreign R&D literature will complete "Bringing Science Information to the Desktop."	$+540,000
Fulfill U.S. obligations to exchange scientific and technical information with two multilateral international energy agencies. The increase will ensure continued domestic access to foreign research results.	$+100,000
The increase in classified information support reflects a continued emphasis on declassification as well as the need to modernize exchange and management of classified/sensitive data.	$+100,000
Total Funding Change, Program Support	$+740,000

TECHNICAL INFORMATION MANAGEMENT
PROGRAM DIRECTION
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals/Ongoing Responsibilities

This program provides Federal staffing and resources to direct, coordinate, and implement the management and dissemination of scientific and technical information resulting from Department of Energy research and development and environmental programs; provide worldwide energy scientific and technical information to the Department of Energy, United States (U.S.) industry, academia, and the public; and fulfill international and interagency scientific and technical information commitments in support of Departmental and U.S. obligations.

Program direction provides overall direction, coordination, implementation, and administrative support required to fulfill the responsibilities of the Technical Information Management Program. Program direction is divided into the following categories:

Salaries and Benefits provides for Federal staff involved in policy development and coordination; implementation and performance of program activities; representation in international information exchange agreements; human resource management; and other Federal responsibilities.

Travel provides for program-related travel to conduct and fulfill responsibilities outlined under salaries and benefits.

Support Services provides on-site services in such areas as mail operations, local area network support, and analysis of electronic information exchange.

Other Related Expenses represent maintenance and utilities costs for the Office of Scientific and Technical Information facility and equipment for office automation and work requirements.

TECHNICAL INFORMATION MANAGEMENT
PROGRAM DIRECTION

II. Funding Table:

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Oak Ridge, TN (HQ)					
Salaries and Benefits	$ 7,500	$ 6,610	$ 0	$ 6,610	$ 6,610
Travel	110	110	0	110	110
Support Services	280	200	0	200	200
Other Related Expenses	520	300	0	300	300
Total	$ 8,410	$ 7,220	$ 0	$ 7,220	$ 7,220
Full Time Equivalents	124	102	0	102	96
Washington, D.C. (HQ)					
Salaries and Benefits	$ 270	$ 270	$ 0	$ 270	$ 270
Travel	20	10	0	10	10
Support Services	0	0	0	0	0
Other Related Expenses	0	0	0	0	0
Total	$ 290	$ 280	$ 0	$ 280	$ 280
Full Time Equivalents	2	3	0	3	3
Total, Technical Information Management Program					
Salaries and Benefits	$ 7,770	$ 6,880	$ 0	$ 6,880	$ 6,880
Travel	130	120	0	120	120
Support Services	280	200	0	200	200
Other Related Expenses	520	300	0	300	300
Grand Total	$ 8,700	$ 7,500	$ 0	$ 7,500	$ 7,500
Full Time Equivalents	126	105	0	105	99

TECHNICAL INFORMATION MANAGEMENT
PROGRAM DIRECTION

III. **Performance Summary - Accomplishments**:	**FY 1997**	**FY 1998**	**FY 1999**
Salaries and Benefits:	$ 7,770	$ 6,880	$ 6,880

The Technical Information Management program is Federally managed and implemented due to the program's inherent government responsibilities. These responsibilities include: (1) maintaining and coordinating a formal Departmental infrastructure to define and implement policy and standards for scientific and technical information in areas such as public access, electronic information exchange, and information security; (2) representing the United States in two multilateral international information exchange agreements, resulting in the acquisition of 85,000 foreign research summaries per year; and (3) management of proprietary and classified information, including serving as the central repository for the Department's 50-year collection of classified and sensitive information. Through partnering, outsourcing, and use of electronic information management technology, Federal staffing has declined from 362 employees to 105 in the last two decades. The FY 1999 budget request reflects a 6 FTE reduction; remaining staff will continue focusing on defining and developing a decentralized electronic "virtual library" of scientific and technical information throughout the Department.

Travel:	130	120	120

Travel funding is required for the partnering and coordination inherent in a nationwide, distributed research and information environment.

III. **Performance Summary - Accomplishments**:	**FY 1997**	**FY 1998**	**FY 1999**
Support Services:	$ 280	$ 200	$ 200
FY 1998 and FY 1999 are at the base level of support services needed primarily for internal and external automatic data processing functions.			
Other Related Expenses:	520	300	300
Expenses reflect facility maintenance costs, including scheduled replacement of parts, equipment, and supplies. Expenses also reflect a transition to Pentium-based computer processors and a Windows NT environment.			
Total Program Direction	$8,700	$7,500	$7,500

TECHNICAL INFORMATION MANAGEMENT
PROGRAM DIRECTION

IV. <u>EXPLANATION OF FUNDING CHANGES FY 1998 TO FY 1999</u>:

While there are no funding changes, a basic cost-of-living increase for salaries and benefits is offset by a reduction of six FTEs.	$ 0
Total Funding Change, Program Direction	$ 0

TECHNICAL INFORMATION MANAGEMENT
PROGRAM DIRECTION (CONT'D)

Support Services	FY 1997 ($000)	FY 1998 ($000)	FY 1999 ($000)	FY 1998/FY 1999 Change ($000)
Technical Support Service				
Analysis and Support of Electronic Information Exchange	$ 170	$ 100	$ 100	0
Management Support Services				
ADP Support	110	100	100	0
Total Support Services	$ 280	$ 200	$ 200	0

Other Related Expenses	FY 1997 ($000)	FY 1998 ($000)	FY 1999 ($000)	FY 1998/FY 1999 Change ($000)
Training	$ 15	$ 15	$ 15	0
Facility Management	395	200	200	0
Software Procurement/Maintenance Activities/Capital Acquisitions	110	85	85	0
Total Budget Authority	$ 520	$ 300	$ 300	0

TECHNICAL INFORMATION MANAGEMENT
CONSTRUCTION
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives: Construction funding is provided to update and renovate general purpose infrastructure in support of the TIM process.

II. Funding Schedule:

Program Activity	FY 1997	FY 1998	FY 1999	$ Change	%Change
Construction	$1,000	$1,000	$ 0	$-1,000	-100.0%
Total, Program Support	$1,000	$1,000	$ 0	$-1,000	-100.0%

III. Performance Summary - Accomplishments:

	FY 1997	FY 1998	FY 1999
• Heating, ventilation and air condition (HVAC) Retrofits of OSTI Facility, Oak Ridge, TN (Project No. 95-A-500) will be completed in FY 1998.	$1,000	$1,000	$ 0
Total Construction	$1,000	$1,000	$ 0

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Decrease reflects completion of HVAC Retrofit Project in FY 1998.	$-1,000,000
Total Funding Change, Construction	$-1,000,000

TECHNICAL INFORMATION MANAGEMENT
CAPITAL OPERATING EXPENSES AND CONSTRUCTION SUMMARY
(Dollars in thousands)

	FY 1997	FY 1998	FY 1999	$ Change	% Change
Capital Operating Expenses					
Capital Equipment (total)...	$43	$0	$200	$+200	----

Construction Project Summary (both Operating and Construction Funded)

Project No.	Project Title	TEC	Previous Appropriated	FY 1997 Appropriated	FY 1998 Request	FY 1999 Request	Unapprop. Balance
95-A-500	Office of Scientific and Technical Information Heating, Ventilation, and Air Conditioning HVAC Retrofits	$4,000	$2,000	$1,000	$1,000	$0	$0
Total Technical Information Management		$4,000	$2,000	$1,000	$1,000	$0	$0

DEPARTMENT OF ENERGY
FY 1999 CONGRESSIONAL BUDGET REQUEST
SCIENCE
(Tabulars in thousands, Narrative in whole dollars)

ENERGY RESEARCH PROGRAM DIRECTION

PROGRAM MISSION

This program provides the Federal staffing and associated funding required to provide overall direction of activities carried out under the following programs in the Office of Energy Research (ER): High Energy Physics, Nuclear Physics, Biological and Environmental Research, Basic Energy Sciences, Computational and Technology Research, Multiprogram Energy Laboratories-Facilities Support, Energy Research Analyses. This funding also provides the necessary support to the Director of ER to carry out ER's responsibilities under the Department of Energy (DOE) Organization Act (P.L. 95-91) and as mandated by the Secretary. These responsibilities include providing advice on the status and priorities of the Department's overall research and development programs and on the management of the Department's multipurpose laboratories; developing research and development plans and strategies; and supporting university and science education. This program also provides program-specific staffing resources at the Chicago, Oakland, and Oak Ridge Operations Offices directly involved in executing ER programs.

Program direction has been divided into four categories: salaries and benefits, travel, support services, and other related expenses, the latter including the Working Capital Fund. “Support services” refers to support services contracts that provide necessary support functions to the Federal staff, such as technical support, computer systems development, travel processing, and mailroom activities. “Other related expenses” refers to other administrative costs of maintaining Federal staff, such as building and facility costs and utilities in the field, information technology expenses, and training. The Working Capital Fund includes centrally provided goods and services at Headquarters, such as supplies, rent and utilities.

The GOAL of Energy Research Program Direction is:

To fund the staff and related expenses that are necessary to provide overall management direction of ER's basic and fundamental scientific research programs funded in the Science appropriation; and to enable the Director of ER to serve as the Department's science advisor for formulation and implementation of basic and fundamental research policy.

The OBJECTIVES related to these goals are:

1. To develop, direct and administer a complex and broadly diversified program of mission-oriented basic and applied research and development designed to support the development of new and improved energy, environmental and health technologies.

2. To manage the design, construction and operation of forefront scientific research facilities for use by the Nation's scientific community.

3. To conduct independent technical assessments, peer reviews and evaluations of research proposals, programs and projects.

4. To enhance international collaboration to leverage the U.S. investment in research and development.

5. To review, analyze and, where appropriate, champion the recommendations of Energy Research's Federally chartered advisory committees including the High Energy Physics Advisory Panel, Nuclear Science Advisory Committee, Basic Energy Sciences Advisory Committee, and Health and Environmental Research Advisory Committee.

PERFORMANCE MEASURES:

1. Responsiveness to national science policy and major science initiatives.

2. Improvement in environment, safety and health compliance.

3. Provision of new and enhanced research facilities and equipment within scope and budget and on schedule.

4. Continued improvement in the utilization of staffing, travel and support contractor funds.

5. Continuance of improved levels of facility operating time.

6. Expansion of international collaborative efforts.

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- Energy Research continues to achieve technical excellence in its programs despite managing one of the largest, most diversified and most complex basic research portfolios in the Federal Government with a relatively small Federal and support contractor staff compared to other programs both within and outside the Department.

- Increased productivity at U.S. scientific research facilities as part of the Scientific Facilities utilization initiative.

- Research operations commenced in FY 1997 at the newly commissioned Advanced Photon Source facility at Argonne National Laboratory. This is an excellent example of a well-planned and managed construction project which was completed on schedule and within its budget.

- Concluded the international agreement for U.S. participation in the Large Hadron Collider project. Signatories included the Secretary of Energy and the Director of the National Science Foundation. Execution of the program has begun.

- Managed the construction of the William R. Wiley Environmental Molecular Sciences Laboratory at Pacific Northwest National Laboratory, structural biology facilities, and the Human Genome Laboratory to completion on time and within budget.

- At Fermilab, complete construction of the C-Zero Experimental Hall within scope and budget, and on schedule (FY 1999 completion); and complete the Main Injector within scope and budget, and on schedule (FY 1999 initial operation).

- Complete the B-factory and its detector at the Stanford Linear Accelerator Center within scope and budget, and on schedule (FY 1999 initial operation).

- Continue construction of the Relativistic Heavy Ion Collider and its detectors at Brookhaven National Laboratory within scope and budget, and on schedule (FY 1999 initial operation).

- Enhance the scientific capabilities for experiments at the Thomas Jefferson National Accelerator Facility (TJNAF) to provide new opportunities for researchers. Three TJNAF experimental halls will be fully operational and the radioactive ion beams enhanced in FY 1998.

- Continue to improve performance of the Radioactive Ion Beam facility at Oak Ridge National Laboratory through the development and use of new beams for carrying out experiments.

- Continue pilots in FY 1998 for transfer of management responsibility from Environmental Management to Energy Research for newly generated wastes at the Stanford Linear Accelerator Center (SLAC) and Fermilab.

- Manage the Joint Genome Institute and the Atmospheric Radiation Measurement sites using the National Laboratories as an integrated system.

- Strengthen integrated safety management and infrastructure management at the National Laboratories.

- Operate the state-of-the-art National Energy Research Scientific Computing and Energy Science Network for the benefit of ER and DOE.

- Continue to improve environmental, safety and health performance at the Brookhaven National Laboratory through aggressive implementation of the DOE Action Plan for Improved Management of the Laboratory.

ENERGY RESEARCH PROGRAM DIRECTION
PROGRAM FUNDING PROFILE
(Dollars in thousands)

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Activity					
Operating Expenses a/	$0	$37,600	$0	$37,600	$39,860
Adjustment	0	0	0	0	0
TOTAL, Energy Research Program Direction	$0	$37,600	$0	$37,600	$39,860
Staffing (FTEs)					
Headquarters FTEs	0	256		256	252
Field FTEs	0	36		36	36
TOTAL, FTEs	0	292	0	292	288

a/ The operating expenses include Working Capital Fund charges, which are estimated to be $2,679,000 in FY 1998 and $2,870,000 in FY 1999.

Public Law Authorization:

Pub. Law 95-91, DOE Organization Act

ENERGY RESEARCH PROGRAM DIRECTION
(Tabular dollars in thousands, narrative in whole dollars)

I. Mission Supporting Goals and Objectives

Program Direction provides the Federal staffing resources and associated costs required to provide overall direction and execution of Office of Energy Research program and advisory responsibilities. Energy Research Program Direction supports staff in the High Energy Physics, Nuclear Physics, Basic Energy Sciences, Biological and Environmental Research, Computational and Technology Research, Multiprogram Energy Laboratories-Facilities Support, and Energy Research Analyses programs, including management and technical support staff. This program also supports staff at the Chicago, Oakland, and Oak Ridge Operations Offices directly involved in program execution. The staff includes scientific and technical personnel as well as program support personnel in the areas of budget and finance, general administration, grants and contracts, information resource management, policy review and coordination, infrastructure management, construction management, and environment, safety and health.

The FY 1999 request includes Working Capital Fund resources of $2,870,000 to cover the costs of centrally provided goods and services at Headquarters, such as supplies, rent, and utilities.

II. Funding Table:

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Chicago					
Salary and Benefits		$1,949		$1,949	$2,104
Travel		93		93	30
Support Services		5		5	187
Other Related Expenses		84		84	104
Total		$2,131		$2,131	$2,425
Full-Time Equivalents		21		21	21

II. Funding Table (cont'd):

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Oakland					
Salary and Benefits		$695		$695	$756
Travel		20		20	12
Support Services		0		0	10
Other Related Expenses		35		35	45
Total		$750		$750	$823
Full-Time Equivalents		8		8	8
Oak Ridge					
Salary and Benefits		$633		$633	$623
Travel		35		35	35
Support Services		0		0	0
Other Related Expenses		32		32	84
Total		$700		$700	$742
Full-Time Equivalents		7		7	7
Headquarters					
Salary and Benefits		$23,343		$23,343	$24,544
Travel		1,015		1,015	1,040
Support Services		4,690		4,690	5,103
Other Related Expenses		4,971		4,971	5,183
Total		$34,019		$34,019	$35,870
Full Time Equivalents		256		256	252

II. Funding Table (cont'd):

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Total Energy Research					
Salary and Benefits		$26,620		$26,620	$28,027
Travel		1,163		1,163	1,117
Support Services		4,695		4,695	5,300
Other Related Expenses		5,122		5,122	5,416
Grand Total		$37,600		$37,600	$39,860
Full-Time Equivalents		292		292	288

III. Performance Summary:

Salaries and Benefits:	FY 1997	FY 1998	FY 1999
Staff funded in this decision unit monitor and evaluate over 3,200 grants and contracts at more than 225 institutions, including universities, industry and other government agencies, in addition to monitoring and evaluating the programs at 13 National Laboratories. ER also manages the Department-wide Small Business Innovation Research and Small Business Technology Transfer programs. Our reengineering efforts have eliminated unnecessary and non-value added work from the system where possible. Elimination of Office of Energy Research support for the Federally staffed Environmental Measurements Laboratory resulted from a review of program priorities that leads to a major savings in salaries and benefits in FY 1998 at the Chicago Operations Office. Further reductions in staff or program direction funding below the FY 1999 request would prevent us from covering the broad spectrum of scientific disciplines which comprise Energy Research programs, which would eventually compromise their scientific		$26,620	$28,027

III. Performance Summary (Cont'd):	FY 1997	FY 1998	FY 1999
productivity and our ability to respond to the needs of the researchers throughout the country who are funded by these programs and utilize their research facilities.			
Travel: The FY 1999 estimate reflects a lower amount of actual travel since anticipated escalation of costs for airfare, lodging, etc., will be absorbed. Further reductions in travel could seriously impact ER's ability to achieve its missions. Alternatives to travel such as teleconferencing will be utilized when possible.		1,163	1,117
Support Services: Provide necessary mailroom, travel processing, environment, health and safety support, computer systems development, and hardware and software installation, configuration, and maintenance activities. Emphasis in FY 1998 and FY 1999 will be placed on implementation of an information architecture for Energy Research to establish integrated business management systems, consistent with the provisions of the Information Technology Management Reform Act of 1996. This is essential to take work out of the system and to meet workload demands. ER is widely acknowledged as being the most efficient and conservative user of support services contracts in the Department.		4,695	5,300
Other Related Expenses: Acquire computer hardware and software in FY 1998 and FY 1999 necessary to accomplish corporate systems development and networking upgrades. The FY 1998 and FY 1999 estimates include $2,679,000 and $2,870,000, respectively, to cover Headquarters Working Capital Fund charges.		5,122	5,416
Total		$37,600	$39,860

EXPLANATION OF FUNDING CHANGES FROM FY 1998 TO FY 1999:

Increase of $1,407,000 in salaries and benefits is due to the impact of general pay increases, promotions and within grade increases, which is partially offset by the decrease of four FTEs.	$+1,407,000
Decrease of $46,000 in travel due to increased use of alternatives to travel.	$-46,000
Increase of $605,000 in support services results from the inclusion in program direction of support service contracts previously included in program budgets as directed by Congress.	$+605,000
Increase of $79,000 due to costs of computer workstations and network infrastructure technology upgrades needed to improve operational efficiencies and for the inclusion of field office printing costs. Increase of $191 for the Working Capital Fund due to general rise in price levels.	$+294,000
Total	$+2,260,000

Support Services	FY 1997 ($000)	FY 1998 ($000)	FY 1999 ($000)	FY 1999/ FY 1998 Change ($000)
Technical Support Service				
Feasibility of Design Considerations				
Economic and Environmental Analysis		1,488	1,488	0
Test and Evaluation Studies			160	+160
Subtotal		1,488	1,648	+160
Management Support Services				
Management Studies		207	207	0
Training and Education		58	58	0
ADP Support		2,282	2,627	+345
Administrative Support Services		660	760	+100
Subtotal		3,207	3,652	+445
Total Support Services		4,695	5,300	+605
Use of Prior Year Balances				

Other Related Expenses	**FY 1997 ($000)**	**FY 1998 ($000)**	**FY 1999 ($000)**	**FY 1999/ FY 1998 Change ($000)**
Training		60	60	0
Working Capital Fund		2,679	2,870	+191
Printing and Reproduction			24	+24
Rental Space				
Software Procurement/Maintenance Activities/Capital Acquisitions		2,383	2,462	+79
Other				
Total Obligational Authority		5,122	5,416	+294
Use of Prior-Year Balances				
Total Budget Authority		5,122	5,416	+294

GENERAL SCIENCE PROGRAM DIRECTION

PROGRAM MISSION

General Sciences Program Direction was transferred to the Science Program Direction decision unit in FY 1998 at the direction of Congress. The program provided the Federal staffing resources and associated funding to plan, direct, and manage a viable, high quality national program of basic research in the fields of high energy physics and nuclear physics in support of the Nation's goals to support basic scientific research. It supported the staff in the Office of the Associate Director for High Energy and Nuclear Physics, the High Energy Physics Division, the Nuclear Physics Division, and associated program and management support staff in the Office of Energy Research. This program also provided program-specific staffing resources at the Chicago, Oakland, and Oak Ridge Operations Offices to support high energy and nuclear physics activities carried out by those offices.

Program direction has been divided into four categories: salaries and benefits, travel, support services, and other related expenses. Support services refers to program direction funded support service contracts that provided necessary support functions to the Federal staff, such as computer systems development, travel processing, technical support, and mailroom. Other related expenses includes other administrative costs of maintaining Federal staff, such as building and facility costs including utilities at field locations, training, information technology expenses, and Working Capital Fund charges for goods and services provided centrally by the Department at Headquarters.

GENERAL SCIENCE-PROGRAM DIRECTION
PROGRAM FUNDING PROFILE
(Dollars in thousands)

Activity	FY 1997 Current Appropriation		FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation
Operating Expenses..	$10,000	a/			
TOTAL, General Science Program Direction..........	$10,000				
Staffing (FTEs)					
Headquarters FTEs.......................................	51				
Field FTEs..	32				
Total, FTEs..	83				

a/ The Operating Expenses included $1,000,000 Working Capital Fund contributions in FY 1997.

Public Law Authorization:
Pub. Law 95-91, DOE Organization Act (1977)

GENERAL SCIENCE PROGRAM DIRECTION

I. Mission Supporting Goals/Ongoing Responsibilities:

This program was transferred to the new Science Program Direction decision unit in FY 1998 at the direction of Congress.

The program included $1,000,000 Working Capital Fund charges to cover the costs of centrally provided goods and services such as supplies, housing, utilities, etc., which previously were budgeted in Departmental Administration.

II. Funding Schedule:

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Chicago					
Salary and Benefits	$1,595				
Travel	23				
Support Services	35				
Other Related Expenses	37				
Total	$1,690				
Full Time Equivalents	17				
Oakland					
Salary and Benefits	$616				
Travel	9				
Support Services	10				
Other Related Expenses		17			
Total	$ 652				
Full Time Equivalents	6				

GENERAL SCIENCE PROGRAM DIRECTION

II. Funding Schedule (cont'd):

	FY 1997 Current Appropriation	FY 1998 Original Appropriation	FY 1998 Adjustments	FY 1998 Current Appropriation	FY 1999 Budget Request
Oak Ridge					
Salary and Benefits	$ 677				
Travel	37				
Support Services	0				
Other Related Expenses	46				
Total	$760				
Full Time Equivalents	9				
Headquarters					
Salary and Benefits	$ 4,690				
Travel	290				
Support Services	464				
Other Related Expenses a/	1,454				
Total	$ 6,898				
Full Time Equivalents	51				
Total Energy Research					
Salary and Benefits	$ 7,578				
Travel	359				
Support Services	509				
Other Related Expenses	1,554				
Total	$ 10,000				
Full Time Equivalents	83				

a/ Includes Working Capital Fund.

GENERAL SCIENCE PROGRAM DIRECTION

III. Performance Summary

	FY 1997	FY 1998	FY 1999
Salaries and Benefits: Funded staff managing and supporting the national high energy physics and nuclear physics program with reduced staffing levels as a result of streamlining efforts.	$7,578	$0	$0
Travel: Provided on-site contractor and facility oversight and participated in major scientific conferences to maintain state-of-the-art scientific expertise.	$359	$0	$0
Support Services: Provided necessary mailroom, travel processing, environment, health, and safety, computer systems and administrative support for the High Energy and Nuclear Physics programs.	$509	$0	$0
Other Related Expenses: Provided hardware and software for information technology improvements and other miscellaneous costs of supporting the program as well as $1,000,000 for Headquarters Working Capital Fund.	$1,554	$0	$0
Total	$10,000	$0	$0

IV. Explanation of Funding Changes from FY 1997 and FY 1998:

This program was transferred to the new Science Program Direction decision unit in FY 1998 at the direction of Congress.

Support Services	**FY 1997 ($000)**	**FY 1998 ($000)**	**FY 1999 ($000)**	**FY 1999/FY 1998 Change ($000)**
Technical Support Service				
Feasibility of Design Considerations				
Economic and Environmental Analysis	175			
Test and Evaluation Studies				
Subtotal	175			
Management Support Services				
Management Studies				
Training and Education	30			
ADP Support	224			
Administrative Support Services	80			
Subtotal	334			
Total Support Services	509			
Use of Prior Year Balances				

Other Related Expenses	FY 1997 ($000)	FY 1998 ($000)	FY 1999 ($000)	FY 1999/ FY 1998 Change ($000)
Training				
Working Capital Fund	1,000			
Printing and Reproduction				
Rental Space				
Software Procurement/Maintenance Activities/Capital Acquisitions	554			
Other				
Total Obligational Authority	$1,554			
Use of Prior-Year Balances				
Total Budget Authority	$1,554			