DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT

OVERVIEW

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

INTRODUCTION

The Biological and Environmental Research (BER) program develops the knowledge needed to identify, understand, and anticipate the long-term health and environmental consequences of energy use and development through its support of peer-reviewed and competitively awarded research at national laboratories and academic institutions. The BER program uses this scientific knowledge to develop technology that can be used to mitigate or correct adverse consequences of energy use and to underpin policy and regulatory development. The program also uses the Department's unique multidisciplinary scientific and technological capabilities to solve major scientific problems in biology, medicine, and environmental science while contributing to the Nation's economic growth, health care, SUSTAINABLE DEVELOPMENT, and education and training of the scientific workforce and an informed public. The program will continue to emphasize support of small science as called for in the Energy Policy Act of 1992.

HEALTH-RELATED PROGRAMS

The Department's Biological and Environmental Research program's responsibilities began with the establishment of the Atomic Energy Commission in 1947. Research into the potential health impacts of radiation accompanied the initial mandate to develop nuclear energy and nuclear weapons technology. Studies centered on health effects in the Japanese atomic bomb survivors and dose-response studies in experimental animals and specifically addressed long-term, late effects, such as cancer. As definitive information was obtained concerning relatively high levels of radiation exposure, attention was turned to potential effects at lower doses. This concern resulted in a comprehensive long-term research program focused on understanding the underlying, fundamental mechanisms of biological damage from radiation and chemical exposure. The initial laboratory research demonstrated that biological repair and recovery processes operate at low levels of X-ray or gamma exposure, thus providing assurance that radiation protection standards based on linear extrapolation of high doses are indeed conservative. A particular emphasis has been placed, in the design and interpretation of this research, on defining the relationship between results obtained with experimental animals and observations made in humans who were exposed accidentally or occupationally to energy-related chemicals or radiation. Understanding these relationships provides information needed to better define the health risks to people from exposure to these agents and has also provided information and techniques useful in reducing risks to people from environmental or accidental exposures.

As the Nation's lead research program for understanding the health consequences of low-level ionizing radiation, the BER program has provided the scientific information used by other agencies to estimate health risks from radiation exposure. For example, the EPA uses information generated in this program to develop and implement policies for reducing the health effects from indoor radon exposure. A direct consequence of studies on the health effects of low-level ionizing radiation, was an improvement in exposure assessment methods, the development of techniques for detecting individual susceptibility, and the development of bioassays for detecting and monitoring early damage. Information generated in this program is used by DOE's Office of Environment, Safety, and Health to develop a program to monitor and provide medical evaluation and surveillance to current and former workers who were exposed or had potential exposures to hazardous and radioactive materials, as required in the Defense Authorization Act of 1993. Research in this program, coupled with advances in the DOE human genome program, has also led to the commercialization of advanced tools for medical diagnosis, including, for example, advances in flow cytometry and cytogenetics that are used in the diagnosis and detection of some genetic diseases and cancers. The BER program maintains extensive scientific and managerial interactions with the European community, including some collaborative research. Research in this portion of the BER program takes advantage of the latest advances and techniques in cell and molecular biology and biochemistry to obtain information from both cell culture and animal systems.

The DOE human genome program is exploiting the multidisciplinary capabilities of the national laboratories to complete a structural analysis of the entire human genome, i.e., the deoxyribonucleic acid (DNA) found in a typical human cell, at the molecular level, in the next 10 to 15 years. This effort requires the development of new biological research resources and technologies and the improvement of existing resources and technologies. Results of this work will provide the ultimate structure of human genes and DNA and, therefore, the basis for improved risk estimates, detailed understanding of the mechanism of mutagenesis and carcinogenesis, and an assessment of individual sensitivities to low levels of exposure to physical and chemical agents. In addition, the technologies, databases, and biological resources being developed by the human genome program will have and are having an enormous impact on a wide variety of biotechnology-related industries and research including medicine and health care, agriculture, energy production, waste control, and environmental clean-up. Examples of current spin-offs of the human genome project include the initiation of genome projects for several economically important plants and animals, the Microbial Genome Initiative described below, and the National Institute of Standards (NIST)/Department of Commerce Advanced Technologies Program to develop compact, low-cost, automated DNA analysis technologies for fast, inexpensive detection of human, animal, and plant disease. In addition, technologies and resources developed in the human genome program are being used and exploited world-wide by the multibillion dollar biotechnology industry.

The DOE human genome program is planned and carried out in coordination with the National Institutes of Health (NIH). The primary DOE contribution is the development of capabilities and tools to analyze the genome at the molecular level and to construct physical maps and determine DNA sequences of human chromosomes. This map and sequence information is critical in the identification and isolation of disease genes, for example, and is used as the basis for the development of molecular diagnostic tests for cancer or genetic diseases. The NIH component of this country's Human Genome Project is oriented towards genetic mapping and characterizing disease-related genes by exploiting human and non-human model systems. An important component of both agencies' human genome programs is the Ethical, Legal, and Social Issues (ELSI) program. The ELSI program investigates ethical, legal, and social implications and effects of genome research including worker privacy issues and impacts on the availability of health care and develops educational materials and programs for both the public and for schools. The DOE program is carried out primarily in the national laboratories with some work in the universities while the NIH program is conducted predominantly in academia.

A new research emphasis, that is based on technologies developed in the human genome program, is the Microbial Genome Initiative to characterize the genomes and proteins of environmentally and industrially important microorganisms. This program will develop DNA sequence and mapping information in microbes with significance for energy production, environmental bioremediation, and industrial applications; contributes to DOE's commitment to ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS and SUSTAINABLE DEVELOPMENT; and has great potential to have a substantial economic impact.

The DOE structural biology research program conducts research to understand the relationship between the molecular structure and biological function of macromolecules such as proteins. Such an understanding is critical to advancing the biotechnology missions of the Department in applications ranging from energy production from biomass to environmental remediation. In addition, technologies developed in this program can, for example, be used to better understand the mechanism of action of drugs used to control or treat a variety of diseases. By developing a detailed, three-dimensional understanding of the interaction of drugs with specific molecular structures on the surface or inside of infectious microorganisms, cancer cells, or diseased cells or tissues, for example, drugs can be redesigned to improve their efficiency or effectiveness. DOE has a special responsibility in structural biology for providing the national scientific community with cutting edge facilities, such as synchrotrons and neutron beam sources needed to conduct structure/function research. The new Advanced Light Source at Lawrence Berkeley Laboratory and the Synchrotron Radiation Source at Argonne National Laboratory will provide unique capabilities for structural biology experiments in addition to those already supported by DOE. The DOE program envisions increased support for the operation of user stations for structural biology at these facilities, but also places a high priority on training a new generation of biologists in this rapidly evolving field.

A new initiative is aimed at developing an advanced biomedical science and technology program. This initiative is in response to the need within the United States for a more efficient and cost-effective health care system, coupled with the aim of harnessing some of the unique scientific and technological capabilities that have been developed within the defense and non-defense scientific communities. The unique multidisciplinary capabilities of the Department's Energy Research and Defense Program's laboratories, in cooperation with other Federal programs and in collaboration with universities and the private sector, will be used to develop new and highly innovative medical sensing, imaging and optical technologies for disease diagnosis and therapy.

An interagency emphasis in Bioinformation Infrastructure addresses the need to support the life sciences with information databases related to the structure and sequence of biological molecules. Database tools to support advanced analyses of biological data, critical to the effective and efficient use of the large amounts of information generated, for example, in both structural biology and genome research, are being emphasized. One aspect of this infrastructure will be expanded in FY 1996 through the development of a computational biology program. This program will cut across several BER programs and link research results from these and other research programs through the use of computer science and information technology. A key goal for the computational biology initiative is to provide the basic understanding and infrastructure needed to predict the functions of biological molecules. Achieving this goal requires a better understanding of the relationship between structure and function and the improved analysis of families of similar genes. The initiative will integrate results from the genome program and from structural biology research. Genome research identifies genes and the biological products from those genes. Structural biology research identifies the structures of these gene products. Both research areas create information and require analytical resources that are unique, but new computer software, approaches to solving complex problems, and interconnected data resources are needed to provide crucial bridges across the research areas for the efficient prediction of the structure and function of biological molecules. Predicting the functions of biological molecules will assist in the application of biotechnology to diverse areas of national need. A roadblock to achieving directed and cost-effective applications of biotechnology is the difficulty in obtaining or designing molecules with desired functions; thus, the anticipated results of this new research in computational biology should further the knowledge and technology base for biotechnology and foster sustainable development and U.S. industrial competitiveness.

The Office of Health and Environmental Research in the Office of Energy Research has the responsibility of assuring compliance with 10CFR part 745, Federal Policy for the Protection of Human Subjects; Notices and Rules for all research involving human subjects conducted at DOE facilities or supported by DOE. As part of this assurance, a complete listing of all current DOE research involving the use of human subjects was compiled and made available to Congress and the public in April 1994. Ongoing and future efforts to assure that all current and future DOE research involving human subjects is conducted in full compliance with the Federal Policy for the Protection of Human Subjects include the organization of regional educational meetings for DOE investigators and managers, the establishment of a compliance and audit system, regular updates of the human subjects research database, publication of resource materials, and the conduct of periodic workshops and meetings. These activities support DOE's recognition of both the importance of research involving human subjects and the need to assure that all human subjects research is conducted in full compliance with federal policy.

ENVIRONMENTAL RESEARCH

The environmental sciences program conducts research on: the environmental consequences of past energy use; environmental threats to future affordable energy use; and ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS and SUSTAINABLE DEVELOPMENT through pollution prevention and remediation. The research is conducted by academic institutions and national laboratories through directed, peer-reviewed, competitive awards. The research supports industry through information and technology transfer programs, as well as through better energy policy due to the research results. The environmental sciences program investigates energy-related topics in a wide variety of mediums, including atmospheric and marine environments, terrestrial (especially subsurface) transport, and ecosystems. The research responds to needs identified in the Energy Policy Act of 1992, the US Global Change Research Program, and the Department's mission in Science and Technology as well as Environmental Quality. The focus is on SUSTAINABLE DEVELOPMENT as it is applied to pollution prevention through ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS and to the balance and synergy between economic development and environmental protection. The research programs focus on developing the understanding and capabilities necessary to predict potential environmental impact due to global change; developing tools such as integrated assessments so science-based environmental and energy policy can weigh the benefits and costs; developing and discovering new microorganisms for waste cleanup and pollution prevention; and investigating selected new topics in structural biology such as new enzymes to digest toxic material, sequester carbon, or increase drought resistance in plants.

Previous research results have enabled the Department to respond effectively to national environmental concerns. For example, the national laboratories and the university community are conducting a series of laboratory and field studies of sulfur and nitrogen oxide processing in support of the Energy Policy Act of 1992. The program will continue to conduct cooperative research with the International Global Atmospheric Chemistry (IGAC) Program through the Committee on Environment and Natural Resources of the National Science and Technology Council, and to pursue research on global ozone redistribution and aerosols and their impacts on ultraviolet-B radiation at the surface. In the area of atmospheric transport chemistry and diffusion, DOE continues to conduct field experiments in complex terrains to support improved emergency preparedness and emergency response capabilities for DOE sites; such experiments will continue near Rocky Flats in FY 1996.

The ocean margins program investigates the "missing carbon problem," in which the sink is unknown for about half of the anthropogenic carbon emitted to the atmosphere, through carbon cycling studies in coastal ocean ecosystems. Research has shown that the generation of fixed carbon on the continental shelf is about 30 to 50 percent of the total carbon fixed in the global ocean. The BER ocean margins program objective is to quantify the role of the coastal ocean in the global flux of carbon and to determine whether continental shelves are quantitatively significant in removing carbon dioxide from the atmosphere and isolating it via burial in sediments or export to the interior ocean. The secondary goal of the program is to quantify the mechanisms by which carbon dioxide is assimilated, transported, and transformed in the coastal ocean and to define ocean-margin sources and sinks in global biogeochemical cycles. Because of the importance of carbon in the coastal ecosystem and off-shore energy resources, this research underpins SUSTAINABLE DEVELOPMENT policy decisions for the coastal region.

The subsurface science program includes DOE's primary long-term research related to the geochemistry, hydrology, and microbiology of the subsurface biosphere, including the mobility and stability of natural chemicals and chemical contaminants in subsoils and groundwater, and insights into the hydrologic cycle. The BER program conducts basic long-term research related to in situ environmental restoration in cooperation with DOE sites and with industry. An active technology transfer program has operated since 1987. New discoveries in such areas as organic-radionuclides contaminant transport and deep microbiology are being transferred rapidly to DOE sites and to energy supply and biotechnology industries, as well as to the Environmental Management program. In order to substantially expand the fundamental understanding of the subsurface biosphere by the year 2000, a five-year integrated molecular to field-scale program is being initiated to determine the factors controlling survival of microbial communities in deep subsurface sediments and groundwater, by building on past DOE discoveries of a complex, microbial ecosystem at depths as great as 500 meters that appear to have survived at least 14,000 years. An important goal of research in microbial origins, or "genesis," is to determine if deep microorganisms have survived for millions of years or have been transported in the recent geological past to their current location. This research has broad implications, from refining DOE new bioremediation cleanup methods to understanding the risks of environmental releases of controlled genetically-engineered microorganisms by industry. The microbial genome research draws on this effort and the wealth of knowledge being gained from the human genome and structural biology programs.

The ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS efforts focus on two areas: the use of bioremediation in the management of industrial waste and integrated assessment to identify high leverage payoffs to environmental technology. The ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS integrated assessment research will promote synergistic environmental and economic progress by focusing on opportunities for lowering environmental discharge, minimizing non-renewable resources, and reducing renewable resource use to sustainable levels. Biotechnology will play an important role in waste cleanup activities, both in managing potentially toxic effluents and in producing nontoxic effluents. Bioremediation, the use of living organisms to reduce or eliminate waste products, has been shown to be useful in water purification, detoxification, and sanitization of domestic and industrial sewage. New efforts will be focused on the field-testing of microorganisms already identified as being useful for bioremediation and on the identification and manipulation of additional microorganisms capable of transforming other contaminants.

Long-term ecosystem studies, including studies carried out on the DOE National Environmental Research Parks, provide the Department with the capability to detect and assess environmental changes and trends as well as the consequences of natural and human-induced stresses. Ecological research addresses the response of biological and ecological systems to regional and global environmental changes and to local disturbances resulting from energy-related activities, including those associated with operations at DOE facilities. The research addresses the long-term consequences of these activities on the integrity and sustainability of ecological systems.

A major environmental concern is climate change from emissions of greenhouse gases, especially carbon dioxide from fossil fuel burning. For over 16 years, the Carbon Dioxide Research program has studied carbon dioxide interactions with the atmosphere, the biosphere, the oceans, and the geosphere and the resulting impacts on critical resources. The Carbon Dioxide Research program is the DOE component of the United States Global Change Research program coordinated by the Committee on Environment and Natural Resources of the National Science and Technology Council. This national program was codified by Congress with the Global Change Research Act of 1990.

Global change also figures prominently as a major environmental issue in the Energy Policy Act of 1992. The research is designed to improve the predictability of global and regional climate change and understand the impacts of global change. To provide essential data, the Atmospheric Radiation Measurement (ARM) program was initiated in 1989. ARM will collect cloud and radiation data in three areas of principal climatological significance over a period of approximately 10 years. ARM began providing data from its first ground site in the United States' southern Great Plains during the spring of 1992. The second site in the Tropical Western Pacific will become operational in late 1994 or early 1995, and the third site on the North Slope of Alaska will be operational in 1996. ARM will accurately quantify the cloud-climate feedback and significantly improve the parameterizations in the climate change prediction models.

Supporting ARM and the atmospheric chemistry program are DOE operations using unmanned aerospace vehicles (UAVs). These experimental platforms provide access to a region of the atmosphere (the tropopause) where major changes are affecting both the global climate and the global ozone layer. Instrumentation research is being supported through the Department of Defense Strategic Environmental Research and Development Program.

Another major DOE emphasis in global environmental change is the Computer Hardware, Advanced Mathematics, and Model Physics (CHAMMP) program. This program is providing an effective integration of advanced computer hardware and software with the next generation of climate models to accelerate the computing throughput by a factor of 10,000 between 1990 and 2000. CHAMMP executes advanced climate models on massively parallel computers to test emerging technologies. These models will be used to predict long-term changes in the climate system and to understand better the feedbacks among climate processes that result in current prediction uncertainties. CHAMMP is also supporting the international research effort, led by DOE, to compare and evaluate the principal climate change prediction models and to identify the key parts that require improvement.

Research continues on the global carbon cycle to identify the principal sources and sinks of carbon and to explore the synergistic effort of carbon dioxide and climate change on vegetation. Related research in the oceans addresses the exchanges of carbon dioxide at the ocean-atmosphere interface and supports the international World Ocean Circulation Experiment (WOCE). DOE is pursuing economic and integrated assessment research that will underpin strategies for SUSTAINABLE DEVELOPMENT and support better decisionmaking. The research is being expanded to provide direct support of integrated assessment. Activities of the Carbon Dioxide Information and Analysis Center in support of scientists and policymakers will continue as well as a fellowship program that provides interdisciplinary graduate and postgraduate education in global environmental change. The National Institute on Global Environmental Change (NIGEC)is also supported.

MEDICAL APPLICATIONS

This research program, mandated initially by the Atomic Energy Act of 1946 to promote the use of radioactive materials and radiation for medical applications, has provided the scientific and technological foundation for the establishment of nuclear medicine as a major clinical specialty. Research in radioisotope production, radiopharmaceutical chemistry, and radioisotope imaging instrumentation, together with investigation of a broad range of diagnostic and therapeutic applications, not only demonstrated and validated advanced diagnostic and therapeutic capability, but also led to the establishment of a vital radionuclide production, radiopharmaceutical development, and radionuclide instrumentation industry. Technology developed under this program provides a noninvasive capability for detection and localization of small lesions, for quantitative measurement of dynamic organ function, and for selective radioisotope and radiation therapy of cancer. This program is formulated to address a broad range of clinical research requirements. The program includes six major areas: (1) research to develop new radioisotopes, (2) development and application of new radiopharmaceuticals, (3) imaging instrumentation research, (4) exploration of new radiation therapy modalities with emphasis on boron neutron capture therapy, and (5) molecular nuclear medicine to apply molecular biology advances to address research needs in nuclear medicine, all structured to demonstrate the (6) clinical feasibility of new, advanced medical technology that derives from the Department's energy and defense research activities.

Summary of FY 1996 Request

The FY 1996 request provides for:

- Continue base programs for biological research, instrumentation, terrestrial transport, and medical applications plus capital equipment for addressing issues such as radon, origins of subsurface bacteria, and boron neutron capture therapy;

- Continue molecular and cellular biological research in support of biotechnology and health effects programs; while phasing out radiological and chemical physics research in support of the health effects program.

- Enhance development and utilization of national user facility infrastructure for structural biology and genetics by increasing operating support and capital equipment; provide planned capital equipment to cover beamline upgrades and new beamlines for user facilities;

- Expand new phase of the human genome project for advanced sequencing technology and its application for pilot-scale operations in partnership with industry, and provide needed capital equipment;

Initiate computational biology program to link advances in biological sciences with computer and information services;

Maintain schedule for projects currently under construction (and base GPP), e.g., Structural Biology Centers at Argonne National Laboratory and Lawrence Berkeley Laboratory, Human Genome Laboratory at Lawrence Berkeley Laboratory, and Environmental and Molecular Sciences Laboratory at Pacific Northwest Laboratory;

Expand efforts to assure that all research involving human subjects conducted at DOE facilities or supported by DOE is in full compliance with federal policy;

Maintain global change research (including expanded program framework for atmospheric sciences, ocean margins, and ecosystem research), continue phased deployment of second Atmospheric Radiation Measurement site in Western Pacific and continue development of third ARM site on North Slope of Alaska; augment research on natural sinks and processes for greenhouse gases, and continue UAV operations; and increase focus on global change impacts and integrated assessment for sustainability;

Initiate ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS focusing on bioremediation of industrial waste and integrated assessment to identify high leverage payoffs for environmental technology;

In partnership with Defense Programs and industry, exploit dual use capabilities in biological sensors, lasers, and imaging technologies to develop advanced biomedical technologies to meet needs of health care community for improved practices in disease diagnosis and therapy;

Continuing development of a microbial genome program to explore the fundamental molecular and structural biology of industrially important microorganisms, including bacteria of potential importance for waste clean-up applications;

Continue development of coupled climate system models for assessments that utilize state-of-the-science computational techniques on the most advanced supercomputers;

Continue extensive international intercomparison of atmospheric climate models and complete quantification of uncertainties and research requirements;

Performance Evaluation

General performance measures of program outputs for basic research include such metrics as the number of scientists supported, the number of students earning advanced degrees, the number of scientific publications in peer-reviewed journals, the number of awards from professional organizations, and the number of citations in scientific publications. Metrics for the transfer of new knowledge to a technology application include the number of cooperative agreements with industry, the number of projects attaining support from a DOE Energy Technology program, the number of invention records and patents, and the number of industry users at scientific user facilities and the number of small business innovative research projects (SBIR) initiated. For construction projects, metrics can include cost and schedule milestones completed against approved project baseline. These performance measures are easily tabulated, commonly used, and begin to provide a framework for evaluating program efficiency. However, meaningful performance measures in basic science are more useful when described in qualitative, rather than quantitative terms. For example, in order to measure outcomes, or program effectiveness, the impact of the research outputs must be assessed in terms of the quality and impact of the new knowledge gained, its usefulness to technology development, and its longer-term benefit to society. Although there are limited and expensive methods for evaluating the quality of science through peer-review metrics, no metric exists that can accurately measure science's impact on technology and society.

Evaluation of the BER program is routinely conducted through a variety of peer review processes to maintain a high level of scientific quality in the performance of ongoing programs and projects and as a basis for funding new initiatives. Peer review procedures used include:

Panels: To review research proposals received in response to specific program solicitations, ad hoc review panels comprised of outside experts are assembled. All submissions are reviewed by the panel for scientific merit and individually rated by each panelist. Technical staff in the Office of Health and Environmental Research (OHER) review the proposals for programmatic priority. A final merit ranking is then established by program staff and the available funds allocated to the highest ranking proposals. All new and renewal applications, both from DOE facilities or the private scientific sector, are subject to this process. Over a dozen panels were convened in FY 1994 for programs such as the human genome, ELSI, radon, microbial genome, CHAMMP, ARM, UAV, National Biomedical Tracer Facility (NBTF), electron beam, terrestrial carbon research, subsurface sciences, atmospheric science(2), and measurement sciences.

Letter Reviews: New proposals received during the course of the year from both the national laboratories, universities, and the private sector that are not submitted in response to a specific solicitation are reviewed individually by mail review. Technical staff within OHER select three or four experts in the particular scientific area of interest and request a written review of the proposal. These reviews are analyzed by the technical staff person, summarized and circulated for review and comment to a team of OHER technical staff, representing relevant scientific disciplines of the BER program. Senior staff within OHER evaluate the programmatic priority of each proposal. Funding is allocated on the combined basis of scientific merit (quality) and programmatic priority (relevance). The procedure is also employed for review of extramural renewal proposals at three year intervals to consider productivity and merits of newly proposed work.

HERAC: The Health and Environmental Research Advisory Committee (HERAC) was created in 1983 to provide broad oversight and review of the BER program. It reports to the Director, Office of Energy Research, and responds to specific charges developed by that Office. HERAC usually addresses issues such as scope, balance, and direction within selected program areas. HERAC has conducted some 15 program reviews of the BER program since 1984. Three subcommittees developed reports in FY 1994, including the Human Genome, Program for Ecosystem Research, and Protection of Human Research Subjects. At the first meeting of HERAC in FY 1995, the Committee began preparations to address three new charges. The Committee will review and evaluate future directions for the Medical Applications program; a new paradigm for conducting health effects research by incorporating new advances stemming from the Human Genome and Structural Biology programs; and the current BER activities supporting the basic research needs of the Office of Environmental Management and the Office of Energy Efficiency and Renewable Energy.

Office of Program Analysis: The Office of Program Analysis (OPA), within the Office of Energy Research, is charged with conducting scientific peer reviews of selected research areas in the Department. Acting independently of the program office which funds the research, OPA convenes panels of scientific experts to hear technical presentations from each research investigator in the selected research area. The technical merit of each project is determined quantitatively and a meritorious ranking is obtained. Eight program areas within BER have been reviewed by OPA over the past 6 years involving nearly 500 projects.

The Medical Applications program was reviewed by OPA in FY 1992. Approximately 118 individual projects, at laboratories, universities, and medical centers, were reviewed by three panels of outside independent reviewers. The review indicated that 8.5 percent of the projects were outstanding, 47.5 percent were strong, 28 percent were good, 14.4 percent contained some deficiencies, warranting attention by the Program Manager, and 1.7 percent (two projects) were deemed to have serious shortcomings. As a result of the review, all projects with some or serious deficiencies were either terminated or recast and downsized to resolve the concerns.

A portion of the Structural Biology program was reviewed by OPA in FY 1994. Thirty-two individual projects, at both universities and laboratories, were reviewed by a panel of outside independent reviewers. The review indicated that 28 percent of the projects rated excellent, 50 percent rated strong, and 22 percent rated as good.

Portions of the Structural Biology and Genome programs concerned with computation and analysis conducted at both universities and laboratories were reviewed by a panel of outside independent reviewers under the purview of OPA in FY 1994. Of the 10 projects reviewed, 20 percent were rated as outstanding, 20 percent strong, 50 percent good, and 10 percent deemed to have some deficiencies warranting management attention.

As a result of these reviews, the shortcomings identified for "good" projects and deficiencies of weaker projects served as a point of discussion between DOE program staff, the principal investigator, and, where relevant, with the national laboratory management, to clarify and rectify points of concern. Subsequent funding levels for such projects are based, in part, on the response to these deliberations.

At the OPA review of DOE's large computational research programs in FY 1994, four global change programs (including two conducted at DOE laboratories) from the Computer Hardware, Advanced Mathematics, and Model Physics projects (CHAMMP) were evaluated. Three of the four were deemed outstanding, the other very good.

Site Visits: OHER organizes and conducts site visits periodically to review specific laboratory and university programs and large projects. Technical staff within OHER select a team of independent experts for a 2-3 day visit to the research institution. Individual evaluations are prepared by each of the reviewers and returned to OHER. Over 60 site visits have been organized during the past 5 years. In FY 1994, site visits were conducted for nine program areas, including the Human Genome Centers (LANL, LBL, LLNL, plus BNL, University of Washington, and Harvard), Informatics (JHU), Health Effects (LBL, LLNL), X-ray Microscopy (LBL), Climate Modeling (LLNL), ARM (ANL, ORNL), Ocean Margins (BNL), Subsurface Sciences (ORNL, PNL, LBL, and academia), Nuclear Medicine (UCLA), and Boron Neutron Capture Therapy (MIT, New England Medical Center).

Other Review Processes: Other processes have also been employed to obtain peer review of specific components of the BER program. The National Academy of Sciences has conducted evaluations of selected program areas at the request of the Department, most recently for the biomedical isotopes and, in progress, for the radiation research program and, jointly funded with NIH and DOD, on real-time medical imaging. Similarly, the JASON group has provided an assessment of the scientific merit of new proposed program activities. JASON is a group of approximately 55 individuals dedicated to sophisticated scientific and technical research and analysis in support of the national security community. In addition, interagency committees such as the Committee on Earth and Environmental Sciences have conducted peer reviews of program elements.

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands narrative in whole dollars)

LEAD TABLE

Biological and Environmental Research

Activity	FY 1994 Adjusted	FY 1995 Appropriation	FY 1995 Adjustment	FY 1995 Adjusted	FY 1996 Request
Biological and Environmental Research	$319,848	$340,921	-$7,020	$333,901	$333,019
Program Direction	6,889	7,500	0	7,500	7,600
Capital Equipment	20,957	25,701	-1,161	24,540	24,000
Construction	47,482	70,700	0	70,700	67,045
Subtotal, Biological and Environmental Research	$395,176	$444,822	-$8,181	$436,641	$431,664
Adjustment	-$6,878 a/	-$5,401 a/	$0	-$5,401 a/	$0
Total	$388,298 b/c/	$439,421	-$8,181	$431,240	$431,664

a/ 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.

b/ Funding of $5,170,000 in FY 1994, $17,100,000 in FY 1992 and $28,500,000 in FY 1993 provided by the Defense Environmental Restoration and Waste Management program for the Environmental Molecular Sciences Laboratory.

c/ Excludes $4,700,000 which has been transferred to the SBIR program and $158,000 which has been transferred to the STTR program.

Activity	FY 1994 Adjusted	FY 1995 Appropriation	FY 1995 Adjustment	FY 1995 Adjusted	FY 1996 Request
Summary					
Operating Expenses	$320,360	$343,781	-$7,020	$336,761	$340,619
Capital Equipment	20,526	24,940	-1,161	23,779	24,000
Construction	47,412	70,700	0	70,700	67,045
Total, Program	$388,298	$439,421	-$8,181	$431,240	$431,664
Staffing Total FTEs					
Headquarters	60	62	0	62	62
Field	88	88	0	88	88
Total	148	150	0	150	150

Authorization: P.L. 95-91 "Department of Energy Organization Act" (1977), Section 203

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ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands narrative in whole dollars)

SUMMARY OF CHANGES
Biological and Environmental Research

FY 1995 Appropriation		$ 444,822
- Adjustment		- 8,181
FY 1995 Adjusted		$ 436,641
- Maintain analytical technology research	+	174
- Maintain ongoing environmental research efforts at a slightly reduced level	-	300
- Develop cooperative ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS for bioremediation and integrated assessment research program	+	6,000
- Maintain efforts in biological research	+	706
- Phase out radiological and chemical physics research in support of health effects	-	4,535
- Maintain ongoing general life sciences research efforts	+	1,753
- Initiate new computational biology research program	+	3,000
- Maintain ongoing global change research efforts	+	1,552
- Maintain ongoing medical applications research at a reduced level	-	1,132
- Complete maintenance surveillance activities for the Power Burst Facility	-	1,100

- Support new initiative in advanced biomedical technology research and associated capital equipment needs	+ 3,400
- Complete Congressionally directed university projects	- 10,000
- Maintain program direction needs	+ 100
- Support capital equipment needs for global change, genome, structural biology and the base programs	- 940
- Increase general plant projects to support high priority ES&H activities	+ 950
- Continue construction of the Structural Biology Centers at ANL and BNL	- 4,505
- Continue construction of the Human Genome Laboratory at LBL	- 10,100
- Continue construction of the Environmental Molecular Sciences Laboratory at PNL	+ 10,000
FY 1996 Congressional Budget Request	$431,664

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ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Analytical Technology

Dosimetry and instrumentation research produces the advanced technology required for improved health protection practices and for an enhanced measurement capability that undergirds experimental health, biological, and environmental studies.

Radiation dosimetry research will provide an improved capability for the determination of human exposure to ionizing radiation and to environmental radon which in turn will lead to the enhanced protection of radiation workers and the general population, and a firmer basis for the evaluation of human health risk and for the development of radiation protection guidelines.

Measurement science will provide new technology for chemical characterization of biological systems with high spatial and temporal resolution in support of the health effects program, and for study of ocean and subsurface environments, including mixed hazardous wastes, in support of the environmental sciences program. In addition to providing an advanced instrumentation capability for the health, biological, and environmental research programs, these new measurement technologies are transferred to the private sector for commercial application with the resultant benefit to the U.S. economy of increased international competitiveness.

II. A. Summary Table: Analytical Technology

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Dosimetry Research	$ 4,559	$ 4,186	$ 4,260	$ 74
Measurement Science	4,687	4,520	4,620	100
Total, Analytical Technology	$ 9,246	$ 8,706	$ 8,880	$ 174

II. B. Laboratory and Facility Funding Table: Analytical Technology

Ames Lab	$ 346	$ 309	$ 330	$ 21
Argonne National Lab (East)	599	282	0	-282
Brookhaven National Lab	0	0	0	0
Environmental Measurements Lab	3,493	3,285	3,391	106
Idaho National Engineering Lab	107	145	200	55
Inhalation Toxicology Research Institute	82	0	0	0
Lawrence Berkeley Lab	601	425	340	-85
Lawrence Livermore National Lab	114	57	0	-57
Oak Ridge National Lab	1,769	1,099	915	-184
Pacific Northwest Lab	690	333	0	-333

II. B. Laboratory and Facility Funding Table: Analytical Technology

	FY 1994 Adjusted	FY 1995 Estimate	FY 1996 Request	$ Change
All Other	1,445	2,771	3,704	933
Total, Analytical Technology	$ 9,246	$ 8,706	$ 8,880	$ 174

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Analytical Technology			
Dosimetry Research	Increased emphasis was placed on studying behavior of radon and radon daughters in typical indoor environments. These studies coupled with our understanding of particle-size distribution in the indoor environment were used to focus research on determining the lung dose from radon exposure. Studies on interaction of neutrons with matter will be de-emphasized and phased out. Quality assurance and quality control programs to maintain the accuracy of radiation measurements were conducted in collaboration with other federal agencies and governments.	Activities related to understanding radon and its daughters' interaction with biological material will continue. This research will provide information on correctly determining the dose from radon exposure to relevant cells in the human body. Quality assurance and quality control programs for exposure from radon and its daughters will continue by encouraging intercomparison of data from different laboratories and projects. Interaction and transport of neutrons and its secondaries in matter will be reduced in scope.	Characterization of availability and distribution of radon and its daughters in the indoor environment will continue. Complex physical and chemical processes involved in the interaction of radon with indoor air will continue. This information should provide a better estimate of dose from radon exposure to humans. Quality control and quality assurance programs associated with radon exposure studies will continue by providing intercomparison of dosimetry data from different laboratories and projects. Other radiation protection dosimetry research will be reduced in scope.
	$ 4,559	$ 4,186	$ 4,260

III. Analytical Technology (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Measurement Science	The utilization of lasers for characterizing complex mixtures of large molecules were developed with emphasis on techniques making use of highly reliable diode lasers. Techniques were sought for enhanced imaging of biological materials using newly developed probing techniques based on the free electron laser as well as through innovative optics for electron microscopy. The mass spectrometric analysis of mixtures of macromolecules significant in health or experimental studies were pursued using the new technique of laser desorption combined with recently discovered selective variants of mass spectrometry.	Emphasis will be continued on high sensitivity and high resolution techniques for the characterization of biologically active materials. New microscope technology, including atomic force, scanning tunneling, photon tunneling and exciton emission, will be applied to imaging biological materials at the cellular and subcellular level. Laser techniques will be applied in the study of biological macromolecules by mass spectrometry through improved desorption and ionization. Instrumentation to study human exposure and health effects of hazardous materials will be sustained while development of procedures for the routine analysis of radionuclides will be phased down. Distribution of FY 1995 funding by major laboratory and facility is subject to change pending on extensive peer review.	Chemical characterization of biological systems will be sought using new technologies capable of imaging chemical composition with resolution at the cellular and subcellular level. Instrumentation using advanced optional and electrochemical sensors will also be sought. Environmental measurement techniques for oceanographic and subsurface research will be supported with emphasis on remote continuous field monitoring. Distribution of FY 1996 funding by major laboratory and facility is subject to change pending completion of an extensive peer review in FY 1995.
	Funding in the amount of $61,000 and $5,000 has been transferred to the SBIR program and the STTR program, respectively.	Funding in the amount of $105,000 and $5,000 has been budgeted for the SBIR program and the STTR program, respectively.	Funding in the amount of $106,000 and $8,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 4,687	$ 4,520	$ 4,620
Analytical Technology	$ 9,246	$ 8,706	$ 8,880

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Environmental Research

Emissions and disturbances from energy sources have impacts at scales from local to worldwide. Environmental research is intended to improve the predictive understanding of the potential environmental consequences of energy production and use, and to identify and quantify energy-related environmental tradeoffs or constraints that may limit or impede SUSTAINABLE DEVELOPMENT. This program addresses the transport of emissions and their behavior through the atmosphere, oceans, solid earth, and ecosystems at differing spatial scales and time sequences. The program is tied to the goal of SUSTAINABLE DEVELOPMENT through increased understanding of the fate of pollutants and the ability to remediate or restore existing or future sites. This information on the impacts of pollutants and their byproducts on the environment provides a basis for pollution prevention technology development. The ability or inability of biological systems to adjust to disturbances from energy extraction, supply, and production is also an important aspect of sustaining ecosystem processes and the development of mitigation techniques to control damage. The broad program focuses on selected areas of research that provide information for unifying concepts that can help solve future energy/environmental concerns. Recent technical advances, such as those in molecular biology, have provided a new fundamental understanding of living organisms as well as new experimental tools. The programs and projects are peer reviewed by outside experts and are competitively awarded.

The Atmospheric program has two components. The first is atmospheric chemistry and addresses the processes that control tropospheric and stratospheric ozone and aerosol formation. Fine aerosols are a continuing scientific issue and current controversy in global environmental change and human health. Reduced emphasis will be placed with the second component which explores transport and diffusion over complex terrain with the goal of enhancing the emergency preparedness and response systems at critical DOE sites.

The Marine program investigates the exchange of energy-related and natural materials between the continental shelf and the open ocean. Close collaboration with other programs conducting open ocean and nearshore research helps understanding the dynamics of the ocean margins and its influence on both land and open ocean systems, particularly from the viewpoint of energy discharges and their assimilation into the ocean. With as much as half of the productivity of the ocean located along the ocean margins, this program is also providing important information on carbon flux and may hold the key to a significant part of the missing component of the world-wide carbon budget.

The Subsurface Science program conducts research on subsurface sediments and groundwater systems, on microbial communities in deep sediments and aquifers, and on the mechanisms that control the mobility of organic-radionuclide complexes. The program addresses the fundamental physical, chemical, and microbiological mechanisms that control reactivity, stability, and transport of chemical mixtures, as well as hydrogeological and geochemical factors that control the presence, distribution, and origins of microbial communities in deep geological systems. Research on microbial origins includes studies of what may be ancient microbial communities that have evolved in situ and communities that have been transported at various times to the deep subsurface. DOE deep microbiological research has gained international recognition and new microorganisms have been discovered at great depths. Research is also conducted on bacterial transport processes, leading to bioremediation and to the assessment of the risks associated with release of genetically engineered microorganisms (GEMs). Additional partnerships with other Departmental elements, particularly DOE/Environmental Management (environmental remediation), DOE/Civilian Radioactive Waste Management (risk assessment based on bacterial long distance transport and survival over millennia) and DOE/Fossil Energy (oil and gas production, in cooperation with industry) are being forged, with the goal of accelerating the development of information and new technologies to meet Departmental needs. Training and problem-solving workshops at various DOE sites, an expanded program of the Subsurface Microbiology Culture Collection for the biotechnology industry to improve international competitiveness in pharmaceuticals, and a Cooperative Research and Development Agreement with industry and several federal agencies are among the elements of a technology transfer program that has operated since 1987.

The microbial genome research will map and sequence microorganisms related to environmental and energy issues of the Department. Priority will be given to those with potential industrial applications. The environmental radon research program is moving to address air quality issues and

I. Environmental Research (Cont'd)

identify high risk areas.

The ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS program will foster economic growth and competitiveness by encouraging the evolution from pollution control and waste management to pollution prevention and resource conservation. Research will be initiated in biotechnology and integrated assessment. Biotechnology will play an important role in waste cleanup activities, both in managing potentially toxic effluents and in producing non-toxic effluents. Bioremediation, the use of living organisms to reduce or eliminate waste products, has been shown to be effective in water purification, detoxification, and sanitization of domestic and industrial sewage. New efforts will be focused on the field-testing of microorganisms already identified as being useful for bioremediation and on the identification and manipulation of additional microorganisms capable of transforming other contaminants. BER will establish one to two field research sites, adjacent to sample processing facilities and instrumentation, where bioremediation strategies can be evaluated and verified on a long-term, iterative basis. These sites will be located at National Laboratories and include partnerships with the bioremediation industry. Strategies will include the release of organisms under controlled conditions that will enable the monitoring of specific activities; the redesign of enzymes to more efficiently catalyze selected chemical reactions, and the genetic engineering of microorganisms containing those enzymes for use in the remediation of wastes recalcitrant to other remediation technologies. The integrated assessment activities will help assure that resources are optimized on process developments where it makes sense, for example, where there is a gain across a large number of companies or industries, or where the wastes to be minimized are particularly harmful. The assessment research will also assist the evaluation of energy and other policy options by providing measures of their expected environmental and sustainable impacts.

Research on Ecosystem Functioning and Response is focused in the Program for Ecosystem Research (PER) to provide knowledge of biological adjustment and impact caused by global change and to develop an understanding of the mechanisms controlling them. This knowledge will assist DOE in resolving its environmental problems and provide a biological basis for making ecological risk and injury assessments. The theoretical, modeling, and field/laboratory experiments will be integrated into multidisciplinary research projects that are coordinated through the DOE Environmental Research Parks.

II. A. Summary Table: Environmental Research

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Atmospheric Science	$ 13,301	$ 13,203	$ 13,320	$ 117
Marine Transport	6,937	7,143	7,155	12
Terrestrial Transport	18,091	18,548	24,305	5,757
Ecosystem Functioning and Response	4,113	5,506	5,320	-186
Total, Environmental Research	$ 42,442	$ 44,400	$ 50,100	$ 5,700

II. B. Laboratory and Facility Funding Table: Environmental Research

	FY 1994 Adjusted	FY 1995 Estimate	FY 1996 Request	$ Change
Argonne National Lab (East)	$ 1,696	$ 1,723	$ 1,752	$ 29
Brookhaven National Lab	4,851	4,326	4,300	-26
Environmental Measurements Lab	1,294	1,334	1,334	0
Fermi National Accelerator Lab	0	0	0	0
Idaho National Engineering Lab	1,048	445	510	65
Lawrence Berkeley Lab	1,560	963	1,015	52
Lawrence Livermore National Lab	1,217	408	230	-178
Los Alamos National Laboratory	933	665	876	211
Oak Ridge Institute for Science & Education	0	50	50	0
Oak Ridge National Lab	3,529	1,865	2,355	490
Pacific Northwest Lab	9,617	8,817	8,797	-20
Sandia National Laboratories	18	0	0	0
Savannah River Ecology Lab	50	0	0	0
Savannah River Technology Center	192	148	300	152
All Other	16,437	23,656	28,581	4,925
Total, Environmental Research	$ 42,442	$ 44,400	$ 50,100	$ 5,700

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Environmental Research			
Atmospheric Science	The atmospheric chemistry research program continued to strengthen regional, continental and global dispersion models and enhance studies on ocean-atmosphere exchange processes. The program continued modeling studies to improve the understanding of the important role of emissions of dimethylsulfide from oceanic biota in atmospheric chemistry and cloud radiative properties. The primary data set were the field experiments conducted in FY 1993. These natural emissions and processes must be better understood in order to determine the environmental effects of energy-related pollutants.	The atmospheric chemistry research program will continue to provide data for regional, continental and global dispersion models and enhance studies on ocean-atmosphere exchange processes. The program will continue modeling studies to improve the understanding of the important role of chemistry and cloud radiative properties.	The outside expert review of extra and/or intramural programs and projects will be completed. The atmospheric chemistry research program will continue to focus on tropospheric and stratospheric ozone and fine aerosols to strengthen regional, continental and global models. The program will continue modeling studies to improve the understanding of the important role of chemistry and aerosols in cloud radiative properties.
	Field experiments were continued. The focus remained on the continental and oceanic fate of energy related pollutants. The university grants program in atmospheric chemistry issued another solicitation.	Field experiments will be delayed; although the focus will remain on the continental and oceanic fate of energy related pollutants. The university grants program in atmospheric chemistry will continue.	Field experiments will be initiated in the Pacific region. The focus will remain the continental and oceanic fate of energy related pollutants.
	The global tropospheric chemistry model was implemented on a massively parallel computer system and was tested with International Global Atmospheric Chemistry (IGAC) program field results.	The global tropospheric chemistry model, implemented on a massively parallel computer system, will continue to be tested with IGAC field results.	The global tropospheric chemistry model will continue to be tested with field results.
	Reanalysis of stratospheric ozone data was enhanced and experimental studies to quality-assure ground based and airborne instruments probing stratospheric ozone-related chemical species and processes were conducted.	Reanalysis of stratospheric ozone data and continued experimental studies to quality-assure ground based and airborne instruments probing stratospheric ozone-related chemical species and processes will continue.	Reanalysis of the stratospheric ozone data will continue. Experimental studies to quality-assure ground based and airborne instruments probing stratospheric ozone-related chemical species and processes will continue.

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Atmospheric Science (Cont'd)	Continued reanalysis of surface UV-B data.	Reanalysis of surface UV-B data will continue and UV-B measurement technology development and research on the ecological effects will be initiated.	Reanalysis of surface UV-B data will continue. UV-B measurement technology development will be initiated to begin studies on UV-B impact on ecosystems.
	The Atmospheric Studies in Complex Terrain (ASCOT) field program around the Rocky Flats Plant continued to be coordinated with ongoing studies in the Denver area. The emphasis was on analysis of data obtained from the FY 1993 field experiments. The data from tracers and remote sensing instrumentation was invaluable to validate models of dispersion on the mesoscale (within 100 km).	The ASCOT field program around the Rocky Flats Plant will continue to be coordinated with ongoing studies in the Denver area. The emphasis is on analysis of field data including new intensive measurements in FY 1994. The data from remote sensing instrumentation will be invaluable to validate models of dispersion on the mesoscale (within 100 km) including emergency response models.	The ASCOT research projects have been reviewed by outside experts. The program around the Rocky Flats Plant will continue. The emphasis is on analysis of field data to improve models. The data from remote sensing instrumentation will be invaluable to validate models of dispersion on the mesoscale (within 100 km) including emergency response models.
	A field program in environmental processes and climate research was conducted using the research aircraft. Activities will include support for Atmospheric Radiation Measurement (ARM) and IGAC programs.	The research aircraft will continue to provide the critical experimental support to the atmospheric chemistry studies including those addressing aerosols and changes in ozone concentrations.	The research aircraft will be made available for collaboratory research with other organizational programs to provide the critical experimental support to the atmospheric chemistry studies including those addressing aerosols and changes in ozone concentrations. Selected flights will support ARM.
	$ 13,301	$ 13,203	$ 13,320
Marine Transport	This year initiated the evaluation of the first three year phase of the Ocean Margins program which anticipates the conduct of a fully coordinated interdisciplinary full field year program in FY 1995 and FY 1996. Preliminary evaluation of the studies scoping the burial of carbon in estuarine, shelf, and off-shelf sediments were conducted and were used to locate the site of the FY 1995 field year program. New analytical methods and instruments were evaluated and design changes initiated. Intra-program	This is the year for initiating a major field program. Evaluation of the first three year phase of the Ocean Margins Program will be completed. Studies scoping the burial of carbon in estuarine, shelf, and off-shelf sediments will be completed, evaluated, and transitioned into the comprehensive program. New analytical instruments will be adapted into the program design. The continuing application of molecular biological techniques will be imbedded into the matrix of the field program research plan. Intra-program	The field experimental phase of the Ocean Margins Program (OMP) will be fully operational to quantify the role of the coastal ocean in the global flux of carbon. Activities will include combined satellite, aircraft, shipboard, and moored-instrument measurements to quantify water, carbon, and nutrient fluxes between estuarine systems, the shelf, and the interior ocean near Cape Hatteras, NC, where carbon burial and cross-shelf exchange is expected to be maximum. Field measurements will focus on oxygen and

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Marine Transport (Cont'd)	planning and inter-institutional planning was formulated and a plan established for conducting the field year. Logistical staging and coordination of program projects was initiated. Notice for additional complementary projects was promulgated and finalized. Application of molecular biological techniques to biological processes was expanded.	planning and inter-institutional planning will be further refined and the field study site finalized. Logistical staging will continue and all projects will be transitioned into the initial phase of the FY 1995 field program, which will extend into FY 1996.	CO2 budgets, biomarkers, isotopic tracers, and modelling to integrate and assess ocean-atmosphere gas exchange, primary productivity, bacterial respiration, biogeochemical processes, ecological dynamics, and carbon sources and sinks at the land/ocean interface. New molecular biological tools will be utilized to determine how biological processes are regulated and controlled by genetic limitations and environmental variables. Research within the operational phase of OHP will also provide "sea-truth" information for calibrating remotely sensed data on coastal productivity and "dispersal and fate" information for energy-related materials in coastal waters. This information underpins policy decisions on resource development and environmental sustainability in changing coastal areas.
	$ 6,937	$ 7,143	$ 7,155
Terrestrial Transport	Completed testing, modification, and evaluation of the statistical protocol to correlate environmental information with indoor radon concentrations and to identify areas of high radon risk potential. Began developing the methodology for transferring this protocol to industry and state/local agencies for its implementation on a "zip code" size regional scale. Initiated the construction of an additional pair of subsurface structures in a more complex geological	Experimental studies on the subsurface structures that have been equipped for continuous monitoring of environmental variables (temperature, pressure, moisture) and indoor radon concentrations will be conducted. Planning for the construction of an additional pair of subsurface structures in a more complex geological terrain (perhaps in New York) where severe occurrences of indoor radon have been observed. Conduct site-specific field studies to refine the statistical	Peer review of environmental radon research projects will be conducted to maintain a competitive program of cutting-edge science. Research emphasis will be shifted to: 1) quantifying the relationships between environmental variables and radon entry into homes; 2) predicting areas of highest risk potential for indoor radon: and 3) using radon as a tracer to quantify indoor and outdoor processes that affect energy-related emissions and air quality.

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Terrestrial Transport (Cont'd)	terrain where severe occurrences of indoor radon have been observed. Completed maps of geographic areas with high radon fluxes from soils to the atmosphere. Utilized the radon flux information to address future concerns involving the movement of gases or volatile chemicals in soils and their release into the atmosphere. Examined potential of using radon as a tracer for examining atmospheric transport processes.	protocol to identify areas of high radon risk potential. Measurements of short-lived thoron (radon-220) to help resolve indoor sources, aerosol dynamics, and transport patterns for radon and other contaminants affecting indoor air quality. New research projects using radon as a tracer to quantify indoor and outdoor processes that affect the transport of energy-related emissions will be initiated.	Experimental studies on the subsurface structures that have been equipped for continuous monitoring of environmental variables (temperature, pressure, moisture) and indoor radon concentrations will be continued. A refined statistical protocol for identifying areas of high radon risk potential will be transferred to industry and state/local agencies for implementation. Research projects using radon flux information to address atmospheric transport and air quality concerns will be expanded.
	Continued studies comparing deep microbiological communities with increased emphasis on spatial and vertical microbial heterogeneity. Tested new hypotheses on microbial presence and distribution at the millimeter to meter scale using whole core segments and scale flow cell research as part of GEMHEX series. Continued initial exploratory research on in situ microbial "genesis" and survival of ancient microbial communities using 2500 meter deep Texaco Oil Company and other samples. Began research on fluid inclusions. Increased industry and university outreach in scientific disciplines related to deep microbiology through Pacific Northwest Laboratory Environmental Science Research Center (ESRC). Accelerated intermediate scale simulations related to microbial origins. Deep microbiology research has potential long term benefits to biotechnology, bioremediation, and	Results from analyses of deep subsurface microbiology will be extended to investigations of the spatial and vertical microbial heterogeneity under natural field conditions. Information on microbial distributions in subsurface sediments and groundwater is very limited and is needed by DOE sites and industry to enhance the long term effectiveness (and reduce costs) of bioremediation. Research will continue on "genesis" and survival of ancient microbial communities using samples from the 2500 meter deep Texaco Oil Company samples and from samples from new field sites with natural, sterile controls and where microbiota may be isolated in situ. Cooperative programs with Departmental groups responsible for characterizing and evaluating the risks of storing nuclear waste over 10,000 years in a national high level waste repository will be initiated. Multi-institutional partnerships will	Analysis of deep subsurface microbial communities that appear to have survived for thousands of years, or been transported over kilometer-scale distances will be refined using samples obtained from field study sites. A scientific peer review of all research related to deep microbial origins will be completed. Exploratory sampling at Yucca Mountain, in cooperation with DOE/Civilian Radioactive Waste Management will begin. Training workshops in aseptic sampling and transfer of data from field programs will be accelerated. Transfer of new heat-tolerant and other bacteria from deeply buried sediments to industry will be initiated by Florida State University and the Pacific Northwest Laboratory Environmental Sciences Research Center.

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Terrestrial Transport (Cont'd)	understanding the mechanisms of natural gas formation. Accelerated transfer of subsurface microbial culture collection isolates to industry. Continued research on the analysis of novel microbial gene sequences, including isolates of anaerobic thermophiles and novel metal-reducing bacteria. Compared gene sequences of subsurface and surface bacteria to determine unique sequences.	be formed for practical applications of studies of the survival of bacteria over millennia, and regional transport of bacteria over thousands of meters. This research has implications that include assessing the evolution of oil and gas reservoirs, and the security of nuclear wastes disposed to geologic sites. Drilling and sampling at two field sites will completed.	
	Exploited new flow cells that simulate subsurface conditions at cost savings compared to field programs. Completed research on code development and field validation of reactive transport models such as HYDROGEOCHEM and integrated new predictive capabilities into controlled intermediate scale flow cells.	Exploit new flow cells that simulate subsurface conditions at cost savings compared to field programs. Plan bench-top simulations of the mobility and stability of organically - complexed radionuclides using unique flow cells that simulate subsurface conditions. Controlled experiments using these flow cells compliment field programs of importance to bioremediation, and do not replace field programs.	Exploit new flow cells that simulate subsurface conditions at cost savings compared to field programs. Maintain research using state of the art flow cells to reduce costs and to test new concepts of value to environmental remediation. Plan one demonstration of flow cell technology to test new remedial action approaches, and assess cost savings in DOE/Environmental Management plume remediation focus area.
	Investigated organic-radionuclide complexes that occurred at DOE sites which represented serious mixed waste cleanup problems. Planned bench top simulations of the mobility and stability of organic-radionuclide complexes and simulated transport of complexes using prototype flow cells. Utilized state-of-the-art physical, chemical, and molecular biological methods to investigate the mobility and stability of organic-radionuclide complexes. The information base on geochemical and microbiological mechanisms that control the stabilization, biodegradation, and mobility of radionuclide complexes is extremely limited. This basic research has long term cost benefits to DOE	Investigate organic-radionuclide complexes that occur at DOE sites which represent serious mixed waste cleanup problems. Refine and integrate new reactive transport models to study mixed waste chemistry (organically - complexed radionuclides) using state-of-the-art flow cells. Incorporate simulations of natural subsurface geochemical and microbiological heterogeneities to evaluate the mobility and/or containment of Cobalt-EDTA complexes in preparation for field studies at DOE sites. Utilize state-of-the-art chemical tracer and molecular biology methods to investigate organic-radionuclide complexes. This laboratory research will compliment a	Investigate organic-radionuclide complexes that occur at DOE sites which represent serious mixed waste cleanup problems. Initiate multidisciplinary research on the mobility and/or stability of Cobalt-EDTA (mixed waste) complexes important to developing new in situ environmental remediation methods. Comparable investigations of other radionuclide complexes will be planned, in partnership with DOE/EM and/or DOE sites and industry. Complete geochemical-microbiological simulations to investigate Cobalt-EDTA using state of the art flow cells. Analyze effects of geochemical-microbiological interactions to contain and stabilize mobile Cobalt-EDTA complexes in support of environmental

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Terrestrial Transport (Cont'd)	sites nationally, and to industry.	field initiative in bioremediation.	remediation. Plan exploratory testing of one new remediation method to stabilize Cobalt, and reduce the risks of environmental transport. Integrate flow cell research with field research at DOE field site, in partnership with the Environmental Management (EM) program.
	Planned interdisciplinary field program in bacterial transport.	Begin a limited field program in bacterial injection and transport that is needed to overcome the impediments of introducing native bacteria for future in situ environmental remediation at DOE sites. Evaluate/plan bench-top simulations of bacterial transport. Complete characterization of field site on Nature Conservancy lands at Oyster, Virginia to enhance understanding of the hydrogeologic, chemical and physiological mechanisms that control bacterial transport. Continue involvement of stakeholders including Northampton County and State agencies in Virginia.	Continue bacterial transport field experiment at Oyster, Virginia in cooperation with Nature Conservancy, and Virginia county-state groups. Initiate injection experiments. Refine exploratory risk assessment/stakeholder participation process and extend to one DOE study site. Develop partnership with industry-university consortium to transfer site experience, and cooperate with industry-sponsored flow cell experiments using site materials.
	Maintained research facility and technology transfer programs at ESRC, in support of environmental remediation. Modified future directions of PNL ESRC, as required, to increase focus on natural heterogeneity, a high research priority. Completed three year basic research projects which were mature candidates for DOE applied research funding. Maintained PNL Subsurface Environmental Research Facility and supported design of flow cells that simulate deep subsurface temperatures and pressures. Developed biotechnology CRADA's.	Maintain research facility and technology transfer programs at Environmental Sciences Research Center (ESRC), in support of environmental remediation. Research at PNL ESRC on natural physical, chemical and microbial heterogeneity using intact cores and outcrop blocks will be maintained, but plans to extend research to humid eastern coastal plain sediments will be curtailed. Technology transfer using intact cores, outcrop blocks and field methods will be enhanced and biotechnology CRADAs based on novel microorganisms from the Texaco site and other sources will be explored. Test series of problem	Maintain research facility and technology transfer programs at ESRC, in support of environmental remediation. PNL ESRC responsibilities to include an expanded technology transfer program, added industry and university outreach, and management of multi-institutional field programs. Hands-on problem solving workshops for DOE sites tested in FY 1995, CRADA development, and other technology transfer in support of site cleanup will be expanded. In partnership with Lawrence Berkeley Laboratory, and Princeton University, new customer needs in DOE/Fossil Energy and DOE/Civilian Radioactive Waste

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Terrestrial Transport (Cont'd)		solving ("hands on") workshops at DOE sites to transfer basic research experience for environmental remediation, with emphasis on immiscible fluid containment and risk assessment. Mature research in multiphase fluid flow will be reduced. ESRC will cooperate with Florida State University in analysis and test-marketing of the Subsurface Microbiology Culture Collection to industry. One industry market test will be completed.	Management will be addressed with a focus in geomicrobiology. University outreach in microbial ecology and transfer of the DOE Culture Collection to industry at fair market value in partnership with Florida State University will be increased. A business plan to market DOE's Subsurface Microbial Culture Collection to include international competitiveness and jobs creation will be developed with industry/Florida State University.
	Colloids are submicron-sized particles which facilitate the rapid transport of contaminants in groundwater. Reduced research on the origins of inorganic colloids and colloidal aggregates with emphasis on processes that control the formation and deposition of natural colloids in groundwater. Accelerated research at the field scale, on the mechanisms that control bacterial transport and deposition in porous media in support of bioremediation.	Colloids are submicron-sized particles which facilitate the rapid transport of contaminants in groundwater. Restructure laboratory and field research in organic and inorganic colloidal transport and accelerate transfer to DOE sites and other federal agencies. Implement results of FY1994 scientific peer review. Accelerate transfer of state of the art sampling protocols to DOE/DP (WIPP site), DOE sites, EPA and other agencies initiated in FY94. Seek to co-fund research within DOE on colloidal transport. Accelerate technology transfer of colloids research results for environmental remediation. Reduce mature basic research in colloids. Plan multi-university integrated laboratory - field program to reduce costs.	Colloids are submicron-sized particles which facilitate the rapid transport of contaminants in groundwater. Complete colloids technology transfer program at DOE sites. Maintain multi-university program in colloid formation and transport at reduced level. Redirect funds to increase cooperative studies within DOE, and industry.

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Terrestrial Transport (Cont'd)	Natural subsurface variability (or heterogeneity) is a key factor that frustrates successful environmental remediation. The horizontal and vertical variability of microbial communities is most poorly understood. Increased research on physical, chemical, and microbial heterogeneity using intact cores, outcrop blocks, and field methods.	Natural subsurface variability (or heterogeneity) is a key factor that frustrates successful environmental remediation. The horizontal and vertical variability of microbial communities is most poorly understood. Initiate integrated research in natural subsurface heterogeneity, with emphasis on how physical (hydrogeologic) and chemical variations control the distribution and abundance of native microbial communities at semi-arid western sites. Develop new statistical and field sampling protocols to assess microbial heterogeneity. Plan to apply results at Hanford site in partnership with DOE/EM and site contractors. Conduct exploratory studies at humid eastern sites.	Natural subsurface variability (or heterogeneity) is a key factor that frustrates successful environmental remediation. The horizontal and vertical variability of microbial communities is most poorly understood. Maintain field research program. Extend research protocols in subsurface microbial heterogeneity to humid eastern sites. Extend experience by supporting field injection experiments in bacterial transport at eastern field site. Develop cooperative research program with the EM program. Seek linkages of research with bioremediation industry will be completed in collaboration with PNL/ESRC.
	Began laboratory experiments and scale-up that will lead to controlled field release of a genetically-engineered microorganism (GEM), with emphasis on bioremediation process monitoring and verification.	In preparation for field release of a genetically - engineered microorganism (GEM), experiments will be initiated in controlled field lysimeters available at ORNL. Focus of the work will be risk assessment, process monitoring and verification, with the goal being an eventual field release for in situ clean up. This project is jointly supported by the BER and EM programs.	Field lysimeter research will continue on the fate, efficacy, and risk assessment of a GEM designed to accomplish in situ bioremediation. This project is jointly supported by the BER and EM programs.
	Research that focuses on the mapping and sequencing of microbial genomes was initiated. Priority for support was given to microorganisms that: (1) relate to the environment and energy; (2) have evolutionary significance; and (3) have potential industrial application. Potential microorganisms of interest included anaerobic hyperthermophiles, metal-reducing bacteria, and bioremediative bacteria. This activity is part of an interoffice initiative to exploit the rapidly	Research that focuses on the mapping and sequencing of microbial genomes will be maintained. Priority for support will be given to microorganisms that: (1) relate to environmental, energy, and other missions of DOE; (2) have evolutionary significance; and (3) have potential industrial application. This activity is part of an interoffice initiative to exploit the rapidly developing technologies in the Human Genome program.	Research that focuses on the mapping and sequencing of microbial genomes will continue. Emphasis will be on high throughput of genomic data using proven technology. This activity is part of an interoffice initiative to exploit the rapidly developing technologies in the Human Genome program.

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Terrestrial Transport (Cont'd)	developing technologies in the Human Genome program.		
	No activity.	No activity.	The ENVIRONMENTAL TECHNOLOGY PARTNERSHIPS program will focus on the development of systems-based approaches and solutions to sustainable industrial production through DOE-assisted evolution from "end of pipe" control to green design. New efforts in bioremediation will be focused on the field-testing of microorganisms already identified as being useful and on the identification and manipulation of additional microorganisms capable of transforming other contaminants. One to two field research sites will be established, adjacent to sample processing facilities and instrumentation, where bioremediation strategies can be evaluated and verified on a long-term, iterative basis. These sites will be located at national laboratories and include partnerships with the bioremediation industry. The research will evaluate strategies under different geochemical and hydrological states. Technology development will be a critical focus. Additionally, characterization of biodegradative enzymes and their catalytic activities through application of structural biology will provide seminal data for the advancement of techniques in bioremediation, and it will also enable the development of chemical processes based on the environmentally benign catalysts found in living cells. Further research in microbial biology should enable the identification of additional remediation targets and, through genetic engineering, increase the efficacy of the microorganisms'

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Terrestrial Transport (Cont'd)			sequestration and degradation processes. Integrated assessments will be conducted so that design and programmatic decisions match environmental goals. Life cycle analyses of important source materials, waste products, and energy sources will be conducted with an emphasis on indirect effects, for example, the use of snap-fits instead of screws to enable faster disassembly, solvent substitutions, and waste heat marketing. Risk assessments will be conducted so that penalties for resource use and disposal can be adequately approximated; for instance, the Toxics Release Inventory may be improved to include human exposure data as well as cancer, birth defects, and other health endpoints.
	$ 18,091	$ 18,548	$ 24,305
Ecosystem Functioning and Response	Ecological research was realigned to focus on experimental and observational studies that provide information needed to assess the potential consequences on terrestrial ecological systems of human-induced atmospheric and climatic changes. Such research will contribute to the identification of energy-related environmental benefits, constraints, or tradeoffs that may enhance or impede SUSTAINABLE DEVELOPMENT, and provide information on potential policy options that could mitigate the changes or ameliorate the resulting adverse ecological responses. Research was focused on improving the predictive understanding of the responses of biological and ecological systems to atmospheric and climatic forcing factors, and identifying the mechanisms	DOE will continue to support peer-reviewed research in universities and in the DOE laboratories on the potential ecological consequences of human-induced atmospheric and climatic changes. Such research will contribute to the identification of energy-related environmental benefits, constraints, or tradeoffs that may enhance or impede SUSTAINABLE DEVELOPMENT, and provide information on potential policy options that could mitigate the changes or ameliorate the resulting adverse ecological responses. Planning will be initiated on how to most effectively use ecological research facilities and capabilities within and across the DOE laboratories, including the DOE National Environmental Research Parks, to address the needed research.	Peer-reviewed research in universities and in the DOE laboratories will be continued on the potential ecological consequences of human-induced atmospheric and climatic changes. Such research will contribute to the identification of energy-related environmental benefits, constraints, or tradeoffs that may enhance or impede SUSTAINABLE DEVELOPMENT, and provide information on potential policy options that could mitigate the changes or ameliorate the resulting adverse ecological responses. Interagency and multi-laboratory projects, involving the use of facilities and capabilities at the DOE laboratories, other agencies, and universities will be initiated to address the needed research. Research will continue to

III. Environmental Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Ecosystem Functioning and Response (Cont'd)	controlling the responses. Initial emphasis was on experimental and observational studies to quantify direct and indirect responses at the organism, population, community and ecosystem levels to changes in temperature, moisture, and atmospheric composition. The long-term goal is to develop predictive models for use in assessing the consequences on ecological systems of human-induced atmospheric and climatic changes resulting from energy-related emissions of aerosols and greenhouse gases.	Research will continue to focus on improving the predictive understanding of the responses of biological and ecological systems to atmospheric and climatic forcing factors, and to identify the mechanisms controlling the responses. Experimental studies will be continued to quantify direct and indirect responses at the organism, population, community and ecosystem levels to changes in temperature, moisture, and atmospheric composition, with the long-term goal of developing reliable predictive models for use in assessing the potential consequences on ecological systems of human-induced atmospheric and climatic changes resulting from energy-related emissions of aerosols and greenhouse gases.	focus on improving the predictive understanding of the responses of biological and ecological systems to atmospheric and climatic forcing factors, and to identify the mechanisms controlling the responses. Experimental studies will be continued to quantify direct and indirect responses at the organism, population, community and ecosystem levels to changes in temperature, moisture, and atmospheric composition, with the long-term goal of developing reliable predictive models for use in assessing the potential consequences on ecological systems of human-induced atmospheric and climatic changes resulting from energy-related emissions of aerosols and greenhouse gases.
	The DOE National Environmental Research Parks were organized to support site specific activities at DOE national laboratories.	The DOE National Environmental Research Parks will be organized as a network of sites to document the response of ecological systems and communities to atmospheric and climatic variation and to measure and inter-compare the response of these systems to experimental and natural perturbations and stresses associated with energy production.	The DOE National Environmental Research Parks program will continue to support research on the adverse and beneficial responses of ecological systems to atmospheric and climatic variation and to other natural and experimental perturbations and stresses associated with energy production and use.
	Funding in the amount of $661,000 and $22,000 has been transferred to the SBIR program and the STTR program, respectively.	Funding in the amount of $838,000 and $42,000 has been budgeted for the SBIR program and the STTR program, respectively.	Funding in the amount of $975,000 and $73,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 4,113	$ 5,506	$ 5,320
Environmental Research	$ 42,442	$ 44,400	$ 50,100

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Health Effects

The primary objective of the Health Effects research subprogram is to conduct an interdisciplinary program of high-quality, basic and applied, peer-reviewed research and technology development aimed at providing information and technology relevant to understanding and mitigating the potential health effects of energy development, use, and waste cleanup. The thrust of this subprogram is to improve our abilities to estimate the type and magnitude of human health risk that result from low-level exposures to energy-related agents such as radiation and chemicals both at home (e.g., radon) and at work (e.g., waste site cleanup).

Previous studies in the Health Effects research program on the health effects of low-level ionizing radiation and chemicals have led to an improvement in exposure assessment methods, the development of techniques for detecting individual susceptibility to disease, including cancer, and the development of bioassays for detecting and monitoring early damage. With cleanup of chemical and radiation waste sites a major goal of the Department, there is a need for occupational monitoring and health surveillance procedures that can better detect exposure, estimate risks, and define the genetic predisposition factors influencing individual worker susceptibility to chemical or radiation exposure. Current models for predicting exposure and risks are intended to make these predictions at the level of the total population and not at the level of the individual worker. However, factors affecting susceptibility to exposure or disease are known to vary from one individual to another and may, therefore, significantly alter the health impacts of low-level exposures to some individuals more than to others. The Health Effects research program is conducting research to develop new molecular-based tools for health surveillance and biological dosimetry. A major emphasis in this program is on the determination of individual susceptibility. Research is also conducted to increase our understanding, at the cellular and molecular levels, of fundamental mechanisms of the long-term health effects (e.g., cancer, immune system impairment, etc.) of exposure to energy-related materials, that will improve estimates of risks.

An emphasis is placed on research that utilizes the unique resources and tools developed in the Department's human genome and cellular and molecular biology programs. The human genome program, in addition to progress in the mapping and sequencing of human DNA, has made numerous scientific and technologic advances that are having enormous scientific and commercial impacts in research and industry. The Health Effects research program will exploit advances made in the genome program to facilitate their introduction and use in both basic and applied research and as part of the U.S. biotechnology infrastructure.

II. A. Summary Table: Health Effects

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Biological Research	$ 32,257	$ 31,794	$ 32,500	$ 706
Radiological and Chemical Physics	4,726	5,127	592	-4,535
Total, Health Effects	$ 36,983	$ 36,921	$ 33,092	$ -3,829

II. B. Laboratory and Facility Funding Table: Health Effects

	FY 1994 Adjusted	FY 1995 Estimate	FY 1996 Request	$ Change
Argonne National Lab (East)	$ 4,111	$ 3,555	$ 3,825	$ 270
Brookhaven National Lab	505	347	380	33
Inhalation Toxicology Research Institute	6,996	6,408	6,325	-83
Lab of Radiobiology and Environmental Health	1,305	1,217	705	-512
Lawrence Berkeley Lab	2,811	2,802	2,620	-182
Lawrence Livermore National Lab	903	893	980	87
Los Alamos National Laboratory	1,497	1,784	1,030	-754
Oak Ridge Institute for Science & Education	1,694	1,853	1,015	-838
Oak Ridge National Lab	5,343	4,555	4,715	160
Pacific Northwest Lab	3,655	3,975	2,905	-1,070
All Other	8,163	9,532	8,592	-940
Total, Health Effects	$ 36,983	$ 36,921	$ 33,092	$ -3,829

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Health Effects			
Biological Research	Continuing research focused on reducing the uncertainty in current risk estimation by increasing understanding of the fundamental mechanisms of interactions between cells and radiation.	Continue analysis of interspecies and interlaboratory lifetime carcinogenesis studies to increase the utility of the calculated risk factors in the estimation of human health risk. Continue to focus on the acquisition and utilization of information on the biological effects of environmentally relevant doses of energy-related radiation and chemicals and on the mechanisms of carcinogenesis to reduce uncertainties in current risk estimation.	Complete majority of long-term dose-response animal studies designed to evaluate toxicity of energy related agents. Continue development of improved methods for extrapolating results of interspecies carcinogenesis studies to estimate human risk at low levels of exposure.
	Sustained funding and oversight of the radiation biology archive and analysis of data from the dose-response life-span studies.	Sustain funding and oversight of the radiation biology archive and continue to enter data from completed multispecies lifetime carcinogenesis studies.	Complete the entry of data from multispecies lifetime carcinogenesis studies in the radiation biology archive.

III. Health Effects (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Biological Research (Cont'd)	Developed and employed human cell culture models for examining the effects of low levels of chemicals and radiation. Exposed individual human cells to precise and reproducible doses and examined the influence of dose, dose rate, and radiation quality on cell viability, chromosomal aberrations, DNA repair, and mutation induction.	Utilize human cells and tissues to determine the influence of dose, dose rate, at the cellular and molecular levels to improve ability to extrapolate estimates of risk from studies using animals and animal cells to humans.	Develop and use microbeam irradiator at Pacific Northwest Laboratory as a national resource for investigating the interaction of radiation with individual human cells or groups of cells.
	Continued studies that compare cellular and molecular effects in rodents exposed in the laboratory with observed effects in humans (e.g., uranium miners lung cancer).	Expand the use of genetically altered mice to study the roles and effects of specific genes in disease development, especially cancer. Increase focus on new molecular-based tools for health surveillance and biological dosimetry.	Expand research to map spontaneous and induced mutations in mice and identify chromosomal regions in mice that are highly homologous to regions of human chromosomes. These mutants will be used, where possible, to characterize, understand, and, ultimately, to support the mitigation of genetic and developmental disorders that afflict humans. Expand the use of genetically altered mice, e.g. transgenic or targeted mutant mice, to study the roles and effects of specific genes or cancer development and disease susceptibles.
	Continued efforts to quantitate individual differences in susceptibility to exogenous energy-related agents and identify early molecular markers of exposure and disease. Completed studies, in mice, to examine the risk of heritable mutations from radiation exposures.	Expand cellular and molecular studies that examine the roles of specific genes, DNA repair, genetic susceptibilities and environmental factors (e.g. passive and active cigarette smoke) in the induction of lung cancer by radon.	Increase overall emphasis on the characterization of factors affecting individual susceptibility to exposure or disease. Continue research investigating cellular and molecular responses to damage of DNA. Continue to isolate and characterize specific genes that are expressed in response to low levels of exposure to radiation or chemicals and define the minimum exposure necessary for their induction.

III. Health Effects (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Biological Research (Cont'd)	Expanded research aimed at understanding the molecular and cellular mechanisms involved in radon-induced lung cancer and developing the related knowledge necessary to improve estimates of the health risk associated with indoor radon exposure.	Develop probes for the early detection of radon-induced lung cancer in former uranium miners.	Continue development of methods to validate radiation doses received by uranium miners as well as methods to detect the development and susceptibility to lung cancer in these miners. Complete study designed to develop a predictive method for locating residences with unusually high levels of radon.
	Developed database for research at DOE facilities or supported by DOE that involves human subjects. Organized interagency and DOE-wide human subjects research meetings. Continued publication of human subjects research newsletter. Continued biannual meetings with DOE human subjects working group.	Establish compliance and audit system for research involving human subjects. Develop and implement procedures for efficient update of human subjects research database. Update human subjects research resource manual. Organize regional educational meetings for DOE investigators and managers on human subjects research issues. Continue publication of human subjects research newsletter. Continue biannual meetings with DOE human subjects working groups.	Continue implementation of new system to monitor and audit DOE research involving human subjects for compliance with federal regulations. Update human subjects research database. Continue regional educational meetings for DOE investigators and managers on human subjects research issues. Continue publication of human subjects research newsletter. Continue biannual meetings with DOE human subjects working group. Organize interagency human subjects research meeting.
	No activity.	No activity.	Initiate efforts to exploit advances made in the genome program by facilitating their introduction and use in both basic and applied research with a continued emphasis on improved estimation of risk to individuals. Initiate efforts to screen populations for individuals with exposure-induced or heritable conditions that may affect their susceptibility to energy-related materials.
	No activity.	No activity.	Initiate research on the toxicity and the mechanisms of that toxicity of chemicals and radiations found in DOE clean-up sites in support of the DOE's waste cleanup efforts.

III. Health Effects (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Biological Research (Cont'd)	Funding in the amount of $484,000 and $17,000 has been transferred to the SBIR program and the STTR program, respectively.	Funding in the amount of $621,000 and $31,000 has been transferred to the SBIR program and the STTR program, respectively.	Funding in the amount of $650,000 and $49,000 has been transferred to the SBIR program and the STTR program, respectively.
	$ 32,257	$ 31,794	$ 32,500
Radiological and Chemical Physics	Multi-disciplinary research to elucidate and understand in detail initial physical and chemical interactions between biomolecules and ionizing radiation and chemicals proceeded at a reduced level. This research included measurement and calculation of initial physical events such as ionizations and excitations. Spatial and temporal distribution of these species in condensed phase were investigated. These physical events were then correlated with ensuing chemical events such as radical species. Information obtained from this research was used to enhance understanding of radiobiological effects at low doses and dose rates. Also, effects on biological systems such as cells and organs as a function of radiation quality were studied. Computational and theoretical studies continued on the conformational and structural changes in biomolecules produced by ionizing radiation. A correlation between these changes and ultimate biological effects was investigated.	Research associated with understanding the structure of biomolecules such as DNA and proteins and the structural change under the influence of ionizing radiation will be enhanced. Emphasis will be placed on determining the relationship of these initial structural changes to the biological activity. Phenomenological and mechanistic models for interpolating/extrapolating the biological effects at all levels of organization such as molecular, cellular, organ, etc., will be emphasized. Study of spatial and temporal distribution of initial physical species such as ionizations and excitations in biologically relevant media will continue. These studies will be further extended to determine the distribution of chemical species in the natural environment of the cell.	Investigation of basic physical and chemical processes initiated by interaction of ionizing radiation with matter will be phased out, as will research on characterization of the spatial and temporal distributions of various radiation induced physical and chemical species. Understanding of the structure of biomolecules such as DNA, proteins, and the structural change under the influence of radiation will be investigated. Application of basic physical and chemical process information will be used for the development of biophysical and biochemical models for use in quantifying radiation risk.

III. Health Effects (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Radiological and Chemical Physics (Cont'd)	Fundamental mechanisms involved in energy transfer processes in biomolecules were investigated to provide a clear identification of various energy transfer pathways. The effect of these various energy transfer pathways on the resulting changes in biomolecules and model liquids were investigated. These studies coupled with description of initial physical and chemical events should provide a sound scientific basis for relating initial damage to the ultimate health effects such as cancer.	Research on fundamental energy transfer mechanisms and pathways in biomolecules will continue in order to study the changes in the biological effects at the cellular and molecular level. When coupled with the results of basic research on the primary physical mechanisms of radiation interaction with biological systems, these studies will provide a firmer basis for relating initial damage processes to the resultant biological effects.	Energy transfer pathways and mechanisms of energy transfer in model biomolecules will be phased out.
	Funding in the amount of $71,000 and $2,000 has been transferred to the SBIR program and the STTR program, respectively.	Funding in the amount of $102,000 and $5,000 has been budgeted for the SBIR program and the STTR program, respectively.	Funding in the amount of $12,000 and $1,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 4,726	$ 5,127	$ 592
Health Effects	$ 36,983	$ 36,921	$ 33,092

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: General Life Sciences

The General Life Sciences research subprogram has two major goals: (1) to develop fundamental biological information and technologies that can be applied in studies of energy-related health effects and (2) to develop and utilize unique DOE resources and facilities in support of Departmental and national goals in the areas of biotechnology and biomedical science, energy use and production, and waste cleanup. These goals are accomplished through an interdisciplinary program of high-quality, basic and applied, peer-reviewed research and technology development. Research is conducted in the areas of molecular and cellular biology, the human genome, and structural biology.

General Life Sciences research is closely integrated with the Health Effects research program through its support of molecular and cellular biology research to identify and characterize genes involved in the repair of damage to DNA and to understand mechanisms that control the cell cycle. This information is useful in efforts to estimate individual human health risk from radiation or chemical exposure by helping to identify biological factors that determine an individual's responsiveness and susceptibility to these agents. This information is also important in research to understand fundamental mechanisms of long-term health effects such as the development of cancer. Technology developed in this program, such as that used to detect and identify altered chromosomes commonly found in individuals exposed to toxicants, who have cancer, or one of several different genetic diseases, is also being used in support of the Health Effects research program and is being transferred to the broader research, medical, and commercial biotechnology communities.

The General Life Sciences research program also supports the development and application of new technologies for mapping and sequencing the entire human genome, i.e., the DNA found in a typical human cell. In addition to the fundamental information provided by this research in support of the Health Effects research program, the technologies, databases, and biological resources being developed by the human genome project will have and are having an enormous impact on a wide variety of biotechnology-related industries and research including medicine and health care, agriculture, energy production, waste control, and environmental clean-up. An important new research program that was possible as a result of technological developments in the human genome program is the microbial genome program to characterize the genomes and proteins of environmentally and industrially important microorganisms. This program will develop DNA sequence and mapping information in microbes with significance for energy production, environmental bioremediation, and industrial applications and has great potential to have a substantial economic impact.

Another unique aspect of the General Life Sciences program is its development and support of DOE national user facilities for the determination of biological structure. Current and developing structural biology user facilities at DOE laboratories are increasingly important in the national effort to elucidate the structure of key biological molecules and to relate their molecular structure to their function. Such an understanding is critical to advancing the biotechnology missions of the Department in applications ranging from energy production from biomass to environmental remediation to improving human health through design and production of 'designer drugs' with much greater effectiveness or specificity of action. DOE has a special responsibility in structural biology for providing the national scientific community with cutting edge facilities, such as synchrotrons and neutron beam sources needed to conduct structure/function research. The recently completed 1-2 GeV Advanced Light Source (ALS) and the new Synchrotron Radiation Source at ANL will provide unique capabilities for structural biology experiments in addition to those already supported by DOE. Funding is requested in support of the operation of user stations for structural biology at these facilities and to ensure the training of a new generation of biologists in this rapidly evolving field.

A continuing and expanding thrust that links structural biology and human genome research is the emphasis in Bioinformation Infrastructure, to be developed in FY 1995, that addresses the need to support the life sciences with information databases related to the structure and sequence of biological molecules. Structural biology and genome research create vast amounts of information and require analytical resources that are unique, including new computer software, approaches to solving complex problems, and interconnected data resources, to provide crucial bridges

I. General Life Sciences (Cont'd)

across the research areas for the efficient prediction of the structure and function of biological molecules. One aspect of this infrastructure will be expanded in FY 1996 through the development of a computational biology program. This program will cut across several BER programs and link research results from these and other research programs through the use of computer science and information technology. A key goal for the computational biology program is to provide the basic understanding and infrastructure needed to predict the functions of biological molecules. Predicting the functions of biological molecules will assist in the application of biotechnology to diverse areas of national need.

II. A. Summary Table: General Life Sciences

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Structural Biology	$ 17,366	$ 19,245	$ 22,357	$ 3,112
Molecular Biology	12,705	12,949	13,080	131
Cellular Biology	6,466	7,526	8,165	639
Genome	61,215	69,174	70,045	871
Total, General Life Sciences	$ 97,752	$ 108,894	$ 113,647	$ 4,753

II. B. Laboratory and Facility Funding Table: General Life Sciences

Ames Lab	$ 237	$ 269	$ 269	$ 0
Argonne National Lab (East)	5,327	4,831	5,472	641
Brookhaven National Lab	9,012	9,394	8,997	-397
Lab of Radiobiology and Environmental Health	1,553	1,215	560	-655
Lawrence Berkeley Lab	12,906	14,000	14,770	770
Lawrence Livermore National Lab	11,515	11,763	11,873	110
Los Alamos National Laboratory	14,475	13,802	13,439	-363
Oak Ridge Institute for Science & Education	1,339	1,327	1,296	-31
Oak Ridge National Lab	7,985	7,964	7,634	-330
Pacific Northwest Lab	1,135	1,331	1,261	-70
Stanford Synchrotron Radiation Lab	982	1,247	1,650	403
All Other	31,286	41,751	46,426	4,675
Total, General Life Sciences	$ 97,752	$ 108,894	$ 113,647	$ 4,753

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
General Life Sciences			
Structural Biology	Continued to support user stations for structural biology at major DOE facilities such as National Sychrotron Light Source, Stanford Synchrotron Radiation Laboratory, and High Flux Beam Reactor. Provided some funds for staffing user-stations for x-ray microscopy at the ALS at LBL; these microscopes came on line at the end of FY 1994.	Continue to support operation of beamlines for structural biology at DOE national facilities. Begin operation of new beamline for spectroscopy at the ALS at LBL and new multipurpose beamline at SSRL, both of which should be ready for initial testing during FY 1995.	Continue to support operation of beamlines for structural biology at DOE national facilities. Continue operation of new beamlines for spectroscopy and crystallography at the Advanced Light Source at LBL and the new multipurpose beamline at SSRL.
	Supported initial staffing for user service groups for x-ray crystallography and spectroscopy at the GeV and x-ray crystallography at the ALS Synchrotron Radiation Source at ANL. Continued research on new detector concepts to enable full utilization of new generation of light sources.	Continue research into instrumentation and techniques for utilization of the Synchrotron Radiation Source at ANL. Support staffing of a Macromolecular Structural Database to maintain it fully current with flow of submitted structures.	Initiate operation of Structural Biology Center at the Synchrotron Radiation Source at ANL. Continue support of Macromolecular Structure Database jointly with other federal agencies.
	Maintained structural biology research on important macromolecules. Continued to focus on fine structure of chromatin and expanded study of structures of membranes. Developed interdisciplinary centers which combine structural biology, chemistry, computational sciences, and molecular biology for cutting edge research in biotechnology making use of particularly strong opportunities offered by DOE laboratories for development of such centers.	Continue research into relationship of structure and function of biologically important macromolecules. Emphasize application of multiple disciplines to solution of problems in biotechnology and environmental science. Seek new insight into design of structures to perform desired functions, such as enzymes modified to synthesize or consume a specific compound (for example, to detoxify a hazardous waste).	Continue research into relationship of structure and function of biologically important macromolecules. Apply multiple disciplines to solution of problems in biotechnology and environmental science. Seek new insight into structure-function relationships, such as enzymes modified to enhance bioremediation (for example, to detoxify a hazardous waste).

III. General Life Sciences (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Structural Biology (Cont'd)	Continued to design at these centers new classes of novel biomolecular structures for use in diagnostic and therapeutic applications, and in research that relates function to molecular structure. Supported the Protein Databank at BNL, an international resource containing three dimensional coordinates of biological macromolecules.	Expand new studies employing computational approaches to predict protein structures.	Expand new studies employing computational approaches to predict protein structures.
	No activity.	No activity.	Initiate computational biology program. Facilitate development of data resources that will permit linkage and integrated analysis of genomic, DNA sequence, and structural biology data. Foster development of computer software and approaches to solving complex problems that can be used to generate, store, and analyze structural biology data.
	No activity.	No activity.	Together with the genome program, ensure that DNA sequence data and genomic data are captured in powerful data structures that will enable different data resources to be interconnected for analysis and subsequent prediction of molecular function. Implement basic computational biology research into powerful and user-friendly tools for data analysis.
	No activity.	No activity.	Ensure interaction of BER programs with other agencies on the coordinated development of biological information resources.
	$ 17,366	$ 19,245	$ 22,357

III. General Life Sciences (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Molecular Biology	Continued efforts to map, clone, and characterize human DNA repair genes and other genes involved in response to radiation and chemical insult. Identified DNA sequences governing the expression of DNA repair genes and determine their chromosomal organization in the context of chromosome fine structure being established by the Human Genome Program. Used small fragments of DNAs representing repair genes to isolate and study the repair enzymes, their interactions, and the pathways that determine how DNA damage is fixed or repaired. Determined whether elevated expression of certain repair genes can protect cells against radiation injury. Began examining the degree of intragenomic heterogeneity of repair in humans and determine how this is mediated by specific genes. Utilized new technologies to develop assays for detecting chromosomal changes associated with specific genes (e.g., cancer-causing genes or tumor suppressor genes).	Utilize isolated human, animal, and microbial genes involved in DNA repair to increase understanding of the role of DNA repair in protecting organisms from the effects of exposure to low levels of toxicants. Initiate research using genetically altered mice to characterize the role of DNA repair genes in development and susceptibility to disease.	Begin to use isolated human and animal DNA repair genes and enzymes to assess variability in repair among human populations. Expand the number of genes examined in research using genetically altered mice to characterize the role of DNA repair genes in development and susceptibility to disease. Expand efforts to characterize mechanisms regulating DNA repair to determine the association between deficiencies in DNA repair and increased health risk.
	Used the proteins identified in these studies to develop markers for exposure and increased sensitivity to DNA damaging agents. Continued studies that develop molecular probes and use chromosomal painting techniques to detect chromosome damage, in order to develop more sensitive biological markers of exposure and dose for use in human epidemiological studies.	Initiate research to understand fundamental mechanisms controlling the cell cycle that regulates normal growth. Initiate efforts to transfer information on DNA repair to studies aimed at understanding individual susceptibility to energy related materials. Continue efforts to characterize mechanisms regulating DNA repair to determine the association between deficiencies in DNA repair and increased health risk.	Continue research to understand fundamental mechanisms controlling the cell cycle and alterations in those mechanisms that occur during the development of cancer. Expand efforts to transfer information on DNA repair to studies aimed at understanding individual susceptibility to energy related materials.

III. General Life Sciences (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Molecular Biology (Cont'd)	Further developed the technique of chromosome painting, the use of fluorescent-tagged probes which hybridize to specific regions of a chromosome's DNA, for use in detecting chromosome damage.	Continue the development and use of chromosome painting probes and methodologies for use in the detection and characterization of chromosomal damage.	Begin to automate the use of chromosome painting probes and methodologies for detection and characterization of chromosomal damage in large populations.
	Developed new research using technology developed in the genome program, to efficiently characterize the fundamental biology and genetics of industrially important microorganisms.	Initiate research to study the genomes and specific proteins of industrially important microorganisms and to characterize fundamental aspects of their biology that have industrial applications.	Continue research to study the genomes and specific proteins of industrially important microorganisms and to characterize fundamental aspects of their biology that have industrial applications.
	$ 12,705	$ 12,949	$ 13,080
Cellular Biology	Continued study of tissue and organ-specific cytogenetic responses.	Continue the development and use of new cytogenetic technologies, e.g., chromosome painting, to detect and characterize chromosome damage.	Complete the development of cytogenetic technologies, e.g., chromosome painting.
	Developed methods for integration of both DNA clone gene libraries and protein databases to provide a means for identifying expressed genes and gene products that appear in response to genetic stress (e.g., radiation or chemical exposure) and quantify cell responses to the stress. It is important to determine what stress proteins do, how they are regulated, and the exposure levels necessary for their induction.	Isolate and characterize genes that regulate cell proliferation and begin examining alterations in those genes that occur during carcinogenesis. Isolate and characterize the specific genes induced at low levels of exposure to radiation or chemicals and define the minimum exposure necessary for their induction.	Complete studies of genes that regulate cell proliferation and that are induced at low levels of exposure to radiation or chemicals.
	No activity.	No activity.	Initiate studies to develop an understanding of how molecular structure determines the function of biomolecules. Focus efforts on the redesign of microbial enzymes with an emphasis of enzymes having specificity for contaminants of importance to the Department's waste sites.

III. General Life Sciences (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Cellular Biology (Cont'd)	No activity.	No activity.	Begin to develop and exploit advances made in the Department's genome, structural biology, and computational biology programs with an emphasis on transfer of knowledge and technology to both research and commercial applications and in support of U.S. biotechnology infrastructure.
	$ 6,466	$ 7,526	$ 8,165
Genome	Maintained FY 1993 level of mapping and sequencing of genetically active and other selected regions of the genome, in order to provide new mapping landmarks. Finished constructing physical maps of the chromosomally aligned DNA clones of several chromosomes. Expanded physical mapping activities. Improved data analysis algorithms and data retrieval software for mapping and sequencing data. Supported improvement of the Human Genome Database for chromosome mapping information with facile interface to sequence and other biological databases. Improved automated and robotized manipulations required to increase the efficiency and reduce the cost of DNA cloning, mapping, and sequencing. Encouraged national laboratory-private sector interactions and technology transfer. Continued efforts to address ethical, legal, and social issues and emphasize educational activity.	Maintain FY 1994 level of chromosome mapping and development of improved resources for mapping and sequencing. Enhance completed chromosomal maps with more detailed features in preparation for DNA sequencing. Begin large scale sequencing by progressive systems integration, from automated sample preparation to interpretation of DNA sequence data. Provide essential improvements in supporting database services and interpretative algorithms. Refine correlations of functionally similar human and mouse chromosomal regions, supporting future use of the mouse model to aid interpretation of human sequence. Encourage national laboratory-private sector interactions and technology transfer. Continue to address ethical, legal and social issues and emphasize educational activities.	Maintain FY 1995 level of chromosome mapping and development of improved resources for mapping and sequencing. Develop more high resolution chromosomal maps in preparation for DNA sequencing. Put more emphasis on scale sequencing by progressive systems integration, from automated sample preparation to interpretation of DNA sequence data. Bring revolutionary sequencing methodologies into proof-of-concept trials. Improve support of database services and development of interpretative algorithms. Refine correlations of functionally similar human and mouse chromosomal regions. Encourage and facilitate national laboratory private sector interactions and technology transfer. Continue to address ethical, legal and social issues and emphasize educational activities. Interact on a broader scale with other programs within and outside of ER. Maintain joint planning and coordination of research with National Institutes of Health and further develop and sponsor joint research initiatives.

III. General Life Sciences (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Genome (Cont'd)	Funding in the amount of $1,482,000 and $48,000 has been transferred to the SBIR program and the STTR program, respectively.	Funding in the amount of $2,149,000 and $107,000 has been budgeted for the SBIR program and the STTR program, respectively.	Funding in the amount of $2,273,000 and $170,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 61,215	$ 69,174	$ 70,045
General Life Sciences	$ 97,752	$ 108,894	$ 113,647

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Medical Applications

This research program, mandated initially by the Atomic Energy Act of 1946 to promote the use of radioactive materials and radiation for medical applications, has provided the scientific and technological foundation for the establishment of Nuclear Medicine as a major clinical specialty. Research in radioisotope production, radiopharmaceutical chemistry, radioisotope imaging instrumentation together with investigation of a broad range of diagnostic and therapeutic applications not only demonstrated and validated advanced diagnostic and therapeutic capability but also led to the establishment of a vital radionuclide production, radiopharmaceutical development, and radionuclide instrumentation industry. Technology developed under this program provides a non-invasive capability for detection and localization of small lesions, for quantitative measurement of dynamic organ function, and for selective radioisotope and radiation therapy of cancer and has achieved a reduction in medical costs through, for example, avoidance of unnecessary surgery.

In recent years, the medical applications program has been reformulated to address a broad range of clinical research requirements. The current program includes six major areas: (1) research to develop new radioisotopes, (2) development and application of new radiopharmaceuticals, (3) instrumentation, (4) clinical feasibility, (5) exploration of new radiation therapy modalities, with emphasis on Boron Neutron Capture Therapy, and (6) molecular nuclear medicine to bring and apply molecular biology advances to address research needs in nuclear medicine. A new biomedical science and technology initiative is planned for FY 1996 in partnership with the Office of Economic Competitiveness of the Department of Energy's Office of Defense Programs.

The radioisotope and radiopharmaceutical chemistry research program develops and evaluates new radioisotopes and labeled compounds for investigating normal and diseased organ function and thus enhancing diagnosis and therapy. The instrumentation program develops improved measurement imaging technology to achieve higher spatial resolution and more accurate quantitation of organ physiology. The clinical feasibility effort extends the basic findings from the research laboratory toward the initial investigation of their applicability in human patients. Radiation therapy research explores the application of new radioactive materials and radiation technology as potential radiation therapy methodologies. Molecular nuclear medicine research will include investigations of radiolabeled molecular probes for neurotransmitter and neuroreceptor studies, while exploiting new molecular biology approaches for labeling and investigating biological function.

The DOE program in molecular nulcear medicine is directed toward development of advanced nuclear medicine technology and initial exploration of its medical applicability. It compliments the National Institutes of Health (NIH) research programs which are more strongly clinical and disease oriented. Advanced procedures and technologies developed under the DOE program become the province of the NIH when larger scale phase III clinical trials are warranted.

The long range goal of the advanced biomedical science and technology initiative is to develop and facilitate the application and transfer of advanced highly efficient medical technologies and scientific advancements to cost-effective clinical applications for commercialization. This initiative is in response to the need within the United States for a more efficient and cost-effective health care system coupled with the aim of harnessing some of the unique scientific and technological capabilities that have been developed within the defense and non-defense scientific communities to accomplish that end and to address the mission needs of the Biological and Environmental Research program of the Office of Energy Research and the Economic Competitiveness Program of the Office of Defense Programs. The DOE national laboratories and off-site grantees offer many multidisciplinary research and development competencies including biological, medical, chemical, and physics research, computational and material sciences, and engineering. Collaborative opportunities with the Advanced Research Projects Agency (ARPA) of the Department of Defense are being discussed.

Traditionally, technology development and research have been sponsored by DOE Defense Programs and Department of Defense programs to meet

I. Medical Applications (Cont'd)

specific missions while other research has been supported by non-defense programs and agencies under the aegis of quite different program missions. It is the potential blending of various communities that holds great promise of making tremendous contributions to the development of new and highly innovative medical technologies of the future. This can only be accomplished by commercialization through U.S. industry, therefore, technology transfer to the private sector is the important final stage of this endeavor.

II. A. Summary Table: Medical Applications

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Radioisotope Development	$ 3,113	$ 1,638	$ 1,256	$ -382
Radiopharmaceuticals	12,216	13,227	10,598	-2,629
Instrumentation	3,519	5,196	6,516	1,320
Clinical Feasibility	2,848	2,191	2,122	-69
Boron Neutron Capture Therapy	8,915	9,777	9,461	-316
Molecular Nuclear Medicine	3,015	5,003	5,947	944
Advanced Biomedical Science and Technology	0	0	3,000	3,000
Power Burst Facility	1,555	1,100	0	-1,100
Congressionally Directed Projects	14,695	10,000	0	-10,000
Total, Medical Applications	$ 49,876	$ 48,132	$ 38,900	$ -9,232

II. B. Laboratory and Facility Funding Table: Medical Applications

Brookhaven National Lab	8,946	9,260	10,267	1,007
Idaho National Engineering Lab	4,860	2,480	1,500	-980
Lawrence Berkeley Lab	2,679	2,392	2,404	12
Los Alamos National Laboratory	701	749	744	-5
Oak Ridge Institute for Science & Education	408	314	317	3
Oak Ridge National Lab	1,171	1,171	1,132	-39
All Other	31,111	31,766	22,536	-9,230
Total, Medical Applications	$ 49,876	$ 48,132	$ 38,900	$ -9,232

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Medical Applications			
Radioisotope Development	Continued improvements in yield, radiopurity, and separation chemistry for selected isotopes including technetium-99m and scandium-47, copper-67, yttrium-90, and samarium-153m for use in radioimmunotherapy. Research on biomedical generator systems continued to increase yield and purity. Rhenium-188 and Indium-191m generators was provided to collaborators for evaluations. Project definition phase studies for a National Biomedical Tracer Facility were initiated.	Efforts in radioisotopes processing, targetry and target chemistry will continue to improve the purity, yield and specific activity of radioisotopes for medical applications. Emphasis will be placed on radionuclide generators which can be made readily available for on-site storage and production of radioisotopes for clinical use. The accelerator, reactor and generator produced radioisotopes including technetium-99m, rhenium-188, copper-67, samarium-153, and yttrium-90 will be explored and evaluated for radiolabeling of immunoconjugates, monoclonal antibodies and molecular probes. Project definition studies for a National Biomedical Tracer Facility will continue.	Efforts in optimizing target design, radioisotope processing, purification and generator development for medically useful radioisotopes will continue. New target chemistry and research will focus on high current machines. Emphasis will be placed on new radioisotope generators for on-site storage, separation, and availability of radioisotopes for medical use in a clinical setting.
	$ 3,113	$ 1,638	$ 1,256
Radiopharmaceuticals	Emphasized development of labeled compounds which will enable the study of fundamental metabolic and physiological processes in both normal and disease states. These include radiolabeled monoclonal antibodies for both diagnosis and therapy and specific ligands for neuroreceptor populations known to be altered in various disease states. Rapid, automated chemical synthesis procedures were developed to label monoclonal antibodies with short-lived positron emitting isotopes for early detection of tumors. Research on the mechanisms of toxicity of drugs of abuse and to assess the metabolic and neurochemical changes associated with drug addiction and withdrawal was continued using a variety of positron labeled drug	Radiolabeling of biologically active molecules including pharmaceuticals, monoclonal antibodies against tumor associated antigens, and the drugs of substance abuse will receive continued emphasis in radiopharmaceutical development for metabolic, diagnostic and therapy studies. Design and synthesis of radioactively labeled medicinal compounds, more commonly known as radiopharmaceuticals, will be continued to improve target selectivity, specificity and localization properties in order to study the concentration of radiopharmaceuticals in body organs by imaging with sensitive radiation detectors. The radiopharmaceutical research will emphasize studies of cancer detection and treatment, brain	New organic synthesis and genetic engineering approaches will be pursued to develop molecular probes of high and selective target specificity. Radiolabeling of new medicinal agents and the agents of substance abuse will continue to receive emphasis. The new radiolabeled agents will be studied for diagnosis and therapy with special focus on heart, brain, and cancer targeting. New radiopharmaceutical advances will be applied to study the biochemical targets, chemical metabolism, and radiopharmaceutical continuation at the target site for effective diagnosis and improved therapy. Radiopharmaceutical research, in addition to the studies of cancer detection and treatment, and brain and heart metabolism, will also contribute

III. Medical Applications (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Radiopharmaceuticals (Cont'd)	compounds and neurotransmitters. Copper-67 labeled porphyrin compounds were developed to detect cancer cells in sputum samples from patients with early stage lung cancer. These compounds were also evaluated for therapy.	and heart metabolism, and will also contribute to the diagnosis and therapy of other organs disfunction such as cardiopulmonary disease and mental disorders.	to the diagnosis and therapy of other organs.
	$ 12,216	$ 13,227	$ 10,598
Instrumentation	Emphasis was placed on application of medical imaging technology to the study of disease states at the molecular level. Development of high resolution, high sensitivity, and high speed Positron Emission Tomography (PET) systems was continued with two new systems under development. New scintillation crystals such as lead sulfate and cerium doped rare earth compounds was evaluated. SPECT imaging is widely utilized in clinical applications and development of systems with improved resolution and sensitivity was initiated. Design of instrumentation for true three-dimensional (3-D) PET imaging was completed and evaluations started. New image reconstruction algorithms for 3-D representation were completed as well as algorithms for quantitative volumetric calculations of metabolic processes. A synchrotron- based x-ray computed tomography facility to image tumors and atherosclerotic plaques in the major arteries of the head and neck was developed.	Research will be maintained on development of high resolution, functional imaging systems to enable non-invasive study of both normal and abnormal physiology and metabolism at the molecular level. Emphasis will be placed on quantitative measurement of neurotransmitter, neuroreceptor and reuptake sites as related to diagnosis and therapy of brain disease. Evaluation of a three dimensional PET system for pediatric brain studies will be completed. New concepts for PET detector systems with substantial improvements in spatial and temporal resolution will be evaluated. Advanced image reconstruction algorithms which improve spatial resolution and minimize artifacts will be developed. Development of instrumentation for application of synchrotron x-rays to coronary studies, computed tomography and radiotherapy will be enhanced.	New technology for fabricating photodiode detector arrays will be used to assemble PET detector modules with very low electronic noise. The technology will be transferred to a U.S. manufacturer. To overcome the limitation of existing scintillation detectors for PET, a systematic search of promising crystals will be made in collaboration with theoreticians to guide the search. Substantial improvements in spatial resolution and sensitivity are anticipated. High resolution PET systems will be used to identify and quantify measure specific receptor sites in the brain for neurological studies.
	$ 3,519	$ 5,196	$ 6,516

III. Medical Applications (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Clinical Feasibility	Continued neurological studies at national laboratories and university medical centers to define the molecular basis of psychiatric disorders using quantitative PET studies of neuroreceptor sites. Initiated clinical studies with tin-117m Diethylene Tetra-amine Penta-acetic Acid (DPTA), a chelating agent for palliative treatment of bone pain in breast and prostate cancer patients.	Positron emission tomography will be exploited for neuroreceptor/transmitter studies of brain function involving dopamine and serotonin in psychiatric disorders. Evaluation of the tungsten-188/ rhenium-188 generator for immunoconjugate radiolabeling to target tumors and the tin-117m DTPA palliative treatment of bone pain in breast and prostate cancer patients will be continued.	The radioisotope, radiopharmaceutical, and monoclonal antibody agents with promising preliminary biological results through animal screening data will be further developed to study the clinical potential in humans and for technology transfer.
	$ 2,848	$ 2,191	$ 2,122
Boron Neutron Capture Therapy	Phase I clinical tests of boronophenylalanine (BPA) continued and tests of boron sulfhydryl (BSH) were initiated. Research on a variety of boron compounds with improved localization in tumor tissue continued. Accelerator neutron sources were evaluated as a more practical, cheaper alternative to fission reactors.	Emphasis will be placed on the development of new boron containing compounds including porophyrins, nucleosides, liposomes and monoclonal antibodies, with improved biodistribution and pharmacokinetic properties. Reactor neutron facilities for animal and human patient studies will be upgraded. Development of accelerator neutron sources will be continued. Initial clinical studies of boronophenylalanine toxicology will continue and studies of efficacy in treatment of glioma multiforma will be planned. This will be a combined phase I and II clinical trial that involves both the drug and neutron radiation.	A strong emphasis will be placed on conducting human clinical trials, closely coordinated with the Food and Drug Administration, to demonstrate application to the treatment of brain tumors, such as glioblastoma and melanoma. It is anticipated that the compound, boronphenylalanine will advance to Phase II clinical trials using the Massachusetts Institute of Technology reactor, and the fructose derivative of this compound will enter Phase II trials at the upgraded Brookhaven Medical Research Reactor. In addition, Phase I clinical trials on the compound sodium borocaptate will be continued. New facilities and personnel for the compassionate treatment of cancer patients will also be provided. In addition, a core research program will be maintained to develop new boron-labeled compounds, improved neutron beam resources, and accurate radiation dosimetry measurements for treatment planning. Transfer of the technology to general medical practice will be facilitated through assistance to others in the preparation and evaluation of neutron

III. Medical Applications (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Boron Neutron Capture Therapy (Cont'd)			sources and in development of treatment planning computer codes.
	$ 8,915	$ 9,777	$ 9,461
Molecular Nuclear Medicine	Research in nuclear medicine based on advances in molecular and structural biology continued including design, synthesis, and application of new radiolabeled compounds for neurotransmittal and neuroreceptor studies, high resolution imaging technology, and applications to disease associated target studies.	Molecular nuclear medicine research will exploit the most current molecular biology, biotechnology and nuclear medicine techniques to develop innovative radiolabeled molecular and genetic probes of high epecificity; to study the mechanism of macromolecular interactions underlying normal genetic, cellular and physiological processes; and to detect, localize and, potentially ameliorate, macromolecular, cellular and systemic pathologies with much greater selectivity. Current emphasis will be on nucleic acid, peptide, and genetically engineered protein and antibody probes to study neuroreceptors and neurotransmitters regulating brain function and to study cancer cell surface receptors for tumor localization and targeting.	Molecular nuclear medicine will supply new biotechnologies and highly sensitive imaging approaches to study molecular biology in vivo. New innovative radiolabeled molecular, metabolic and genetic markers will be developed to study receptor population, receptor signaling, cell communication and gene expression in normal and disease states. Molecular nuclear medicine will focus on characterizing the defects of the disease at molecular and cellular levels and designing new molecular medicine therapies. Emphasis will continue on nucleic acid, peptide, and genetically engineered protein and antibody probes to study neuroreceptors and neurotransmitters regulating brain function and to study tumor receptors and tumor receptor targeting.
	$ 3,015	$ 5,003	$ 5,947

III. Medical Applications (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Advanced Biomedical Science and Technology	No activity.	No activity.	Emphasis will be given to developing and applying microsensors, laser technologies and high resolution portable imaging devices; improving computational analysis of imaging data; and developing patient data and information networks. This will be accomplished by applying the unique capabilities of the Department's Energy Research and Defense laboratories in cooperation with other Federal programs and in collaboration with universities and the private sector.
	$ 0	$ 0	$ 3,000
Power Burst Facility	Initiated preparation for decontamination and decommissioning of the Power Burst Facility at INEL.	Continue preparation for D&D of PBF.	No activity.
	$ 1,555	$ 1,100	$ 0
Congressionally Directed Projects	Congressionally directed projects were conducted. Funding in the amount of $716,000 and $24,000 has been transferred to the SBIR program and STTR program, respectively.	Congressionally directed projects will be conducted. Funding in the amount of $855,000 and $43,000 has been budgeted for the SBIR program and STTR program, respectively.	No activity. Funding in the amount of $778,000 and $58,000 has been budgeted for the SBIR program and STTR program, respectively.
	$ 14,695	$ 10,000	$ 0
Medical Applications	$ 49,876	$ 48,132	$ 38,900

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Carbon Dioxide Research

The link between carbon dioxide and global warming has important impacts on energy policy, economic development, and international affairs. Additional funds are requested in FY 1996 to accelerate global warming research as part of the United States Global Change Research program (US/GCRP). Emphasis is placed on experimental studies of the cloud-climate feedback, on innovative hardware-software applications to advanced climate models, and on the impacts and mitigation of global environmental change. The program includes a mix of extra and intramural research selected competitively via outside expert peer review. In the core program, the carbon cycle research will address fluxes of Carbon Dioxide (CO2) between atmosphere, biosphere and land and ocean surfaces, and of cycling of carbon within the terrestrial biosphere and the oceans. This understanding is required for predicting atmospheric CO2 change due to fossil fuel use and deforestation, and for estimating sinks for excess CO2 generated by fossil fuel. Products from this research include mechanisms for sequestering carbon as a means for stabilizing atmospheric CO2. By mitigating atmospheric greenhouse gas increases and associated climate change, this research provides vital information for assessments of future SUSTAINABLE DEVELOPMENT and environmental protection. The core program also develops and tests models that predict the global and regional climate change induced by increasing atmospheric concentrations of CO2 and other greenhouse gases. This includes modeling climate change, with emphasis on the coupled climate system of the atmosphere, ocean and cryosphere. A key element is support of the Program for Climate Model and Diagnosis and Intercomparison which engages virtually every climate modeling group in the world. The CORE program is being enhanced to address global change impacts and core research associated with SUSTAINABLE DEVELOPMENT.

Research on plant response to increasing CO2 concentrations contribute to environmental sustainability. Emphasis is placed on plant carbon metabolism to address basic biological mechanisms that affect direction, rate and magnitude of CO2 fixation by land ecosystems. This research contributes unique data for assessment of global change impact on ecosystems and contributes important information on sustainable environmental quality.

The Information and Integration activity operates the ORNL Carbon Dioxide Information Analysis Center including its operation as a World Data Center under the United Nations auspices. The Center conducts quality audits on global and regional data sets and makes the data sets available to global change researchers and policy makers.

The Atmospheric Radiation Measurement activity (ARM) determines the radiation balance from the surface of the Earth to the top of the atmosphere and the atmospheric characteristics responsible for this balance, improves the parameterization of the formation and evolution of clouds in climate models, creates an experimental testbed for testing process models used in general circulation models (GCMs) and supports satellite ground truth measurements. The research involves a network of ground-based remote sensing instruments as well as campaign studies using aircraft and tethered platforms. ARM focuses on quantitative links between greenhouse gases and climate change and examines climate feedbacks and energy fluxes in the coupled land/atmosphere/ocean system. The research also examines atmospheric cycling and transformation of radiatively and chemically important trace species.

The Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP) activity accelerates and improves prediction of the response of global and regional climates to the increasing atmospheric concentration of CO2 and other greenhouse gases. Developing advanced climate models requires a better theoretical foundation for long term climate prediction and computers capable of increasing throughput by a factor of at least 10,000 over 1990 era models, as well as mathematical formulations and software that use parallel processing and improved algorithms.

The Oceans Research activity conducts a global survey of CO2 in the ocean to improve ocean circulation models used for climate research. The research involves integrated laboratory, observational, and modeling studies to understand mixing, transport processes and carbon cycling in the ocean and the exchange of heat and carbon between the ocean and the atmosphere. The activity is focused on central questions concerning the

I. Carbon Dioxide Research (Cont'd)

rates of carbon and heat transport in the ocean, and changes in the oceanic CO2 reservoir.

The Quantitative Links program was phased out in FY 1995. The research was designed at initiation to be completed within 5 years. The products of the Quantitative Links program contributed to increased understanding of cloud radiative properties (now explored within ARM) and data analyses have fed into the international assessments.

The National Institute for Global Environmental Change (NIGEC) provides support for research through six regional academic centers on the highest priority areas in DOE's Global Change Research, including regional and global climate modeling, greenhouse gas sources and sinks, and impacts on regional ecosystems of climatic and atmospheric changes, and the development of models and approaches for assessing the integrated impacts of and responses to climate change.

Unmanned Aerospace Vehicles (UAVs) will be used in support of the ARM Program and other process-oriented studies of environmental change. UAVs are needed to extend the ARM energy balance and cloud data to regional scales and to investigate processes not accessible by ground facilities.

The Integrated Assessment Research activity (previously titled Economics) will expand to respond to an Office of Science and Technology Policy request for better links between the natural sciences in the USGCRP and policy needs. The integrated assessment models will help evaluate benefits and costs of various policy alternatives as measured in a broad economics context, including parameters that cannot be converted to dollars. Results from the research on technology innovation and diffusion and greenhouse gas damage indices sponsored by the program will be integrated into the assessment process.

The Global Change Education activity will maintain the fellowship program that provides 4 years of tuition, fees, and support for graduate students and 2 years of support for post-doctoral positions. Special emphasis will also be given to involving students in ongoing research at national laboratories to achieve practical experience in the multi-disciplinary sciences of global change. Such environmental education directly supports long-term needs for SUSTAINABLE DEVELOPMENT. Presently, the Global Change Educational Program is supporting 26 postdoctoral fellows conducting research at 21 different DOE, university, and other federal agency laboratories, and the education and training of 52 graduate students at 31 different universities including Historically Black Colleges and Universities.

II. A. Summary Table: Carbon Dioxide Research

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Core Program	$ 15,996	$ 21,823	$ 23,435	$ 1,612
Information & Integration	2,132	1,899	2,033	134
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	10,470	10,267	10,857	590
Quantitative Links	4,257	2,032	0	-2,032
Atmospheric Radiation Measurement (ARM)	29,847	28,285	29,687	1,402
Oceans Research	5,116	4,427	4,469	42
National Institute for Global Environmental Change (NIGEC)	10,537	11,270	11,000	-270
Unmanned Aerospace Vehicles	0	1,000	1,000	0
Global Change Integrated Assessment Research	2,461	3,319	3,319	0
Education	2,733	2,526	2,600	74
Total, Carbon Dioxide Research	$ 83,549	$ 86,848	$ 88,400	$ 1,552

II. 8. Laboratory and Facility Funding Table: Carbon Dioxide Research

	FY 1994 Adjusted	FY 1995 Estimate	FY 1996 Request	$ Change
Argonne National Lab (East)	$ 1,154	$ 834	$ 850	$ 16
Brookhaven National Lab	2,619	2,038	2,030	-8
Environmental Measurements Lab	403	415	415	0
Lawrence Berkeley Lab	672	342	0	-342
Lawrence Livermore National Lab	6,056	6,170	5,825	-345
Los Alamos National Laboratory	3,838	4,341	4,120	-221
Oak Ridge Institute for Science & Education	3,131	2,826	2,900	74
Oak Ridge National Lab	6,125	5,159	4,800	-359
Pacific Northwest Lab	22,442	19,053	19,958	905
Sandia National Laboratories	291	1,335	1,400	65
All Other	36,818	44,335	46,102	1,767
Total, Carbon Dioxide Research	$ 83,549	$ 86,848	$ 88,400	$ 1,552

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Carbon Dioxide Research			
Core Program	Maintained continuity and quality assurance of atmospheric CO2 measurements at Mauna Loa Observatory; provided atmospheric CO2 projections derived from coupled atmosphere-ocean-terrestrial carbon cycle models; and analyzed effects of terrestrial carbon storage on atmospheric CO2 concentration.	Atmospheric CO2 projections derived from coupled atmosphere-ocean-terrestrial carbon cycle models will be provided; and analysis of the effects of terrestrial carbon storage on atmospheric CO2 concentration will be continued.	Atmospheric CO2 projections derived from coupled atmosphere-ocean-terrestrial carbon cycle models will be provided; and analysis of the effects of terrestrial carbon storage on atmospheric CO2 concentration will be continued. Research on terrestrial carbon processes is emphasized and enhanced. Greenhouse gas stabilization research contributes to SUSTAINABLE DEVELOPMENT.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Core Program (Cont'd)	Continued the international comparison of models and observed natural variability of climate; operated model diagnostic center at Lawrence Livermore National Laboratory concentrating on increased model resolution using advanced modeling concepts such as nested fine model grids; developed advanced diagnostic techniques; analysis of traditional climate data used advanced statistical techniques to assess multi-variate climate change.	The comparison of international climate models will continue and the observed natural variability of climate will be investigated. The model diagnostic center at LLNL will concentrate on model to data comparisons and advanced diagnostic techniques will be applied. Advanced statistical techniques to assess multi-variate climate change will be undertaken.	The observed natural variability of climate will be investigated as a basis for detection of climate change. The model diagnostic center at LLNL will concentrate on the international model-to-data comparisons and developing and applying advanced diagnostic techniques. Coupled ocean and atmospheric modeling will commence and advanced statistical techniques to assess multi-variate climate change will be continued.
	Jointly with USDA, completed the first-phase experiment using the Free-Air-CO2-Enrichment (FACE) approach to determine the combined effects of CO2 and water stress on vegetation. Continued field and laboratory experiments to determine the role of CO2 concentration and other key environmental variables in photosynthesis, respiration and growth processes of plants. Emphasized mechanisms that remove CO2 from the atmosphere.	The FACE experiments, in a forest ecosystem, to determine combined effects of CO2 and climate on vegetation will continue and process models of the terrestrial carbon cycle will be developed.	The FACE experiments, in a forest ecosystem, to determine combined effects of CO2 and climate on vegetation will continue. Mechanisms that remove CO2 from the atmosphere will be emphasized and development of process models of the terrestrial carbon cycle will be continued.
	$ 15,996	$ 21,823	$ 23,435
Information & Integration	Operated the ORNL Carbon Dioxide Information Analysis Center including preparations to become a World Data Center under United Nations (UN) auspices. Conducted quality audits on global and regional data sets.	The ORNL Carbon Dioxide Information Analysis Center will be fully supported including the new role of the Center as the World Data Center for Geophysical Data under UN auspices. Quality audits on global and regional data sets will be conducted.	The ORNL Carbon Dioxide Information Analysis Center will be fully supported as a World Data Center for Geophysical Data under UN auspices. Quality audits on global and regional data sets will be conducted.
	$ 2,132	$ 1,899	$ 2,033

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	Implemented climate models and executed simulations on massively-parallel scientific supercomputers that achieve throughput speeds 100 times greater than was possible in 1990 on a conventional vector supercomputer. Conducted simulations and analytical studies to further define the theoretical limits to climate predictability. Continued development of new algorithms that better utilize massively parallel architectures in conjunction with the High Performance Computing and Communications Program.	Climate model simulations on massively-parallel scientific supercomputers will be executed and throughput speeds 100 times greater than was possible in 1990 on a conventional vector supercomputer will be achieved. Development of new algorithms that better optimize climate model performance will continue to build a massively parallel coupled atmosphere-ocean-land-ice climate model. Multi-decade simulations of climate change will be executed to probe the potential of century scale climate prediction. Algorithms that utilize massively parallel architectures will be improved in conjunction with the High Performance Computing and Communications Program.	Coupled climate system models on massively-parallel scientific super-computers will be refined to capitalize on continuing computational improvements. These models will form part of a national earth-system model infrastructure and will be executed to understand decade-to-century climate change and variability. Theories of greenhouse gas warming and climate behavior on century time scales will be rigorously tested with more complete models. Estimates of model uncertainty to greenhouse gas forcing will be critically evaluated.
	$ 10,470	$ 10,267	$ 10,857
Quantitative Links	Completed experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases.	The analyses of the experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases to climate change will be completed.	No activity.
	$ 4,257	$ 2,032	$ 0
Atmospheric Radiation Measurement (ARM)	Increased ARM operation consistent with planned program growth. Conducted major campaigns at the first site in conjunction with USGCRP partners and other national and international interests. Continued preparation of the second and third ARM sites, in the tropical western Pacific ocean region and in the north slope region of Alaska.	Operations at the first ARM site at the Oklahoma-Kansas border will continue. ARM operations at the second ARM site will begin by deploying two transportable Atmospheric Radiation and Cloud Station (ARCS) in the Tropical Western Pacific Ocean locale. Measurement campaigns at each of the two ARM sites in conjunction with USGCRP partners and other national and international collaborators will be conducted. The level of effort in applying ARM data to test and improve	Operations at the first ARM site at the Oklahoma-Kansas border will continue. ARM operations at the second ARM site will intensify by deploying a third and fourth transportable Atmospheric Radiation and Cloud Station (ARCS) in the Tropical Western Pacific Ocean locale. Measurement campaigns at each of the two ARM sites in conjunction with USGCRP partners and other national and international collaborators will be conducted. The level of effort in applying ARM data to test and improve

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Atmospheric Radiation Measurement (ARM) (Cont'd)		cloud radiation parameterizations in global climate models will be expanded. Preparations for the third ARM site on the North Slope of Alaska will be delayed.	cloud radiation parameterizations in global climate models will be expanded. Preparations for the third ARM site on the North Slope of Alaska will continue with completion of the environmental assessment.
	$ 29,847	$ 28,285	$ 29,687
Oceans Research	Continued ocean measurements as part of the global survey of CO2 in the oceans including the Indian Ocean; conducted process modeling including deep convection and the surface mixed layer to understand the exchange of heat and carbon with the atmosphere including role of ocean white caps in ocean/atmosphere exchange of carbon.	Ocean measurements as part of the global survey of CO2 in the oceans including the Indian Ocean will continue; process modeling including deep convection and the surface mixed layer to understand the exchange of heat and carbon with the atmosphere will be conducted; the study of ocean white caps in ocean/atmosphere exchange of carbon to include at-sea experiments will be enhanced.	As part of the World Ocean Circulation Experiment, ocean measurements as part of the global survey of CO2 in the oceans including the Indian Ocean will continue. Process modeling including deep convection and the surface mixed layer to understand the exchange of heat and carbon with the atmosphere will be conducted. The study of ocean white caps in ocean/atmosphere exchange of carbon will include at-sea experiments.
	$ 5,116	$ 4,427	$ 4,469
National Institute for Global Environmental Change (NIGEC)	NIGEC continued to support the highest priority research areas in global and regional climate prediction and in determining the potential consequences of human-induced climatic and atmospheric changes. Support for research funded through the six Regional Centers of NIGEC and its central office focused on global and regional climate predictions, sources and sinks of carbon dioxide, and the consequences of atmospheric and climatic changes on terrestrial ecosystems at regional and sub-regional sections.	NIGEC will continue to support the highest priority research areas in DOE's global change research program including integrated assessment. Support for research funded through its six Regional Centers will focus particularly on identifying the unmanaged and managed ecological systems that are most vulnerable to potential climatic changes and characterizing and quantifying the consequences of climatic and atmospheric changes on these systems. NIGEC will also support research to improve integrated assessments of the economic, social, and environmental consequences of climate change, to quantify the role of terrestrial	NIGEC will continue to support the highest priority research areas in DOE's global change research program including integrated assessment. Support for research funded through its six Regional Centers will focus particularly on identifying the unmanaged and managed ecological systems that are most vulnerable to potential climatic changes and characterizing and quantifying the consequences of climatic and atmospheric changes on these systems. NIGEC will also support research to improve integrated assessments of the economic, social, and environmental consequences of climate change, to quantify the role of terrestrial

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
National Institute for Global Environmental Change (NIGEC) (Cont'd)		ecosystems as a sink of source of carbon dioxide, to improve regional and global climate predictions, and to determine the radiative effects of clouds and aerosols.	ecosystems as a sink of source of carbon dioxide, to improve regional and global climate predictions, and to determine the radiative effects of clouds and aerosols.
	$ 10,537	$ 11,270	$ 11,000
Unmanned Aerospace Vehicles	Available UAVs were instrumented and flown in support of ARM-CART (cloud and radiation testbed) program using funds from the Department of Defense Strategic Environmental Research and Development Program. First flights were engineering tests at Edwards Air Force Base with Air Force support. A spring campaign over the CART site in Oklahoma provided the first climate relevant data from a UAV. NASA tested an advanced UAV for DOE use under an MOA calling for data sharing and cooperative activity between NASA and DOE.	The use of available leased UAVs and instrumentation developed under the DoD Strategic Environmental Research and Development Program (SERDP) will continue to support ARM and other DOE and multi-agency programs. DOE and SERDP support will allow participation in measurement programs designed to answer long standing questions on the role of deep convection and the limit found in the temperature maxima of the warm pool of the Western Pacific. Opportunities for interagency cooperation will be explored. Instrument development funded by SERDP will continue to improve the measurement capability of these platforms for DOE use.	As the SERDP UAV instruments mature they will be test flown. With these DOE funds initial operations for data collection will be conducted. Operations planned include examination of the earth radiation flux profile with two UAVs for simultaneous observations and an exploration of maritime stratus effects to prepare for operations in support of the ARM North Slope of Alaska site. The SERDP instrument development phase of the ARM-UAV program will begin winding down in anticipation of DOE operations taking over the ARM-UAV program. Interagency collaboration will continue to provide strong leverage for utility of data from the UAV program.
	$ 0	$ 1,000	$ 1,000
Global Change Integrated Assessment Research	Multi-year research grants initiated in FY 1993 continued in FY 1994 to investigate two primary topics. The first is the influence of technology innovation and diffusion on all aspects of the economics of global change to improve the formulation of integrated assessments (benefit/cost analyses). The second is research to develop an alternative to Global Warming Potential greenhouse gas indices so that the regulatory process will have a rationale for regulating the different	The Integrated Assessment Research Program will undergo a major expansion in FY 1995 in part as a response to requests by the Executive Office of the President for the USGCRP to better link the natural science research to the policy process through a more intensive integrated assessment effort. The biggest change in 1995 will be the addition of direct support of integrated assessment. In FY 1993 and FY 1994, the IARP (previously titled Economics Research Program) funded	Efforts assist in translating the results from the other research areas into a policy-relevant framework. The program will support integrated assessment efforts, primarily those that are modeling the benefits and costs of policies to mitigate and adapt global climate change. Initiate analysis of larger modeling efforts. Research will be aimed at testing these first full results, at comparing the models, and at identifying important items that the models lack, such as

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Global Change Integrated Assessment Research (Cont'd)	greenhouse gases simultaneously. New research was also undertaken in FY 1994 to extend the new knowledge gained from the current integrated assessment activity, to support further integrated assessment, and to develop and prepare to analyze National Action Plans required by the "Rio Conference." Research included such topics as the fundamental economic driving forces, for instance international economic forecasts, population growth, international trade, impacts of climate change, and economic tradeoffs between generations.	research, such as predicting technology innovation and diffusion, that assists integrated assessment by providing a foundation for specific parts of the analysis. This background research on specific topics will evolve through 1995, perhaps to include quantifying the impacts of potential global climate change on the energy sector and on ecosystems. However, the major change in FY 1995 is the additional emphasis on the development of integrated assessment itself, which will include a balanced support of both the relatively few large global models as well as other modes of analysis, such as regional models and specific analyses.	realistic approximations (reduced form models) of various physical, economic, and socio-economic processes. The program will also identify critical research topics that support the assessment efforts. Topics for investigation include predicting the effectiveness of voluntary actions, the impact of potential climate change on vulnerable sectors, such as unmanaged ecosystems, and valuing the mitigation and adaptation options with reference to the ultimate impacts.
	$ 2,461	$ 3,319	$ 3,319
Education	Maintained tuition and stipend support for training the next generation of energy-related global change scientists. Awarded new graduate-and-postdoctoral-level fellowships to replace ones that have been completed or terminated.	New graduate- and postdoctoral-level fellowships will be awarded to replace ones that have been completed or terminated. The 4-year tuition and stipend support to about 50 graduate students and 2-year research support to about 20 post-doctoral fellows will be maintained. The research experience "practicums" of the graduate-level fellows at the DOE national Laboratories to provide better opportunities for the Fellows to interact with the multidisciplinary staff and state-of-the-art equipment at our labs will be enhanced. A Global Change awards program for faculty and students at Historic Black Colleges and Universities will be initiated.	The number of graduate-level fellowships will be about 35 and includes support for faculty-student awards at Historically Black Colleges and Universities (HBCUs). Support for undergraduate scholarships at HBCUs will increase. Modification of the graduate-level fellowship program to provide 4 years of DOE support over a span of 5 years will be completed in order to provide leveraged support for DOE Fellows from respective universities. The number of postdoctoral-level fellowships will be about 17. An evaluation of the success of both fellowship programs at providing the training and cross-disciplinary skills necessary for conducting global change research will be conducted. Other mechanisms for supporting the science-infrastructure needs of young scientists at research institutions, will be evaluated.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Education (Cont'd)	Funding in the amount of $1,225,000 and $40,000 has been transferred to the SBIR program and the STTR program, respectively.	Funding in the amount of $1,691,000 and $85,000 has been budgeted for the SBIR program and the STTR program, respectively.	Funding in the amount of $1,760,000 and $132,000 has been budgeted for the SBIR program and the STTR program, respectively.
	$ 2,733	$ 2,526	$ 2,600
Carbon Dioxide Research	$ 83,549	$ 86,848	$ 88,400

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Biological and Environmental Research Program Direction

This subprogram provides the Federal staffing resources and associated funding needed to plan, direct, manage, and support a comprehensive multidisciplinary research effort designed to understand the long-term health and environmental effects associated with the development and use of various energy technologies, and to utilize the Department's unique resources to solve major scientific problems in biology, medicine, and environmental science. This staff will help to meet national energy goals of promoting health and safety as well as a clean environment through management of basic research, providing the scientific framework for a sound national energy policy for fossil fuel and radioactive emissions, fostering partnerships for sharing and leveraging resources, promoting the development of a trained and diverse scientific workforce, and maintaining U.S. world competitiveness through advances in biotechnology.

II. A. Summary Table: Biological and Environmental Research Program Direction

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Personnel Compensation	$ 4,360	$ 4,867	$ 4,988	$ 121
Personnel Benefits	984	1,118	1,147	29
Travel	555	530	530	0
Contractual Services	990	985	935	-50
Total, Biological and Environmental Research Program Direction	$ 6,889	$ 7,500	$ 7,600	$ 100

II. B. Laboratory and Facility Funding Table: Biological and Environmental Research Program Direction

All Other	$ 6,889	$ 7,500	$ 7,600	$ 100
Total, Biological and Environmental Research Research Program Direction	$ 6,889	$ 7,500	$ 7,600	$ 100

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Biological and Environmental Research Program Direction			
Personnel Compensation	Provided funds for personnel compensation for 60 full-time equivalents (FTEs) in the Office of Health and Environmental Research and for related program and management support. Includes, for example, regular salaries, lump sum payments for unused annual leave, premium pay, and employee incentive awards.	Provide funds for personnel compensation for 62 FTEs. Includes, for example, regular salaries, lump sum payments for unused annual leave, premium pay, and employee incentive awards.	Provide funds for personnel compensation for 62 FTEs. Includes, for example, regular salaries, lump sum payments for unused annual leave, premium pay, and employee incentive awards. Provide for pay increases resulting from normal within-grade increases, locality and/or general pay raises.
	The Office of Health and Environmental Research provided program management, oversight, guidance and support for over 850 active research projects (reviewing and evaluating many more throughout the proposal selection process) and conducted major reviews of numerous BER-sponsored programs at laboratories and universities. Supported and provided liaison for ongoing research activities including growth in the areas of atmospheric science (ozone) and subsurface microbiology, structural biology, the human genome, and global climate change programs; provided for the added reporting and analysis requirements of the Energy Policy Act; supported the Strategic Environmental Research and Development Program (SERDP) industrial energy and waste minimization efforts; supported SBIR and the ER Laboratory Technology Transfer Program for the cost shared spinoff CRADAs from non-defense laboratories; and increased support for the Environmental Molecular Sciences Laboratory (EMSL). Managed efforts in analytical technology, health and environmental effects of radiation and toxic chemicals, and	Continue program management for ongoing activities as in FY 1994. Support increased emphasis on information infrastructure for structural biology and genetics, advanced sequencing and high resolution mapping of the human genome, new efforts on the microbial genome for industrial and waste cleanup applications, and global climate change programs. Manage efforts in atmospheric science, subsurface microbiology, and ecosystem research. Manage efforts in analytical technology, health and environmental effects of radiation and toxic chemicals, and molecular nuclear medicine, boron neutron capture therapy, including development of a new initiative in advanced biomedical technology to exploit dual use resource capabilities with Defense Programs and Department of Defense programs. Continue to provide ES&H oversight for the safe operation of program facilities. Provide program management, oversight and accountability of contractor operations, including ongoing construction activities for Structural Biology Centers at ANL and LBL, the LBL Human Genome Laboratory,	Continue program management for ongoing activities as in FY 1995. Support increased emphasis on new initiatives in computational biology to link advances in biological sciences with computer and information services; field-scale experiments in partnerships with EM to evaluate in-situ microbial and chemical processes for immobilizing and transforming subsurface contaminants as a cost-effective bioremediation technology option; pilot-scale sequencing and high resolution mapping of the human genome; expanding efforts on the microbial genome for industrial and waste cleanup applications; and global climate change programs. Manage efforts in atmospheric science, subsurface microbiology, and ecosystem research. Manage efforts in analytical technology, health and environmental effects of radiation and toxic chemicals, and molecular nuclear medicine. Support a new initiative in advanced biomedical technology to exploit the potential of dual use capabilities of biological sensors, lasers and imaging technologies for improved health care practices.

III. Biological and Environmental Research Program Direction (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Personnel Compensation (Cont'd)	molecular nuclear medicine. Provided environment, safety and health (ES&H) management capability for the safe operation of program facilities. Continued to oversee contractor operations and accountability including new construction activities for Structural Biology Centers at Argonne National Laboratory (ANL) and Lawrence Berkeley Laboratory (LBL), the LBL Human Genome Laboratory, the EMSL at the Pacific Northwest Laboratory (PNL), and the upgrade of the Brookhaven Linac Isotope Producer at Brookhaven National Laboratory (BNL). Continued liaison with other DOE programs to facilitate technology and information transfer, and with other Federal agencies and international bodies.	and EMSL at PNL. Continue liaison with other DOE programs to facilitate technology and information transfer, and with other Federal agencies and international bodies. Manage program development for enhancing future manpower in health and environmental sciences including newly funded programs for HBCUs. Meet growing responsibilities with respect to the TQM process and oversight of new partnerships between the national laboratories, academia, and the private sector.	Provide program management, oversight and accountability of contractor operations, including ongoing construction activities for Structural Biology Centers at ANL and LBL, the LBL Human Genome Laboratory, and EMSL at PNL. Continue liaison with other DOE programs to facilitate technology and information transfer, and with other Federal agencies and international bodies. Manage program development for enhancing future manpower in health and environmental sciences including the new scholarship programs for HBCUs. Continue to support TQM processes and new partnerships with others.
	Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, information resource management, policy review and coordination, and utilities management.	Continue program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, information resource management, policy review and coordination, and utilities and construction management.	Continue program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, information resource management, policy review and coordination, and utilities and construction management.
	$ 4,360	$ 4,867	$ 4,988
Personnel Benefits	Funded civilian personnel benefits to cover the Civil Service Retirement and Disability Funds, Federal Employees Retirement System, health benefits and life insurance funds, permanent change of station expenses, and unemployment compensation.	Fund civilian personnel benefits to cover the Civil Service Retirement and Disability Funds, Federal Employees Retirement System, health benefits and life insurance funds, permanent change of station expenses, and unemployment compensation.	Fund civilian personnel benefits to cover the Civil Service Retirement and Disability Funds, Federal Employees Retirement System, health benefits and life insurance funds, permanent change of station expenses, and unemployment compensation.
	$ 984	$ 1,118	$ 1,147

III. Biological and Environmental Research Program Direction (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Travel	Provided funds for official domestic, international, and local travel. Funds transferee/new hire permanent change of station transportation.	Provide funds for official domestic, international, and local travel. Fund transferee/new hire permanent change of station transportation.	Provide funds for official domestic, international, and local travel. Fund transferee/new hire permanent change of station transportation.
	$ 555	$ 530	$ 530
Contractual Services	Provided a variety of program support such as printing and editing and contractual services, including, for example, ES&H support and timesharing on various information systems and communication networks; and Automated Office Support Systems (AOSS) workstations.	Continue at a reduced level a variety of program support such as printing and editing and contractual services, including, for example, ES&H support and timesharing on various information systems and communication networks; and Automated Office Support Systems (AOSS) workstations.	Continue at a reduced level a variety of program support such as printing and editing and contractual services, including, for example, ES&H support and timesharing on various information systems and communication networks; and Automated Office Support Systems (AOSS) workstations.
	$ 990	$ 985	$ 935
Biological and Environmental Research Program Direction	$ 6,889	$ 7,500	$ 7,600

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Facilities Operations

Facility operations provide for the necessary capital equipment and construction needs to support the BER program and the Pacific Northwest Laboratory landlord responsibilities. An ability to address health and environmental issues requires a continuing commitment to maintaining advanced instrumentation and facilities.

II. A. Summary Table: Facilities Operations

Program Activity	FY 1994 Adjusted	FY 1995 Adjusted	FY 1996 Request	$ Change
Capital Equipment	$ 20,957	$ 24,540	$ 24,000	$ -540
Construction	47,482	70,700	67,045	-3,655
Total, Facilities Operations	$ 68,439	$ 95,240	$ 91,045	$ -4,195

II. B. Laboratory and Facility Funding Table: Facilities Operations

Ames Lab	$ 0	$ 79	$ 0	$ -79
Argonne National Lab (East)	4,454	7,215	4,684	-2,531
Brookhaven National Lab	7,984	3,002	1,984	-1,018
Environmental Measurements Lab	194	250	200	-50
Inhalation Toxicology Research Institute	762	177	600	423
Lab of Radiobiology and Environmental Health	97	150	100	-50
Lawrence Berkeley Lab	5,316	23,640	11,474	-12,166
Lawrence Livermore National Lab	1,238	1,325	1,363	38
Los Alamos National Laboratory	534	2,043	1,168	-875
Oak Ridge Institute for Science & Education	0	0	0	0
Oak Ridge National Lab	1,020	100	742	642
Pacific Northwest Lab	43,407	49,203	62,600	13,397
Stanford Synchrotron Radiation Lab	2,911	2,003	500	-1,503
All Other	522	6,053	5,630	-423
Total, Facilities Operations	$ 68,439	$ 95,240	$ 91,045	$ -4,195

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1994	FY 1995	FY 1996
Facilities Operations			
Capital Equipment	Maintained capital equipment budget for the core program to provide state-of-the-art instrumentation. ($6,130)	Reduces capital equipment budget for the core program to provide state-of-the-art instrumentation. ($3,184)	Supports capital equipment needs for the core program to provide state-of-the-art instrumentation. ($3,400)
	Completed development and fabrication of x-ray microscopes (scanning and imaging) at the ALS begun in FY 1993 (TEC $4.1M); initiated development of beam line 9 at SSRL with stations for all major x-ray technologies needed for structural biology (TEC $7.5M); initiated development of a new station at the HFBR for high-speed neutron crystallography (TEC $2.9M); funded final stage of upgrade of existing stations at NSLS (TEC $1.0M). ($5,345)	Complete development of beamline 9 at SSRL with four stations for structural biology experiments. Complete development of elliptically polarized wiggler beamline for spectroscopy at the ALS. Continue development of experimental stations for crystallography and x-ray microscopy at ALS and a new station for neutron crystallography at the Brookhaven HFBR; upgrade detector and data management hardware at existing stations. ($8,799)	Complete development of beamline for crystallography at the ALS and station for neutron crystallography at the Brookhaven HFBR; initiate modernization of computer systems at Brookhaven National Laboratory, Argonne National Laboratory, Lawrence Berkeley Laboratory and Stanford Synchrotron Radiation Laboratory structural biology user facilities. ($8,100)
	Supported genome needs for replacement of capital equipment to maintain existing capability. ($2,066)	Supports genome needs for replacement of capital equipment to maintain existing capability. ($2,666)	Supports genome needs for replacement of capital equipment to maintain existing capability. ($2,800)
	Supported capital equipment needs for global climate change including the ARM needs. Among the latter are (1) equipment for Southern Great Plains ARM site particularly high accuracy radiometers, state-of-the-art high resolution spectrometers, and high resolution LIDAR and Radar systems for aerosol, cloud and water vapor diagnostics, (2) remote cloud measurement systems for the ARM Tropical Western Pacific site; these are instrument packages containing surface radiometers, cloud imagers and water vapor profilers. Funds were also provided for a measurement Data Archive System at ORNL; capital for this included hardware for a high speed data processing and storage capability. ($7,416)	Supports capital equipment needs for global climate change, primarily ARM by: (1) upgrading and/or replacing selected instrumentation at the first ARM site, in Oklahoma-Kansas, (2) providing two transportable Atmospheric Radiation and Cloud Stations (ARCS) at the second ARM site, in the Tropical Western Pacific Ocean locale and (3) continued development of the ARM Data Archive System at ORNL. ($9,891)	Supports capital equipment needs for global climate change, primarily ARM by: (1) providing two transportable Atmospheric Radiation and Cloud Stations (ARCS) at the third ARM site, in the North Slope region of Alaska and 2) three additional ARCS for the second ARM site, in the tropical western Pacific locale. ($9,300)

III. Facilities Operations (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Capital Equipment (Cont'd)	No activity.	No activity.	Supports capital equipment needs for new initiative in advanced biomedical science and technology. ($400)
	$ 20,957	$ 24,540	$ 24,000
Construction	Maintained general plant projects at the FY 1993 funding level. ($3,047)	Maintains general plant projects at the FY 1994 funding level. ($3,500)	Maintains general plant projects at the FY 1995 funding level and supports high priority ES&H activities. ($4,450)
	Initiated construction of user center for structural biology at Advanced Light Source at LBL, containing laboratories for sample preparation, characterization and storage, offices for permanent staff of beamlines and for visitors, and computer facilities needed for evaluating data obtained at ALS. The center will occupy a portion of the mezzanine of the ALS, as well as the adjacent Building 80. ($582)	Continue construction of user center for structural biology at ALS, containing laboratories for sample preparation, characterization and storage, offices for permanent staff of beamlines and for visitors, and computer facilities needed for evaluating data obtained at ALS. The center will occupy a portion of the mezzanine of the ALS, as well as the adjacent Building 80. ($4,700)	Complete construction of user center for structural biology at ALS, containing laboratories for sample preparation, characterization and storage, office for permanent staff of beamlines and for visitors, and computer facilities needed for evaluating data obtained through ALS. The center will occupy a portion of the mezzanine of the ALS, as well as the adjacent Building 80. ($2,600)
	Initiated construction of the Structural Biology Center at ANL, including new laboratories and experimental facilities at the Synchrotron Radiation Source and substantially remodeled laboratories and a biohazard containment facility in Building 202 (Biology) at ANL. This project will result in a high-throughput advanced technology center for x-ray crystallography serving the entire U.S. structural biology community. ($3,881)	Continue construction of the Structural Biology Center at ANL, including new laboratories and experimental facilities at the Synchrotron Radiation Source and substantially remodeled laboratories and a biohazard containment facility in Building 202 (Biology) at ANL. This project will result in a high-throughput advanced technology center for x-ray crystallography serving the entire U.S. structural biology community. ($6,700)	Complete construction of the Structural Biology Center at ANL, including new laboratories and experimental facilities at the Synchrotron Radiation Source and substantially remodeled laboratories in Building 202 (Biology) at ANL. This project will result in a high-throughout advanced technology center for x-ray crystallography serving the entire U.S. structural biology community. ($4,295)

III. Facilities Operations (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Construction (Cont'd)	Continued support, provided previously by the Environmental Management program, for construction of the Environmental Molecular Science Laboratory (EMSL) to provide a focused laboratory capability for developing technology solutions to Hanford site-specific environmental restoration and waste management problems for the full duration of site clean-up. The EMSL will focus on a wide variety of experimental and theoretical capabilities in an interdisciplinary culture that will: (1) develop the scientific basis to predict contaminant transport and transformation; (2) advance materials technologies for measurement, containment, and separation of wastes; (3) increase use of biosystems for remediation and knowledge of health effects due to toxic substances; (4) facilitate training, education, and technology transfer initiatives; and (5) achieve transfer of technology through industry involvement. The facility size is approximately 200,000 square feet, housing 209 permanent scientific and support staff, and 60 visiting scientists. Key facility elements include laboratories, offices, conference rooms, computer rooms, library, kitchen, support shops, and a seminar area. Facility design will support state-of-the-art laboratory equipment, provide flexibility to accommodate future equipment, and support educational and technology transfer initiatives. ($32,017)	Continue support for construction of the EMSL to provide a focused laboratory capability for developing technology solutions to Hanford and other DOE site-specific environmental restoration and waste management problems for the full duration of site clean-up. The EMSL will focus on a wide variety of experimental and theoretical capabilities in an interdisciplinary culture that will: (1) develop the scientific basis to predict contaminant transport and transformation; (2) advance materials technologies for measurement, containment, and separation of wastes; (3) increase use of biosystems for remediation and knowledge of health effects due to toxic substances; (4) facilitate training, education, and technology transfer initiatives; and (5) achieve transfer of technology through industry involvement. The facility size is approximately 200,000 square feet, housing 209 permanent scientific and support staff, and 60 visiting scientists. Key facility elements include laboratories, offices, conference rooms, computer rooms, library, kitchen, support shops, and a seminar area. Facility design will support state-of-the-art laboratory equipment, provide flexibility to accommodate future equipment, and support educational and technology transfer initiatives. ($40,000)	Continue support for construction of the EMSL to provide a unique laboratory facility focused on fundamental science needed to advance technology for environmental restoration/waste management at Hanford and other DOE sites. The EMSL will unite experts in a variety of scientific disciplines and focus their efforts on (1) first predicting and then remediating contaminant transport and transformation; (2) development of advanced materials necessary for evaluation and separation of complex wastes, materials that will have a variety of industrial uses; (3) increased use of biotechnology for remediation; (4) evaluation of toxic substances on human (and environmental) health, including development of methodologies of wide applicability in the biotechnology industry; (5) achieve transfer of technology through industry involvement and directly contributes to SUSTAINABLE DEVELOPMENT. The EMSL will be a National User Facility; academic and industrial scientists will work in collaboration with in-house staff; additionally, academic and industrial scientists will have access to the unique equipment to be housed in the EMSL. ($50,000)

III. Facilities Operations (Cont'd):

Program Activity	FY 1994	FY 1995	FY 1996
Construction (Cont'd)	Lack of a continuous supply of some radioisotopes has caused concern throughout the nuclear medicine clinical community because vital diagnostic technology was not available for patient studies, and important biomedical research activities were also affected. The Brookhaven Linac Isotope Producer is a cost effective and rapid means of resolving much of this radioisotope shortfall. The upgrade will increase the beam current of the existing facility by a factor of three, replace the target assembly and improve the hot cell shielding in order to substantially enhance the radioisotopes production capability. Two years will be required to complete the upgrade. ($5,821)	Complete upgrade.	No activity.
	Initiated construction of the Human Genome Laboratory at LBL to provide a state-of-the-art facility for molecular genetics research. The three story building will provide 41,000 gross square feet and 24,050 net square feet of assignable laboratory and office space. The Laboratory will provide an essential core of laboratories for multidisciplinary teams of technical staff that utilize a common pool of instrumentation and cell culture facilities. This building will be adjacent to existing cell biology research facilities that are used for related research on gene expressions and physiology. This and other light laboratory space at LBL is now fully utilized. The Human Genome Laboratory is planned for a staff of 92, including senior scientists, postdoctoral associates, graduate students, technicians and support personnel. Research at the Human Genome Laboratory will directly support the needs of the	Continue construction of the Human Genome Laboratory at LBL to provide a state-of-the-art facility for molecular genetics research. ($15,800)	Continue construction of the Human Genome Laboratory at LBL to provide a state-of-the-art facility for molecular genetics research. ($5,700)

III. Facilities Operations (Cont'd):

Program Activity		FY 1994	FY 1995	FY 1996
Construction (Cont'd)	DOE Biological and Environmental Research program for gene mapping and DNA base sequencing and its related efforts to improve analytical methods, instrumentation and information management. Such efforts will provide a fundamental understanding of the structure and function of the human genome--the genetic basis of susceptibility to disease causing agents--for use in defining risk and providing health protection. ($2,134)			
		$ 47,482	$ 70,700	$ 67,045
Facilities Operations		$ 68,439	$ 95,240	$ 91,045

DEPARTMENT OF ENERGY
FY 1996 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1995 Congressional Budget Request are denoted with a vertical line in left margin.)

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

IV. A. Construction Funded Project Summary

Project No.	Project Title	TEC	Previous Appropriated	FY 1994 Appropriated	FY 1995 Appropriated	FY 1996 Request	Unappropriated Balance
GPE-120	General Plant Projects	---	---	$3,047 b/	$3,500	$4,450	---
94-E-339	Human Genome Laboratory, LBL	24,634	0	2,134	15,800	5,700	1,000
94-E-338	Structural Biology Center, ANL	14,876	0	3,881	6,700	4,295	0
94-E-337	ALS Structural Biology Support Facilities, LBL	7,882	0	582	4,700	2,600	0
94-E-335	BLIP Facility Upgrade	5,821	0	5,821	0	0	0
91-EM-100	Environmental Molecular Sciences Lab., PNL	207,900	50,770 a/	32,017	40,000	50,000	35,113
Subtotal	Line Item Projects	261,113	50,770	44,435	67,200	62,595	36,113
Total Biological and Environmental Research		$XXX,XXX	$XXX,XXX	$47,482	$70,700	$67,045	$36,113

a/ $22,270 prior year funding and $28,500 FY 1993 funding provided by Environmental Management program.
b/ Includes general reduction for use of prior year balances of $70,000.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project GPE-120, General Plant Projects

TEC: $ 4,450
TPC: $ 4,450

Start Date: 2nd Qtr. FY 1996 Completion Date: 4th Qtr. FY 1997

2. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1994	FY 1995	FY 1996	After FY 1996
Previous	XXXXXXXX	$ 1,539	$ 1,886	$ 1,006	$ 1,385
FY 1994 Projects	2,977	400	1,126	1,228	223
FY 1995 Projects	3,500	0	413	766	2,321
FY 1996 Projects	4,450	0	0	500	3,950

3. Narrative: The request supports minor new construction and other capital alterations to land, buildings, and utilities systems. In addition, the cost of installed equipment is included as an integral part of the general plant subprojects.

General plant projects are necessary to maintain facilities in an environmentally safe and health hazard free condition. They ere also required to keep facilities in adequate repair, including roads, parking lots, pavements, etc. The BER program supports such activities as a landlord responsibility for the Pacific Northwest Laboratory and for other laboratories and universities. The FY 1996 General Plant Projects funding will also support high priority ES&H activities identified in the Department's ES&H Five Year Plan.

4. Total Project Funding (B/A):

	Prior Years	FY 1994	FY 1995	FY 1996 Request	To Complete
Construction.....	$ xxx	$ 3,047a/	$ 3,500	$ 4,450	$ XXX

a/ Includes general reduction for use of prior year balances of $70,000.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-339, Human Genome Laboratory
Lawrence Berkeley Laboratory
Berkeley, California

TEC: $ 24,634 a/
TPC: $ 24,934 a/

Start Date: 4th Qtr. FY 1995 Completion Date: 4th Qtr. FY 1997

2. Financial Schedule:

Fiscal Year	Appropriation	Adjustment	Obligations	Costs
FY 1994	$ 2,200	-66a/	$ 2,134	$ 518
FY 1995	15,800	0	15,800	4,970
FY 1996	5,700	0	5,700	9,850
FY 1997	1,000	0	1,000	9,296

3. Narrative: The proposed laboratory will be a three-story building with 41,000 gross square feet and 24,050 net square feet of assignable laboratory and office space.

The Human Genome Laboratory at LBL will support the Department of Energy's program to develop and apply the powerful tools of molecular genetics towards understanding the health and environmental impacts of current and proposed energy technologies. Research conducted at the laboratory will provide a fundamental understanding of the structure and function of the human genome.

4. Total Project Funding (BA):

	Prior Years	FY 1994	FY 1995	FY 1996 Request	To Complete
Construction.....	$ 0	$ 2,134 a/	$15,800	$ 5,700	$ 1,000
Capital Equipment.....	0	0	0	0	0
Operating Expenses.....	170	130	0	0	0

a/ Reflects reduction of funding for FY 1996 rescission.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-338, Structural Biology Center
Argonne National Laboratory (ANL)
Argonne, IL

TEC: $ 14,876a/
TPC: $ 21,596a/

Start Date: 2nd Qtr. FY 1995 Completion Date: 2nd Qtr. FY 1997

2. Financial Schedule:

Fiscal Year	Appropriation	Adjustment	Obligations	Costs
FY 1994	$ 4,000	-119a/	$ 3,881	$ 827
FY 1995	6,700	0	6,700	6,700
FY 1996	4,295	0	4,295	3,700
FY 1997	0	0	0	3,649

3. Narrative: The Structural Biology Center (SBC) proposes to develop and operate a sector of the 6-7 GeV as a user facility for macromolecular crystallography. The major portion of the SBC construction project will be to build two x-ray beamlines--one bending-magnet line and one insertion-device line--with their associated experimental hutches, ancillary instrumentation, and conventional facilities such as offices and laboratories.

Conventional facilities at the 6-7 GeV and in Building 202 will be built and operated to support crystal growth, mounting and alignment at ANL. A fully established biochemistry laboratory will be operated and staffed at ANL and will be available to outside users. A biohazards containment facility will be built and staffed at ANL so the user community can handle their materials as needed.

4. Total Project Funding (B/A):

	Prior Years	FY 1994	FY 1995	FY 1996 Request	To Complete
Construction.....	$ 0	$ 3,881a/	$ 6,700	$ 4,295	$ 0
Capital Equipment.....	0	0	0	200	400
Operating Expenses.....	843	780	830	1,072	2,595

a/ Reflects reduction of funding for FY 1994 rescission.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-337, ALS Structural Biology Support Facilities
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

TEC: $ 7,882a/
TPC: $ 7,982a/

Start Date: 2nd Qtr. FY 1995 Completion Date: 3rd Qtr. FY 1996

2. Financial Schedule:

Fiscal Year	Appropriation	Adjustments	Obligations	Costs
FY 1994	600	-18a/	582	296
FY 1995	4,700	0	4,700	2,300
FY 1996	2,600	0	2,600	5,100
FY 1997	0	0	0	186

3. Narrative: The ALS Structural Biology Support Facilities will provide 11,100 gross square feet of support laboratories and offices, located in the ALS building and in an existing adjacent structure. The facilities will be designed and equipped to support activities in the areas of x-ray microimaging and microholography, x-ray spectroscopy, and x-ray crystallography.

4. Total Project Funding (BA):

	Prior Years	FY 1994	FY 1995	FY 1996 Request	To Complete
Construction.....	$ 0	$ 582a/	$4,700	$ 2,600	$ 0
Capital Equipment.....	0	0	0	0	0
Operating Expenses.....	100	0	0	0	0

a/ Reflects reduction of funding for FY 1994 rescission.

IV. B. Construction Funded Project Descriptive Summary

1. Title and Location of Project: Project 91-EM-100, Environmental Molecular Sciences Laboratory
Pacific Northwest Laboratory
Richland, Washington

TEC: $207,900
TPC: $229,900

Start Date: 2nd Qtr. FY 1994 Completion Date: 4th Qtr. FY 1997

2. Financial Schedule:

Fiscal Year	Appropriation a/	Adjustment	Obligations a/	Costs
1991	$ 5,200	-30c/	$ 5,170	$ 1,500
1992	17,100 b/	0	17,100 b/	3,300
1993	28,500	0	28,500	12,800
1994	33,000	-983d/	32,017	26,282
1995	40,000	0	40,000	56,700
1996	50,000	0	50,000	68,200
1997	35,113	0	35,113	39,118
1998	0	0	0	0

3. Narrative: This facility is approximately 200,000 square feet, housing 209 permanent scientific and support staff and 60 visiting scientists. Facility design will support state-of-the-art laboratory equipment, provide flexibility to accommodate future equipment, and support educational and technology transfer initiatives.

This project will be a new laboratory facility with an initial complement of laboratory equipment. EMSL will be an extension of the current environmental mission at the Hanford site, providing a focused laboratory capability to develop technology solutions to site-specific environmental restoration and waste management problems for the full duration of site cleanup.

4. Total Project Funding (BA):

	Prior Years	FY 1994	FY 1995	FY 1996 Request	To Complete
Construction.....	$50,770	$32,017	$40,000	$50,000	$ 35,113
Capital Equipment	2,320	2,670	0	0	0
Operating Expenses	6,500	2,050	1,400	2,300	4,760

a/ Funds provided by Environmental Management program for FY 1991 through FY 1993.
b/ Excludes $20,000,000 provided by the Department of Defense per the Defense Appropriation Act of FY 1991.
c/ Adjustment reflects a $30,000 general reduction.
d/ Reflects reduction of funding for FY 1994 rescissions.