DEPARTMENT OF ENERGY
FY 1995 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. The BER program uses this scientific knowledge to develop technological tools that can be used to mitigate or correct adverse consequences of energy use. The program also uses the Department's unique multidisciplinary scientific and technological capabilities to solve major scientific problems in biology, medicine, and environmental science. 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 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 dose findings are indeed conservative.

The DOE radiobiology program is the Nation's lead research program for understanding the health consequences of low-level ionizing radiation exposure. This program provides the scientific information that is used by other agencies to estimate health risks from radiation exposures (e.g., EPA uses that information to develop and implement policies for reducing the health effects from radon exposures, but does not support such biological research). Currently, a large component of the program is focused on evaluation of the potential health consequences of indoor radon. The program is active in improving exposure assessment methods, developing techniques for detecting individual susceptibility, and devising bioassays for detecting and monitoring early damage. The BER program also has extensive scientific and managerial interactions with the European community, including some collaborative research. Information that can be generalized for a variety of applications and predictive principles are used by BER researchers to assess the potential health consequences of any proposed energy option. This approach requires the use of molecular, biochemical and cellular information obtained from both cell culture and animal systems. Such information is used to establish the fundamental principles underlying the responses to radiation and other energy-related agents.

Recent reports of unethical conduct involving experiments using radiation on human subjects during the Cold War era have generated intense public, media and Congressional interest. The vast majority of these past radiation studies were aimed at improving ways to diagnose and treat disease or involved statistical studies of the long-term effects on Department of Energy workers. Such studies were invariably conducted under the research and medical ethical practices and standards prevailing at the time, including peer review and informed consent. These types of studies continue to be conducted in DOE Laboratories and universities with funding from DOE programs as well as other agencies such as NIH. The DOE epidemiology program is funded and managed by the Office of Environment, Safety and Health. All current human subjects studies underway in DOE facilities are conducted in full compliance with the Federal Policy for the Protection of Human Subjects promulgated by DOE and 16 Federal agencies in June 1991. In the past, a number of experiments were designed and conducted to investigate the effects of radiation on humans or the way the human body metabolizes radioactive substances to better estimate the risks and improve the basis for radiation exposure standards for

workers and the public. Those studies supported by DOE's predecessor agencies were identified by DOE and reported to Congress in 1984 and in 1986, following Congressional requests for such information. The results of most, if not all, such studies had been reported earlier in the open literature by the original investigators. DOE is not currently supporting any experiments on individuals that involve intentional exposure to external or internal sources of radiation to understand the injurious response by normal tissues.

The DOE human genome program represents a relatively new effort which supports two of the BER objectives. First, it provides new biological and technological approaches, to the more than forty-year-old mission of evaluating effects of low doses of exposure to energy-related agents. Second, the Department is exploiting the multidisciplinary capabilities of its national laboratories to develop the biological research resources and the technologies needed to analyze the entire human genome at the molecular level in the next ten to fifteen years, and is proceeding with such analyses. Results of this work will provide the ultimate structure of the human genetic apparatus and, therefore, the basis for improved risk estimates, detailed understanding of the mechanism of mutagenesis and carcinogenesis, and the assessment of individual sensitivities to low levels of exposure to physical and chemical agents. This new molecular-level information will also significantly affect the biomedical, microbiological, and biotechnology communities by providing new resources and technologies. For instance, in FY 1995, new research will utilize recently developed genomic technologies to characterize the genomes and proteins of industrially important microorganisms. The DOE program is planned and carried out in coordination with the National Institute of Health (NIH). The primary DOE contribution to the Human Genome Project is to develop capabilities and tools to analyze the genome at the molecular level and to construct physical maps and deoxyribonucleic acid (DNA) sequences of human chromosomes. The NIH effort is oriented towards genetic mapping and characterizing disease-related genes by exploiting both human and non-human model systems. 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.

The object of DOE structural biology research is to gain understanding of the relationship between molecular structure and biological function of macromolecules such as proteins. Such understanding is critical to advancing the biotechnology missions of the Department in applications ranging from energy production from biomass to environmental remediation. 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. The Advanced Light Source at Lawrence Berkeley Laboratory and the 6-7 GeV Synchrotron Radiation Source at Argonne National Laboratory will provide unique capabilities for structural biology experiments. The DOE program envisions increased support for operation of user stations for structural biology at the facilities, but also places high priority on training a new generation of biologists in this rapidly evolving field.

A new thrust in Bioinformation Infrastructure will be developed in FY 1995. The Bioinformation Infrastructure activity will address the need to support the life sciences with information databases related to the structure and sequence of biological molecules. Database structures and tools to support advanced analyses of biological data will receive emphasis within this program.

ENVIRONMENTAL RESEARCH

The environmental sciences program conducts fundamental mechanistic research that contributes to many aspects of DOE's mission in energy and the environment. The program supports the energy and biotechnology industries through information and technology transfer programs. The environmental sciences program integrates the results of research into processes and effects in the atmospheric and marine environments and terrestrial transport, and ecosystems. Such research emphasizes the development of new scientific understanding consistent with the Energy Policy Act of 1992, and the United States Global Change Research Program.

The long-term research base established within the DOE environmental research program has enabled the Department to respond effectively to national environmental concerns. Currently, the national laboratories and the university community are conducting a series of laboratory and field studies of the processing of sulfur and nitrogen oxides 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 Earth and Environmental Sciences (CEES), 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 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 1995.

The ocean margins program addresses the fate and effects of energy-related emissions on coastal ocean ecosystems. Research has shown that the generation of fixed carbon on the continental shelf is about 30 to 70 percent of the total carbon fixed in the global ocean. This fact is important both for understanding impacts on renewable resources and for evaluating the global carbon balance. The BER ocean margins program has been restructured to better 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 goals of the program are 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.

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. A 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 Restoration and Waste Management Program through an active program in technology transfer. 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 has implications from the security of deep nuclear waste repositories to genetic engineering of microbiota with favorable survival characteristics. This research has broad implications, from refining DOE new bioremediation cleanup methods to understanding the risks of an environmental release of genetically-engineered microorganisms by industry.

Long-term ecosystem studies, carried out primarily on the DOE National Environmental Research Parks, have provided the Department with the capability to assess and project future ecosystem restoration at DOE sites. Research was started in the 1960's on chemical and water balance in watersheds. Today, DOE is at the forefront of efforts to develop sustainable natural resources essential to environmental quality in regions that are influenced by energy activities (ranging from global impacts to local and regional disturbances). Such environmental research addresses the biological responses in ecosystems to global and regional environmental changes and ecosystem responses to disturbances resulting from energy-related activities identified in the Energy Policy Act of 1992. Future plans include accelerated field investigations in groundwater systems to bring research even closer to meeting the needs of DOE sites.

A major environmental concern is climate change from emissions of greenhouse gases, especially carbon dioxide from fossil fuel burning. For over fifteen 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 Earth and Environmental Sciences of the Office of Science and Technology Policy. This national program was codified by Congress with P.L. 101-106.

Global change also figures prominently as the major environmental issue in the Energy Policy Act of 1992. DOE has launched major research initiatives to improve the predictability of global and regional climate change. To provide essential data, the Atmospheric Radiation Measurement (ARM) Program was initiated in 1989. ARM will collect cloud and radiation data in five areas of principal climatological significance over a period of approximately ten 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 1994, and the third site on the North Slope of Alaska will be completed 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 initiative 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 climate models in order 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 the feedbacks among climate processes that result in prediction uncertainties. CHAMMP is also supporting the international research effort, led by DOE, to compare and evaluate the principal climate change prediction models and 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 the economic research that will underpin the strategies to mitigate climate change and support the associated technological innovations. In response to requests by the Executive Office of the President, economics research has been expanded to an Integrated Assessment Research Program to provide direct support of integrated assessment analysis. Activities of the Carbon Dioxide Information and Analysis Center in support of scientists and policymakers will continue as well as the 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 radonuclide 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. This program has been formulated 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) 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 1995 Request

The FY 1995 request provides for:

- large scale sequencing and high resolution mapping of the human genome and construction of the Human Genome Center at LBL;

- the development of information infrastructure for structural biology and genetics, beamline upgrades and new beamlines for user facilities, and construction of Structural Biology Centers at ANL and LBL;

- development of radiolabeled molecular genetic probes for medical applications;

- continuing global change research including the development of the second Atmospheric Radiation Measurement site in the Western Pacific and continued development of the third ARM site on the North Slope of Alaska;

- maintaining basic subsurface research, including technology and information transfer to DOE sites and industry;

- maintaining broad health effects and environmental research programs addressing issues such as radon, ozone, origins of subsurface bacteria, and carbon metabolism in ocean margins;

- continuing the construction of the Environmental and Molecular Sciences Laboratory at Pacific Northwest Laboratory;

- 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;

- continuing operation of leased unmanned aerospace vehicle (UAV) platforms in support of ARM and Atmospheric Chemistry studies on ozone;

- increased research on advanced instrumentation to improve environmental program measurement capabilities, atmospheric chemistry of sulfates and ozone, and on subsurface, ocean margins and ecosystem research in support of waste remediations and carbon cycling;

- initiation of staging of the field phase of the ocean margins program;

- reorganization of National Environmental Research Parks to coordinate ecological research and restoration activities for DOE compliance responsibilities;

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

- continuation of the extensive international intercomparison of atmospheric climate models and complete quantification of uncertainties and research requirements;

- initiation of integrated assessment research on the impacts and responses to global climate change.

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.

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

LEAD TABLE

Biological and Environmental Research

Activity	FY 1993 Adjusted		FY 1994 Appropriation	FY 1994 Adjustment	FY 1995 Request
Biological and Environmental Research	$319,154		$338,060	-$3,749	$330,921
Program Direction	6,600		7,100	0	7,500
Capital Equipment	20,500		21,600	0	25,701
Construction	5,900		49,300	0	70,700
Subtotal, Biological and Environmental Research	352,154	a/	416,060	-3,749	434,822
Adjustment	-13,760	b/	------	------	------
Total	$338,394	c/d/	$416,060	-$3,749	$434,822

a/ Excludes $4,546,000 which has been transferred to the SBIR program.
b/ Amount of general reduction for use of prior year balances assigned to this program. The total will be taken at the appropriation level.
c/ Reflects program specifc general reduction of $28,000,000 and general reduction for use of prior year balances of $13,760,000.
d/ Funding of $5,170,000 in FY 1991, $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 and Molecular Sciences Laboratory.

Activity	FY 1993 Adjusted	FY 1994 Appropriation	FY 1994 Adjustment	FY 1995 Request
Summary				
Operating Expenses	$311,994	$345,160	-$3,749	$338,421
Capital Equipment	20,500	21,600	0	25,701
Construction	5,900	49,300	0	70,700
Total, Program	$338,394	$416,060	-$3,749	$434,822
Staffing Total FTEs				
Headquarters	61	63	0	62
Field	93	88	0	88
Total	154	151 e/	0	150

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

e/ Revised request.

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ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
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SUMMARY OF CHANGES
Biological and Environmental Research

FY 1994 Appropriation		$ 416,060
- Adjustment		- 3,749
FY 1994 Adjusted		$ 412,311
- Decrease analytical technology research	-	873
- Maintain environmental research efforts including ozone and nitrous oxides	+	53
- Continue construction of the Environmental and Molecular Sciences Laboratory at Pacific Northwest Lab	+	7,000
- Maintain efforts in health effects research	+	34
- Increase structural biology research and capital equipment requirements	+	5,457
- Provide for construction of structural biology centers at ANL and LBL	+	6,800
- Maintain cellular and molecular biology research	+	87
- Increase human genome research, including capital equipment requirements, and provide for continued construction of genome laboratory at LBL	+	19,154
- Increase research on molecular nuclear medicine and monoclonal antibodies	+	1,997
- Completed upgrade of the Brookhaven Linac Isotope Producer at Brookhaven National Laboratory	-	6,000
- Completed Congressionally Directed projects	-	15,400

- Support increase in global change research and capital equipment	+ 5,736
- Reduce capital equipment for base program requirements	- 1,934
- Increase for program direction needs	+ 400
FY 1995 Congressional Budget Request	$434,822

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ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Analytical Technology

This program activity provides a basic and applied research effort for the development of advanced radiation dosimetry and instrumentation technology for use in activities supported by the Biological and Environmental Research program. Environmental research, health effects studies, structural biology, genome, medical applications and global change research depend upon the continuing improvement in instrumentation and measurement technology. Fundamental research in radiation dosimetry is providing improved accuracy in the determination of human exposure to ionizing radiation and to environmental radon, which will achieve a firmer base for the evaluation of human health risk.

Research instrumentation science will provide advanced laser technology and other improved techniques to achieve selected and sensitive measurement capabilities for the quantification of radioisotopic and toxic chemical materials. Basic instrumentation research will also provide an advanced measurement capability needed within the Department's biotechnology initiative. This initiative is projected to bring about a technological revolution in vitally important areas including environmental bioremediation, individual human health risk assessment, and medical diagnosis and treatment. Through technology transfer, fundamental scientific advances from this program are moved into the private sector for commercial application with a major benefit to the U.S. economy and to U.S international competitiveness.

II. A. Summary Table: Analytical Technology

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Dosimetry Research	$ 7,244	$ 4,664	$ 4,220	- 10
Measurement Science	5,098	5,049	4,620	- 8
Total, Analytical Technology	$ 12,342	$ 9,713	$ 8,840	- 9

II. B. Major Laboratory and Facility Funding

AMES LAB	$ 425	$ 357	$ 328	- 8
ARGONNE NATIONAL LAB (EAST)	$ 690	$ 617	$ 589	- 5
BROOKHAVEN NATIONAL LAB	$ 90	$ 0	$ 0	0
ENVIRONMENTAL MEASUREMENTS LAB	$ 4,775	$ 3,600	$ 3,600	0
IDAHO NATIONAL ENGINEERING LAB	$ 115	$ 110	$ 105	- 5
INHALATION TOXICOLOGY RESEARCH INSTITUTE	$ 90	$ 85	$ 0	-100
LAWRENCE BERKELEY LAB	$ 745	$ 619	$ 419	- 32
LAWRENCE LIVERMORE NATIONAL LAB	$ 125	$ 117	$ 114	- 3
OAK RIDGE NATIONAL LAB	$ 1,940	$ 1,720	$ 1,721	0
PACIFIC NORTHWEST LAB	$ 725	$ 711	$ 565	- 21

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

Program Activity	FY 1993	FY 1994	FY 1995
Analytical Technology			
Dosimetry Research	Basic dosimetry research focused on the behavior of indoor radon and radon daughters and on modeling lung dosage. The role of airborne particulate matter in transporting radionuclides to the lung will be studied in detail. Fundamental studies of neutron and mixed field dosimetry were conducted. Quality assurance programs to maintain the accuracy of radiation measurements were conducted in collaboration with other government and private sector organizations.	Applied radiation dosimetry research will be phased out. Increased emphasis will be 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 will be 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 will be 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.
	$ 7,244	$ 4,664	$ 4,220
Measurement Science	New research on laser applications focused on techniques for combining laser vaporization and mass spectrometry to characterize large organic molecules. Application to protein and DNA sequencing were evaluated. Electron and photon tunneling microscopy techniques were explored for imaging biological materials at the cellular and subcellular level. Laser spectroscopy, particularly involving resonance ionization, was applied to very sensitive and selective measurement of complex, biologically active organic compounds. New types of ion microphobes which are under development were applied to direct imaging of target molecules on surface or directly within single biological cells.	The utilization of lasers for characterizing complex mixtures of large molecules will be developed with emphasis on techniques making use of highly reliable diode lasers. Techniques will be 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 will be 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 increased while development of procedures for the routine analysis of radionuclides will be phased down. Distribution of FY 1995 funding by major laboratory and

III. Analytical Technology (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Measurement Science (Cont'd)			facility is subject to change pending on extensive peer review.
	Funding in the amount of $103,000 has been transferred to the SBIR program.	Funding in the amount of $143,000 has been budgeted for the SBIR program.	Funding in the amount of $177,000 has been budgeted for the SBIR program.
	$ 5,098	$ 5,049	$ 4,620
Analytical Technology	$ 12,342	$ 9,713	$ 8,840

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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 can be localized or distributed regionally or worldwide. This program addresses the transport of emissions and their behavior through the atmosphere, oceans and terrestrial ecosystems at different spatial scales, and over different time sequences. This information is essential to determine exposure and influence of these materials and their byproducts on the environment. The ability of biological systems to adjust to disturbances from energy extraction, supply, and production is also an important aspect of sustaining ecosystem processes and mitigation techniques to control damage. The broad program requires focusing on selected areas of research that provide the information for developing unifying concepts that can be translated into resolving current and future energy/environmental concerns. Recent technical advances, including molecular biology have provided new fundamental understanding of living organisms as well as new experimental tools. These will be exploited to advance our understanding of marine and terrestrial ecosystems.

The Atmospheric program has two distinct components. The first is atmospheric chemistry and addresses the processes that control tropospheric and stratospheric ozone and aerosol formation; aerosols are also a continuing scientific issue in global environmental change. The second component explores transport and diffusion over complex terrain with a goal of providing research results to enhance the emergency preparedness and response systems at critical DOE sites. Research is also initiated to use radon as a tracer to quantify indoor and outdoor processes that affect the transport of energy-related emissions.

The Marine program concentrates on the process involved in the exchange of energy-related and natural materials between the continental shelf and the open ocean and understanding the factors controlling these processes. Close collaboration with other programs conducting open ocean and near-shore research makes this program pivotal in understanding dynamics of the ocean margins and their influence on both land and open ocean systems, particularly from the viewpoint of energy discharges and their assimilation into the ocean. With over 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 investigating 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 discoveries at great depths have been made on micro-organisms. Research is also conducted on bacterial transport processes, leading to bioremediation and to the assessment of the risks of genetically engineered microorganisms (GEMs) releases.

Research for Ecosystem Functioning and Response is focused in the Program for Ecosystem Research (PER) to provide knowledge of biological adjustments to environmental variations and changes, 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 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Atmospheric Science	$ 12,254	$ 14,692	$ 14,320	- 3
Marine Transport	7,351	7,248	7,155	- 1
Terrestrial Transport	17,694	18,281	18,925	+ 4
Ecosystem Functioning and Response	6,601	5,946	5,820	- 2
Total, Environmental Research	$ 43,900	$ 46,167	$ 46,220	0

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 1,285	$ 1,204	$ 980	- 19
BROOKHAVEN NATIONAL LAB	$ 4,716	$ 4,362	$ 3,746	- 14
ENVIRONMENTAL MEASUREMENTS LAB	$ 1,334	$ 1,334	$ 1,334	0
FERMI NATIONAL ACCELERATOR LAB	$ 50	$ 0	$ 0	0
IDAHO NATIONAL ENGINEERING LAB	$ 884	$ 745	$ 629	- 16
LAWRENCE BERKELEY LAB	$ 1,070	$ 1,001	$ 942	- 6
LAWRENCE LIVERMORE NATIONAL LAB	$ 1,013	$ 842	$ 901	+ 7
LOS ALAMOS NATIONAL LABORATORY	$ 1,125	$ 708	$ 703	- 1
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 74	$ 0	$ 40	>999
OAK RIDGE NATIONAL LAB	$ 3,171	$ 2,300	$ 1,596	- 31
PACIFIC NORTHWEST LAB	$ 8,908	$ 8,367	$ 8,449	+ 1
SAVANNAH RIVER ECOLOGY LAB	$ 100	$ 0	$ 0	0
SAVANNAH RIVER TECHNOLOGY CENTER	$ 200	$ 198	$ 181	- 9

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

Program Activity	FY 1993	FY 1994	FY 1995
Environmental Research			
Atmospheric Science	To address national environmental objectives, an expanded atmospheric chemistry research program (as recommended by the National Academy of Sciences) strengthened regional, continental and global dispersion models and enhance studies on ocean-atmosphere exchange processes. The program improved our understanding of the important role of emissions of dimethylsulfide from oceanic biota in atmospheric chemistry and cloud radiative properties. These natural emissions and processes must be better understood in order to determine the environmental effects of energy-related pollutants. A major field experiment conducted by the multi-laboratory consortium continues to focus on continental and oceanic fate of energy related pollutants with a tighter coupling to the interagency North American Regional Experiment (NARE) of the International Global Atmospheric Chemistry (IGAC) Project. Research on midlatitude tropospheric and stratospheric ozone has been initiated. Research included ozone trend analysis and heterogeneous chemistry.	The atmospheric chemistry research program will continue to strengthen 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 emissions of dimethylsulfide from oceanic biota in atmospheric chemistry and cloud radiative properties. The primary data set will be 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. Field experiments will be continued. The focus will remain the continental and oceanic fate of energy related pollutants. The university grants program in atmospheric chemistry will issue another solicitation. The global tropospheric chemistry model will be implemented on a massively parallel computer system and will be tested with IGAC field results. Enhance reanalysis of stratospheric ozone data will be enhanced and conduct experimental studies to quality-assure ground based and airborne instruments probing stratospheric ozone-related chemical species and processes. Continue reanalysis of surface UV-B data.	The atmospheric chemistry research program will continue to strengthen 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. Field experiments will be continued, moving from the Atlantic region to the Pacific. The focus will remain the continental and oceanic fate of energy related pollutants. The university grants program in atmospheric chemistry will continue. The global tropospheric chemistry model, implemented on a massively parallel computer system, will continue to be tested with IGAC field results. 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 surface UV-B data and initiate UV-B measurement technology development will continue.
	Data from all researchers of the Kuwait oil fires plume was utilized in model verification and validation studies.	No activity.	No activity.

III. Environmental Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Atmospheric Science (Cont'd)	The second phase of the Atmospheric Complex Terrain (ASCOT) field program around the Rocky Flats Plant was coordinated with ongoing studies of the Denver "brown cloud". Emphasis was placed on the influence of larger scale meteorological flows on local circulations. The use of tracers and remote sensing instrumentation validated 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 data obtained from the FY 1993 field experiments. The data from tracers and remote sensing instrumentation will be 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.
	Funding for the research aircraft greatly enhanced field programs in environmental processes and climate research particularly in support of the IGAC experiments.	A field program in environmental processes and climate research will be conducted using the research aircraft. Activities will include support for ARM and IGAC.	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.
	$ 12,254	$ 14,692	$ 14,320
Marine Transport	Process research in the cycling of carbon began to establish the key measurement parameters and the ideal sampling locations to test cross-shelf exchange processes. Newly developed instruments and analytical methods developed in FY 1992 were assessed and incorporated into plans for the new field program. Necessary new projects enabling a more balanced effort and comprehensive analysis were planned and/or initiated. Molecular biological techniques applied to marine systems promise to help reveal the mechanisms involved in the organismic processing of carbon compounds in the ocean and the genetic and environmental control of many of the reactions involved in the shelf exchange processes in carbon cycling. A subprogram in the application of molecular techniques for analyzing and quantifying the principal biological reactions and the factors	This year will initiate 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 will be conducted and will be used to locate the site of the FY 1995 field year program. New analytical methods and instruments will have been evaluated and design changes initiated. Intra-program planning and inter-institutional planning will be formulated and a plan established for conducting the field year. Logistical staging and coordination of program projects will be initiated. Notice for additional complementary projects will be promulgated and finalized. Application of molecular biological	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. New complementary projects will be evaluated and introduced into the program. Intra-program 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

III. Environmental Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Marine Transport (Cont'd)	controlling these reactions were initiated. The objective is to provide a more discriminating understanding of the set of biological reactions important to the sequestration, transformation, exchanges, and ultimate disposition of carbon dioxide on continental shelves.	techniques to biological processes will be expanded.	extend into FY 1996.
	$ 7,351	$ 7,248	$ 7,155
Terrestrial Transport	Conducted review of environmental radon research. Began to shift research emphasis from identifying the environmental factors that affect radon availability and transport in soil/rock systems to identifying the relationships between environmental variables and radon entry into homes. Expanded experimental studies on the subsurface structures that have been equipped for continuous monitoring of environmental variables (temperature, pressure, moisture) and indoor radon concentrations. These experimental structures have been emplaced in the California Coast Range (near Lawrence Berkeley Laboratory) and in the Colorado Front Range (near Colorado State University). Began to test protocols and models that correlate environmental data with indoor monitoring data in Minnesota and New York.	Complete 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. Begin developing the methodology for transferring this protocol to industry and state/local agencies for its implementation on a "zip code" size regional scale. Initiate 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. Complete maps of geographic areas with high radon fluxes from soils to the atmosphere. Utilize the radon flux information to address future concerns involving the movement of gases or volatile chemicals in soils and their release into the atmosphere. Examine potential of using radon as a tracer for examining atmospheric transport processes. Expand role of the U.S. Geological Survey in identifying areas of high radon risk potential.	Experimental studies with subsurface structures 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 will be initiated. Testing and modification of the statistical protocol to identify areas of high radon risk potential will be completed and transferred to industry and state/local agencies for its implementation. Measurements of short-lived thoron (radon-220) will 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.

III. Environmental Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Terrestrial Transport (Cont'd)	Continued analysis of comparative information base in deep microbiology at DOE Savannah River, Idaho, and Hanford sites. Completed Geochemical Microbial Hydrological Experiment (GEMHEX) sampling and began analysis. Maintained research to exploit new molecular biological techniques to evaluate the deep microbiology culture collection. Defined the fundamental ecological principles that control the distribution, abundance, and diversity of deep microbial communities, and test hypotheses in microbial ecology at the intermediate and field scale. Conducted exploratory research on the survival of possibly ancient subsurface microbial communities, cooperatively with Texaco Oil Company. Enhanced basic research on microbiological-geochemical interactions, with emphasis on the subsurface environmental variables that control deep microbial populations in ground water. Accelerated technology and information transfer of basic research results to industry and DOE sites, with immediate benefit to bioremediation at DOE sites. Accelerated research in genesis of deep microbiota, including their adaptability and survival over tens of thousands of years or millennia, using integrated hydrogeological, geochemical and molecular biology research methods. Prepared research plan and public notice.	Continue analyses of comparative information base in deep microbiology with increased emphasis on spatial and vertical microbial heterogeneity. Test new hypotheses on microbial presence and distribution at the millimeter to meter scale using whole core segments and controlled intermediate scale flow cell research as part of GEMHEX series. Continue initial exploratory research on in situ microbial "genesis" and survival of ancient microbial communities using 2500 meter deep Texaco Oil Company and other samples. Begin research on fluid inclusions. Increase industry and university outreach in scientific disciplines related to deep microbiology through Pacific Northwest Laboratory Environmental Science Research Center (ESRC). Accelerate intermediate scale simulations related to microbial origins. Deep microbiology research has potential long term benefits to biotechnology, bioremediation, and understanding the mechanisms of natural gas formation. Accelerate transfer of subsurface microbial culture collection isolates to industry. Continue research on the analysis of novel microbial genomes, including isolates of anaerobic thermophiles and novel metal-reducing bacteria. Compare genomes of subsurface and surface bacteria to determine unique sequences.	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. Data from whole core segments and controlled flow cell studies of the GEMHEX will transition to natural field studies. Research on use of soil-blocks will be enhanced. 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. Industry and university outreach in scientific disciplines related to deep microbiology will continue through the Pacific Northwest Laboratory Environmental Science Research Center (ESRC), particularly by technology transfer workshops at DOE sites. Additional industrial partners will be sought. Deep microbial research has potential long term benefits to biotechnology, bioremediation, and understanding the presence of natural gas or petroleum resources.

III. Environmental Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Terrestrial Transport (Cont'd)	Extended results of laboratory experiments using state-of-the-art chemical and biological molecular methods aimed at quantifying the mechanisms that are important to stabilization of organic-radionuclide complexes.	Complete research on code development and field validation of reactive transport models such as HYDROGEOCHEM and integrate new predictive capabilities into controlled intermediate scale simulations of the mobility and stability of organic-radionuclide complexes and simulate transport of complexes using prototype flow cells. Utilize 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 sites nationally, and to industry. Prepare multi-agency plan for field release of genetically-engineered microorganisms (GEMS) with ORNL/ University of Tennessee. Begin field-scale experiments on bacterial transport in support of GEMS release. Publish synthesis of international research based on Second International Meeting on Deep Microbiology.	Research that focuses on the mapping and sequencing of novel microbial genomes will be maintained. Priority for support will be given to micro-organisms that: (1) relate to environmental, energy, and other missions of DOE; (2) have evolutionary significance; and (3) have potential industrial application. Potential micro-organisms of interest include anaerobic hyperthermophiles, metal-reducing bacteria, and bioremediative bacteria. This activity is part of an interoffice initiative to exploit the rapidly developing technologies in the Human Genome Program.
	Enhanced research on subsurface physical, chemical and microbial heterogeneity at intermediate and full scale collaboratively among PNL, LBL and ORNL.	Modify future directions of PNL Environmental Science Research Center (ESRC), as required, to increase focus on natural heterogeneity, a high research priority. Complete three year basic research projects which are mature candidates for DOE applied research funding including long residence times for complexed radionuclides, field manipulation of natural processes, and general research on microbial processes. Maintain PNL Subsurface Environmental Research Facility and support design of flow	The integration of reactive transport models into co-contaminants chemistry, heterogeneity and bacterial transport research will be completed. A goal is to integrate predictive modeling into experimental research and reduce costs. Emphasis will be placed on using state-of-the-art physical, chemical, and molecular biological methods to investigate the microbial factors that control mobility and stability of organic-radionuclide complexes. Geosciences research will be accelerated to support field

III. Environmental Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Terrestrial Transport (Cont'd)		cells that simulate deep subsurface temperatures and pressures. Increase technology transfer program. Broaden university participation in ESRC by national solicitation. Increase ESRC research on physical, chemical, and microbial heterogeneity using intact cores, outcrop blocks, and field methods. Develop biotechnology CRADA's.	microbiology studies.
	Completed field injection experiments at colloid research sites and reduce research in organic colloids. Increased research on the genesis and deposition of inorganic colloids. Terminated mature research on colloid-contaminant transport to enhance intermediate scale flow cell laboratory investigations of the geochemical and hydrological mechanisms that control biocolloids, including bacterial transport and deposition.	Reduce 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. Accelerate research at the field scale, on the mechanisms that control bacterial transport and deposition in porous media in support of bioremediation.	Research on the origins of inorganic colloids and processes that control the formation and deposition of natural colloids in groundwater will be restructured following a peer review. Research on the mechanisms that control bacterial transport and deposition in porous media will be maintained.
	Prepared initial plan for field research experiment in bacterial transport of benefit to research in microbial origins and bioremediation.	Complete field characterization plan for bacterial transport and GEMS release sites. Begin site selection process.	Planned field releases of genetically-engineered micro-organisms (GEMS) will be deferred.
	No activity.	No activity.	Research at PNL Environmental Science Research Center (ESRC) on natural physical, chemical and microbial heterogeneity using intact cores and outcrop blocks will be maintained and plans to extend research to humid eastern coastal plain sediments will be extended. Design of low cost flow cells at the University of Notre Dame will be pursued. 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.

III. Environmental Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Terrestrial Transport (Cont'd)	$ 17,694	$ 18,281	$ 18,925
Ecosystem Functioning and Response	Experimental research was started within the Program for Ecosystem Research (PER) to detect biological responses to environmental variations and changes at the physiological level, but within the context of the ecosystem (ecosystem adjustment). Research began on plants and soil microorganism responses to global change (i.e., atmospheric carbon dioxide (CO2) and climate) forcing functions that are expected to effect biological adjustments. These experiments will provide the basis for detecting the mechanisms that control the responses.	Experimental research will continue to detect biological responses to environmental variations and changes at the physiological level, but within the context of the ecosystem (ecosystem adjustment). Research will continue that focuses on plant and soil microorganism responses to environmental forcing functions that are expected to effect biological adjustments (physiological) during energy-related environmental changes in the atmosphere and biosphere, specifically changes in temperature, air contamination with combustion products, water and nutrient availability, and soil disturbances. These experiments will provide the basis for detecting the mechanisms that control the responses.	The Program for Ecosystem Research (PER) will continue to explore: (1) how organisms within terrestrial ecosystems respond to atmospheric and climate changes, such as temperature changes, increases in atmospheric CO2, contaminants, and precipitation changes; (2) how the responses are controlled; (3) how the responses and their controls can be detected and measured; and (4) how the organismic responses can be integrated across organizational levels to project holistic ecosystem adjustments. PER research will primarily quantify causes and effects of physiological responses to environmental forcing functions and to their appropriate control mechanisms.
	Data analyses from the National Environmental Research Parks interlinked with other networks of ecological research established theoretical bases for natural resource management on and off the DOE sites. This research also provides strategic linkages between environmental problems at the national and regional levels, and the ecological processes needed to insert stability into management decisions. ParkNet provides the cross-site data synthesis needed to develop and validate theoretical understanding that is necessary to make correct strategic management decisions for energy development in disturbed ecological systems.	The DOE National Environmental Research Parks will be organized to support site specific activities at DOE National Laboratories.	The DOE National Environmental Research Parks Program will be reorganized to provide an information network that will assist in the resolution of compliance and restoration activities across the laboratory sites. The reorganized program will provide the most cost-effective applications of biotechnologies, ecotechnologies, and engineering technologies to the mitigation and resolution of environmental actions.

III. Environmental Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Ecosystem Functioning and Response (Cont'd)	Funding in the amount of $589,000 has been transferred to the SBIR program.	Funding in the amount of $682,000 has been budgeted for the SBIR program.	Funding in the amount of $924,000 has been budgeted for the SBIR program.
	$ 6,601	$ 5,946	$ 5,820
Environmental Research	$ 43,900	$ 46,167	$ 46,220

DEPARTMENT OF ENERGY
FY 1995 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 program is to conduct an interdisciplinary program of high-quality, basic and applied 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 program is to improve our abilities to estimate the type and magnitude of human health risks that result from low-level exposures to energy-related agents such as radiation and chemicals.

Little information is available about the health effects associated with exposure to radon at the levels commonly encountered by the public. Current estimates of the risk to the public's health are based primarily on studies of underground miners. DOE is carrying out a comprehensive research program aimed at improving the accuracy of the estimates by studying the important differences between mining and residential exposures, and by research to understand the cellular and molecular mechanisms involved in radon-induced lung cancer.

Remediation (cleanup) of chemical and radiation waste sites is a major goal of the Department of Energy. There is a need for improved occupational monitoring and health surveillance procedures that can better detect exposure, estimate risks, and predict effects of low-level exposure. Current models for predicting exposure and risks are based on empirical data and can only be generalized to the total population. However, factors affecting susceptibility to exposure or disease vary from one individual to another and may significantly alter the impact of low-level exposures.

In the last several years, there has been an impressive increase in our understanding of the fundamental mechanisms of cancer induction and tumor cell biology. This has been facilitated by recent advances in molecular biology that allow us to study cancer at the level of individual genes. This increased understanding at the molecular and cellular level will help to improve risk estimates of other long-term health effects (e.g., lung disease, immune system impairment, etc.). In addition, several new or potential technological developments (partly stemming from the Human Genome program) promise to revolutionize our ability to estimate individual susceptibility to exposure.

The budget requested for FY 1995 is critical to the development of new molecular-based tools for health surveillance and biological dosimetry as well as for understanding DNA repair and genetic susceptibility. Human cell culture models need further development to facilitate the study of cancer in the laboratory and to allow separation of the various aspects of cancer initiation and progression. Additional assays with increased sensitivity are needed for detecting the activities of enzymes involved in metabolizing chemicals into cancer causing molecules and enzymes for repairing damaged DNA.

II. A. Summary Table: Health Effects

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Biological Research	$ 32,551	$ 32,945	$ 32,495	- 1
Radiological and Chemical Physics	7,141	4,906	5,390	+ 10
Total, Health Effects	$ 39,692	$ 37,851	$ 37,885	0

II. B. Major Laboratory and Facility Funding

	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
ARGONNE NATIONAL LAB (EAST)	$ 5,225	$ 4,171	$ 4,566	+ 9
BROOKHAVEN NATIONAL LAB	$ 630	$ 425	$ 365	- 14
INHALATION TOXICOLOGY RESEARCH INSTITUTE	$ 7,095	$ 6,705	$ 6,510	- 3
RADIOBIOLOGY AND ENVIRONMENTAL HEALTH LAB	$ 780	$ 1,290	$ 1,317	+ 2
LAWRENCE BERKELEY LAB	$ 2,662	$ 2,750	$ 1,959	- 29
LAWRENCE LIVERMORE NATIONAL LAB	$ 820	$ 915	$ 966	+ 6
LOS ALAMOS NATIONAL LABORATORY	$ 1,145	$ 1,255	$ 1,440	+ 15
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 1,246	$ 1,210	$ 1,019	- 16
OAK RIDGE NATIONAL LAB	$ 6,179	$ 4,796	$ 4,481	- 7
PACIFIC NORTHWEST LAB	$ 4,424	$ 3,434	$ 3,717	+ 8

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

Program Activity	FY 1993	FY 1994	FY 1995
Health Effects			
Biological Research	Continued to consolidate and refocus animal research with the goal of developing the mechanistic information needed to improve our ability to understand and predict health effects associated with exposure to low levels of radiation and/or energy-related chemicals. Maintained funding and oversight of the radiation biology archive and data analysis of dose-response, life-span studies. Initiated new carcinogenesis experiments, using the much studied mouse as a model system for experiments aimed at understanding genetic mechanisms that are involved in tumorigenesis. Completed experiments on neutron tumorigenesis and experiments to estimate the relative biological effectiveness of neutrons for producing cataracts. Initiated new experiments aimed at better understanding the genetic and physiological factors that determine individual susceptibility to radiation and/or chemical carcinogens. Developed	Continuing research will focus on reducing the uncertainty in current risk estimation by increasing understanding of the fundamental mechanisms of interactions between cells and radiation. Sustain funding and oversight of the radiation biology archive and analysis of data from the dose-response life-span studies. Develop and employ human cell culture models for examining the effects of low levels of chemicals and radiation. Expose individual human cells to precise and reproducible doses and examine the influence of dose, dose rate, and radiation quality on cell viability, chromosomal aberrations, DNA repair, and mutation induction. Continue studies that compare cellular and molecular effects in rodents exposed in the laboratory with observed effects in humans (e.g., uranium miners lung cancer). Continue efforts to quantitate individual differences in susceptibility to exogenous energy-related agents and identify	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. Sustain funding and oversight of the radiation biology archive and continue to enter data from completed multispecies lifetime carcinogenesis studies. 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. Expand the use of genetically altered mice to study the roles and effects of specific genes in disease development,

III. Health Effects (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Biological Research (Cont'd)	animal models to study a broader range of radiation tumors and to investigate (in repair deficient animals) what happens to radiation damage in the absence of specific modifying factors such as DNA repair enzymes or stress response proteins. Use the results from cell culture and animal studies to characterize the genetic changes in equivalent human neoplasms. Facilitated bridging the gaps between animal and human investigations. Initiated studies to identify markers that foretell the development of tumors to allow rapid and precise detection of early events leading to cancer.	early molecular markers of exposure and disease. Complete studies, in mice, to examine the risk of heritable mutations from radiation exposures. Expand research aimed at understanding the molecular and cellular mechanisms involved in radon-induced lung cancer and to develop the related knowledge necessary to improve estimates of the health risk associated with indoor radon exposure.	especially cancer. Increase focus on new molecular-based tools for health surveillance and biological dosimetry. Complete studies aimed at improving estimates of radiation exposure from radon to reduce uncertainties in estimating risk and to aid in extrapolation of adverse health effects seen in uranium miners and in exposed animals to human populations exposed indoors. 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. Develop probes for the early detection of radon-induced lung cancer in former uranium miners.
	$ 32,551	$ 32,945	$ 32,495
Radiological and Chemical Physics	Basic research on the fundamental physical processes involved in the interaction of ionizing radiation with biological tissue focused on developing an understanding of the radiobiological effects of low doses and dose rates for the purpose of providing a sound scientific basis to relate initial damage to an ultimate health effect. These studies include energy deposition measurement, energy transfer processes in biological media and interactions that produce DNA damage. The role of structural and conformational changes began to be explored. Both experimental and theoretical techniques applied to identify the nature of radiation specific molecular lesions. The effects of chemical agents at the molecular level also explored.	Multi-disciplinary research to elucidate and understand in detail initial physical and chemical interactions between biomolecules and ionizing radiation and chemicals will proceed at a reduced level. This research will include measurement and calculation of initial physical events such as ionizations and excitations. Spatial and temporal distribution of these species in condensed phase will be investigated. These physical events will then be correlated with ensuing chemical events such as radical species. Information obtained from this research will be 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	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

III. Health Effects (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Radiological and Chemical Physics (Cont'd)	Research included characterization of molecular level damage caused by different types of radiation (molecular signatures), and identification of critical physical mechanisms underlying cancer induction.	of radiation quality will be studied. Computational and theoretical studies will continue on the conformational and structural changes in biomolecules produced by ionizing radiation. A correlation between these changes and ultimate biological effects will be investigated.	determine the distribution of chemical species in the natural environment of the cell.
	Fundamental energy transfer mechanisms and pathways in model liquids, which are biologically relevant, were investigated. The information obtained will be combined with our understanding gained from physical interactions of ionizing radiation to explore the scientific basis for production of radiation effects. These basic studies could also provide a framework for determining the role of structure of biomolecules in biological activity.	Fundamental mechanisms involved in energy transfer processes in biomolecules will be 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 will be 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.
	Funding in the amount of $576,000 has been transferred to the SBIR program.	Funding in the amount of $559,000 has been budgeted for the SBIR program.	Funding in the amount of $758,000 has been budgeted for the SBIR program.
	$ 7,141	$ 4,906	$ 5,390
Health Effects	$ 39,692	$ 37,851	$ 37,885

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: General Life Sciences

General Life Sciences research has two major goals: to develop fundamental biological information and technologies that can be applied in studies of energy-related health effects, and to develop and utilize unique DOE resources in support of Departmental and national goals in the area of biotechnology and biomedical science. This research program contributes to the base of fundamental biological knowledge that is required for the effective study and interpretation of energy-related health effects. Thus, General Life Sciences research is closely integrated with the health effects research program. The program supports molecular and cellular biology research to identify early indicators of biological damage, develop new techniques and experimental systems for assessing biological impact, and provide knowledge that becomes useful in the estimation of human health risk from radiation or chemical exposure. A major emphasis of the molecular and cellular research is the identification and characterization of DNA repair systems and their role in determining the response of individuals at the cellular and molecular levels to energy-related toxicants. Novel repair genes are being identified and examined in model systems to determine the mechanisms of DNA repair. Molecular and cellular research is also developing and utilizing new technologies for identifying and characterizing toxicant-induced chromosomal alterations. These technologies are being transferred to both research and medical communities for application.

In addition to fundamental biological research in the areas of molecular and cellular biology in support of health effects studies, the program encompasses the development and application of new technologies for mapping and sequencing the human genome and also develops and supports unique DOE national user facilities for the determination of biological structure. Current and developing user facilities at DOE laboratories are increasingly important in the national effort to elucidate the structure of biological macromolecules and to relate molecular structure to function. This program also studies how perturbed structures can alter function, a key step in the redesign of proteins for use in biotechnology and bioprocessing industries. DOE's human genome and structural biology research are important components of the effort to maintain national leadership in the rapidly growing field of biotechnology. Thus, this program is a primary focus of research in the generic technologies which underlie the development of biotechnology for Departmental and national goals. A new effort involving the microbial genome conducts fundamental research, using genome-related technology, to efficiently exploit the information encoded in the genomes of industrially important microorganisms.

Funding is requested to support the effective utilization of current and developing structural biology facilities located at DOE laboratories. These funds will increase operating staff and technical support at existing large facilities, i.e., the National Synchrotron Light Source, High Flux Beam Reactor, and Stanford Synchrotron Radiation Laboratory, which are widely used by the outside community. In addition, these funds will serve to create and staff structural biology user facilities at the new 1-2 GeV Advanced Light Source and the new 6-7 GeV Synchrotron Radiation Source. New detectors and other instrumentation are being developed to rapidly acquire data at the new facilities.

A new thrust will be developed for structural biology and genetics. All areas of modern biology, but particularly genomics and structural biology, are generating rapidly expanding amounts of data which is stored in several large databases. The support of data accumulation, storage, integration and retrieval is essential for future research progress in biology and medicine. Early emphasis will be on support and integration of key databases to provide powerful new research tools for the biological community.

II. A. Summary Table: General Life Sciences

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Structural Biology	$ 18,626	$ 16,958	$ 19,355	+ 14
Molecular Biology	15,442	12,876	13,080	+ 2
Cellular Biology	7,843	8,282	8,165	- 1
Genome	60,809	65,036	70,045	+ 8
Total, General Life Sciences	$ 102,720	$ 103,152	$ 110,645	+ 7

II. B. Major Laboratory and Facility Funding

AMES LAB	$ 291	$ 196	$ 269	+ 37
ARGONNE NATIONAL LAB (EAST)	$ 5,720	$ 5,428	$ 5,114	- 6
BROOKHAVEN NATIONAL LAB	$ 9,222	$ 8,293	$ 8,822	+ 6
RADIOBIOLOGY AND ENVIRONMENTAL HEALTH LAB	$ 2,186	$ 1,498	$ 1,574	+ 5
LAWRENCE BERKELEY LAB	$ 12,884	$ 11,804	$ 12,515	+ 6
LAWRENCE LIVERMORE NATIONAL LAB	$ 12,518	$ 11,079	$ 11,581	+ 5
LOS ALAMOS NATIONAL LABORATORY	$ 16,154	$ 12,630	$ 13,959	+ 11
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 1,403	$ 1,277	$ 1,307	+ 2
OAK RIDGE NATIONAL LAB	$ 10,011	$ 7,592	$ 8,415	+ 11
PACIFIC NORTHWEST LAB	$ 862	$ 833	$ 1,203	+ 44
STANFORD SYNCHROTRON RADIATION LAB	$ 1,250	$ 920	$ 1,397	+ 52

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

Program Activity	FY 1993	FY 1994	FY 1995
General Life Sciences			
Structural Biology	Increased support for current and developing structural biology user facilities. First priority is to augment user support resources at existing facilities (NSLS, HFBR, SSRL) which are widely used by the outside community. This will increase the rate of structure determination and allow development of advanced diffraction techniques which promise to significantly advance the field. The 1-2 GeV Synchrotron Radiation Source at LBL is scheduled for commissioning in FY 1993. Funding was provided to increase operating support for staff to participate in improving capability of user facilities, including microscope design and other technical support.	Continue to support user stations for structural biology at major DOE facilities such as NSLS, SSRL, and HFBR. Provide some funds for staffing user-stations for x-ray microscopy at the Advanced 1-2 GeV at LBL; these microscopes will come on line at the end of FY 1994. Support initial staffing for user service groups for x-ray crystallography and spectroscopy at the 1-2 GeV and x-ray crystallography at the 6-7 GeV at ANL. Continue research on new detector concepts to enable full utilization of new generation of light sources.	Continue to support operation of beamlines for structural biology at DOE national facilities. Begin operation of new beamline for spectroscopy at the Advanced Light Source (1-2 GeV) at LBL and new multipurpose beamline at SSRL, both of which should be ready for initial testing during FY 1995. Continue research into instrumentation and techniques for utilization of the 6-7 GeV light source at ANL. Support staffing of a Macromolecular Structural Database to maintain it fully current with flow of submitted structures.
	Expanded structural biology research on important macromolecules. Continued a focus on fine structure of chromatin; and structures of membranes where DOE researchers have been among the world's leaders. Interdisciplinary centers which combine structural biology, chemistry, computational sciences, and molecular biology became a focus of cutting edge research in biotechnology. DOE laboratories offer a particularly strong opportunity to develop such interdisciplinary centers. These centers will lead to development of new classes of novel biomolecular structures with tailor-made functions and a major potential source of technology transfer.	Maintain structural biology research on important macromolecules. Continue to focus on fine structure of chromatin and expand study of structures of membranes. Develop 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 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. Support the Protein Databank at BNL, an international resource containing three dimensional coordinates of biological macromolecules.	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). Expand new studies employing computational approaches to predict protein structures.

III. General Life Sciences (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Structural Biology (Cont'd)	No activity.	No activity.	Create a basic bioinformation infrastructure that will capture the rapidly increasing amounts of genetic and structural biology data in robust databases. Implement required improvements in databases that store and analyze structural biology data.
	$ 18,626	$ 16,958	$ 19,355
Molecular Biology	Continued to clone and characterize DNA repair genes. The repair proteins produced from these cloned genes will also be used to develop cell-free assay systems to study the relationship between DNA repair and chromosome structure. Examined the consequences of defective DNA repair mechanisms in whole organisms using mouse strains with deficiencies for DNA repair. Direct in vivo/in vitro comparisons of radiation-induced mutations were made between these mice and cell lines containing repair defects to compare the response of specific tissues to radiation exposure. Began to determine the types and numbers of mutations observed in genes related to cancer. Validated models for detecting exposure and develop a basis for using data from cell cultures and animals for predicting human health risks from environmental and occupational exposures.	Continue efforts to map, clone, and characterize human DNA repair genes and other genes involved in response to radiation and chemical insult. Identify 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. Further develop 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. Use 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. Use the proteins identified in these studies to develop markers for exposure and increased sensitivity to DNA damaging agents. Determine whether elevated expression of certain repair genes can protect cells against radiation injury. Begin examining the degree of intragenomic heterogeneity of repair in humans and determine how this is mediated by specific genes. Develop new research using technology developed in the genome program, to efficiently characterize the fundamental biology	Utilize isolated human and animal genes to develop increased understanding of the role of DNA repair in protecting organisms from the effects of low levels of exposure to toxicants. Continue efforts to characterize the mechanisms of regulation and action of DNA repair genes to determine the association between deficiencies in DNA repair and increased health risk. Use cell culture and animal models for normal, enhanced, and reduced or deficient DNA repair to determine the role of repair genes in decreased or increased sensitivity to radiation or chemicals. Continue efforts using mice to characterize the role of DNA repair genes in development and disease susceptibility. Continue the development of chromosome painting probes and methodologies as a national resource for use in the detection and characterization of chromosomal damage. Continue to study the genomes and specific proteins of industrially important microorganisms and to characterize fundamental aspects of their biology that would find use in industrial applications.

III. General Life Sciences (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Molecular Biology (Cont'd)		and genetics of industrially important microorganisms.	
	Continued research aimed at developing efficient, automated scoring of chromosome aberrations (cell changes resulting from damage by radiation or chemicals). Sustained research to elucidate chromosomal rearrangements associated with specific tumor types and develop diagnostic markers characteristic of such rearrangements (e.g., specific chromosomal translocations associated with radiogenic leukemia). Began to develop molecular markers to identify individuals who are particularly sensitive to effects of radiation or chemicals to better protect them from occupational exposure.	Continue 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. Utilize new technologies to develop assays for detecting chromosomal changes associated with specific genes (e.g., cancer-causing genes or tumor suppressor genes).	Begin to characterize the genes and gene products responsible for exposure-induced genetic instability and determine their role(s)in disease development, especially cancer.
	$ 15,442	$ 12,876	$ 13,080
Cellular Biology	Initiated development of cell and organ culture systems with human cells in order to decrease reliance on animal models, to allow the compression of the carcinogenic process into a practical time frame for experimentation, and to simplify the study of cancer development or DNA repair. Use of human organ culture systems to study radiation induced transformation provided an important tool for understanding development and progression of cancer in humans. Accelerated application of technologies from Human Genome Program (HGP) to investigations of cellular structures and functions that could form the basis for improved detection and quantitation of human exposures.	Continue study of tissue and organ-specific cytogenetic responses. Develop 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.	Continue the development and use of new cytogenetic technologies, e.g., chromosome painting, to detect and characterize chromosome damage. 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.

III. General Life Sciences (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Cellular Biology (Cont'd)	$ 7,843	$ 8,282	$ 8,165
Genome	Accelerated mapping and sequencing genetically active and other selected regions of the human genome. Finished constructing physical maps of chromosomally aligned DNA clones for several human chromosomes. Initiated physical maps of additional chromosomes. Improved data analysis algorithms and data retrieval software for mapping and sequencing data and support development of a large public database for chromosome mapping information. Improved automated and robotized manipulations required to greatly increase the efficiency and reduce the cost of DNA cloning, mapping and sequencing. Encouraged national laboratory-private sector interactions and technology transfer. Expanded efforts to address ethical, legal, and social issues and emphasize educational activities.	Maintain FY 1993 level of mapping and sequencing of genetically active and other selected regions of the genome, in order to provide new mapping landmarks. Finish constructing physical maps of the chromosomally aligned DNA clones of several chromosomes. Expand physical mapping activities. Improve data analysis algorithms and data retrieval software for mapping and sequencing data. Support improvement of the Human Genome Database for chromosome mapping information with facile interface to sequence and other biological databases. Improve automated and robotized manipulations required to increase the efficiency and reduce the cost of DNA cloning, mapping, and sequencing. Encourage national laboratory-private sector interactions and technology transfer. Continue 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.
	Funding in the amount of $1,509,000 has been transferred to the SBIR program.	Funding in the amount of $1,529,000 has been budgeted for the SBIR program.	Funding in the amount of $2,213,000 has been budgeted for the SBIR program.
	$ 60,809	$ 65,036	$ 70,045
General Life Sciences	$ 102,720	$ 103,152	$ 110,645

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Medical Applications

Medical Applications research was initiated under the Atomic Energy Act of 1946, with a prime objective to promote the use of radioactive material and radiation for diagnosis and treatment of human diseases. This program has generated important and significant scientific knowledge and technological breakthrough in the field of clinical medicine, and has established one of the vital components of today's medical health care practice. This program is responsible for establishment of the new world-wide medical speciality called nuclear medicine. Research supported under this program is essential for continued development of major new advances in diagnostic and therapeutic technology, which in turn will provide great benefit to the advancement of clinical medicine. Efforts to develop new biotechnologies for diagnosis and therapy will be continued. Radioisotopes with improved purity, yield and high specific activity will be developed for radiopharmaceutical evaluations including radiotracer, and radioimmunotherapy research. Molecular nuclear medicine research will focus on the development of new probes to study the molecular and cellular mechanisms related to cancer, and to investigate brain and myocardial receptors underlying normal physiological processes and pathological states. Preclinical and clinical feasibility studies will continue with focus on radiolabeled monoclonal antibodies and transverse coronary angiography.

Research emphasis will continue to be placed on the applications of medical imaging technology for the study of disease states at the molecular level. Development of high resolution, high sensitivity, and high speed positron emission tomography systems will be vigorously pursued. Also, a synchrotron-based x-ray computed tomography facility to image tumors and atherosclerotic plaques in the major arteries of the heart and neck will be developed. Research programs will continue to support projects related to exploration of new radiation therapy modalities with special emphasis on boron neutron capture therapy. Advances made in other fields such as molecular biology and structural biology will be incorporated into medical applications research programs to enhance design, synthesis, and application of new radiolabeled compounds for neurotransmittal, neuroreceptor and disease associated target studies.

The Department of Energy's program in biomedical technology research focuses on development of advanced nuclear medicine technology and initial exploration of its medical feasibility. The information generated from this program is continuing to be transferred to the private sector for commercialization and is used by the National Institutes of Health for clinical efficacy studies when appropriate.

II. A. Summary Table: Medical Applications

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Radioisotope Development	$ 2,205	$ 2,895	$ 2,353	- 19
Radiopharmaceuticals	13,450	13,613	13,800	+ 1
Instrumentation	5,790	3,683	4,544	+ 23
Clinical Feasibility	3,445	3,255	3,678	+ 13
Boron Neutron Capture Therapy	6,880	8,992	9,002	0
Molecular Nuclear Medicine	1,770	2,860	4,418	+ 54
Power Burst Facility	2,700	1,600	1,100	- 31
Congressionally Directed Projects	0	15,400	0	-100
Total, Medical Applications	$ 36,240	$ 52,298	$ 38,895	- 26

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 250	$ 0	$ 0	0
BROOKHAVEN NATIONAL LAB	$ 8,822	$ 8,836	$ 8,732	- 1
IDAHO NATIONAL ENGINEERING LAB	$ 3,700	$ 2,785	$ 1,333	- 52
LAWRENCE BERKELEY LAB	$ 2,668	$ 2,565	$ 2,330	- 9
LOS ALAMOS NATIONAL LABORATORY	$ 1,530	$ 722	$ 815	+ 13
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 320	$ 306	$ 311	+ 2
OAK RIDGE NATIONAL LAB	$ 1,195	$ 1,145	$ 1,132	- 1

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

Program Activity	FY 1993	FY 1994	FY 1995
Medical Applications			
Radioisotope Development	Continued development of chelators, using automation and other methods to improve the efficiency with which radionuclides of medical interest are separated from other material. Initiated preclinical and clinical studies of new radionuclides for which generators have been developed.	Continue 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 will continue to increase yield and purity. Rhenium-188 and Indium-191m generators will be provided to collaborators for evaluations. Project definition phase studies for a National Biomedical Tracer Facility will be 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.
	$ 2,205	$ 2,895	$ 2,353
Radiopharmaceuticals	Developed new agents for attaching antibodies to radionuclides. These agents first attach to the antibody, then the combination is attached to a radionuclide. Immunoconjugates formed from these new agents were labeled with various radiometals and evaluated in vitro and in mice bearing implanted human tumors. Began a dose escalation trial of tin-117m in humans and begin development of separation chemistry for a higher specific activity tin-117m necessary to deliver therapeutic amounts of radioactivity. Copper-67, porphyrin-linked antibodies will be used in therapeutic studies of human colorectal carcinoma.	Emphasize 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 will be 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 will be continued using a variety of positron labeled drug compounds and neurotransmitters. Copper-67 labeled porphyrin compounds	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 and heart metabolism, and will also contribute to the diagnosis and therapy

III. Medical Applications (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Radiopharmaceuticals (Cont'd)		will be developed to detect cancer cells in sputum samples from patients with early stage lung cancer. These compounds will also be evaluated for therapy.	of other organs disfunction such as cardiopulmonary disease and mental disorders.
	$ 13,450	$ 13,613	$ 13,800
Instrumentation	Research on improved detector systems for Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) imaging extended to include a survey to identify new scintillation crystals, and theoretical studies to assist in designing scintillators with improved properties. A new approach to reconstructing emission tomography images using statistically based algorithms was studied particularly as applied to very large data sets generated by high resolution systems. Design and development of a multi-slice, high resolution PET system for brain research based on a new detector assembly is in progress. Evaluation of a miniature gamma camera for rapid blood flow measurements in the operating room context is proceeding and a prototype clinical camera will be fabricated.	Emphasis will be 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 PET systems will be continued with two new systems under development. New scintillation crystals such as lead sulfate and cerium doped rare earth compounds will be evaluated. SPECT imaging is widely utilized in clinical applications and development of systems with improved resolution and sensitivity will be initiated. Design of instrumentation for true three-dimensional (3-D) PET imaging will be completed and evaluations started. New image reconstruction algorithms for 3-D representation will be 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 will be 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.
	$ 5,790	$ 3,683	$ 4,544

III. Medical Applications (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Clinical Feasibility	Continued to exploit unique facilities of the National Laboratories through applications to a broader spectrum of human diseases and more basic studies of disease processes at the molecular biology and structural biology levels.	Continue neurological studies at National Laboratories and university medical centers to define the molecular basis of psychiatric disorders using quantitative PET studies of neuroreceptor sites. Initiate 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.
	$ 3,445	$ 3,255	$ 3,678
Boron Neutron Capture Therapy	Continued preclinical studies. Developed clinical protocols for initiation of clinical trials of brain tumor and melanoma.	Phase I clinical tests of boronophenylalanine (BPA) will continue and tests of boron sulfhydryl (BSH) will be initiated. Research on a variety of boron compounds with improved localization in tumor tissue will continue. Accelerator neutron sources will be 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 malignant melanoma will be planned.
	$ 6,880	$ 8,992	$ 9,002

III. Medical Applications (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Molecular Nuclear Medicine	An expanded research effort exploited advances in molecular biology and the Human Genome program. They will increasingly provide capabilities to predict individual resistance or susceptibility towards environmental factors such as energy related chemicals and radiation. This capacity will revolutionize medicine enabling sharply focused diagnostic methodology for very early detection of disease by nuclear medicine and other technologies. Improved molecular genetics technology will provide new approaches to engineering and tagging monoclonal antibodies with radionuclides, boron, or other agents for diagnostic and therapeutic applications. The possible use of molecules targeted to specific cell-surface receptors also were explored. Use of synchrotron light source facilities for medical research, such as x-ray angiography, was expanded.	Research in nuclear medicine based on advances in molecular and structural biology will continue 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 specificity; 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.
	Funding in the amount of $540,000 has been transferred to the SBIR program.	Funding in the amount of $739,000 has been budgeted for the SBIR program.	Funding in the amount of $778,000 has been budgeted for the SBIR program.
	$ 1,770	$ 2,860	$ 4,418
Power Burst Facility	Maintenance and surveillance activities continued.	Initiate preparation for decontamination and decommissioning of the Power Burst Facility at INEL.	Continue preparation for D&D of PBF.
	$ 2,700	$ 1,600	$ 1,100
Congressionally Directed Projects	No activity.	Congressionally directed projects will be conducted.	No activity.
	$ 0	$ 15,400	$ 0

III. Medical Applications (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Medical Applications	$ 36,240	$ 52,298	$ 38,895

DEPARTMENT OF ENERGY
FY 1995 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 1995 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. 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. 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 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. Also included in the core program is DOE's unique research on plant response to increasing CO2 concentrations. This work focuses attention on plant carbon metabolism, specifically to address basic biological mechanisms that affect direction, rate and magnitude of CO2 fixation by land ecosystems as well as biotic responses to CO2 enrichment.

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 Quantitative Links activity will conclude a broad range of research to link the predicted global and regional climate changes with observed changes in measurable Earth system properties. Field studies have been emphasized.

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

The National Institute for Global Environmental Change (NIGEC) provides support for research through six regional academic centers on the highest

I. Carbon Dioxide Research (Cont'd)

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 in FY 1995 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 FY 1993 and FY 1994 program will be integrated into the assessment process.

The Global Change Education activity will maintain the on-going fellowships and scholarships. 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. 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 60 graduate students at 31 different universities.

II. A. Summary Table: Carbon Dioxide Research

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Core Program	$ 19,476	$ 16,066	$ 17,055	+ 6
Information & Integration	2,255	2,233	2,110	- 6
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	10,895	11,622	11,190	- 4
Quantitative Links	4,820	4,707	3,071	- 35
Atmospheric Radiation Measurement (ARM)	25,904	29,642	31,166	+ 5
Oceans Research	5,408	5,057	5,051	0
National Institute for Global Environmental Change (NIGEC)	10,863	11,228	11,521	+ 3
Unmanned Aerospace Vehicles	0	0	1,047	>999
Global Change Integrated Assessment Research	1,710	1,710	3,476	+103
Education	2,929	2,865	2,749	- 4
Total, Carbon Dioxide Research	$ 84,260	$ 85,130	$ 88,436	+ 4

II. B. Major Laboratory and Facility Funding

	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
ARGONNE NATIONAL LAB (EAST)	$ 939	$ 839	$ 888	+ 6
BROOKHAVEN NATIONAL LAB	$ 2,912	$ 2,618	$ 2,579	- 1
ENVIRONMENTAL MEASUREMENTS LAB	$ 415	$ 415	$ 415	0
LAWRENCE BERKELEY LAB	$ 342	$ 332	$ 314	- 5
LAWRENCE LIVERMORE NATIONAL LAB	$ 7,472	$ 6,243	$ 6,315	+ 1
LOS ALAMOS NATIONAL LABORATORY	$ 3,977	$ 3,338	$ 3,701	+ 11
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 3,185	$ 3,149	$ 2,929	- 7
OAK RIDGE NATIONAL LAB	$ 6,652	$ 5,857	$ 5,864	0
PACIFIC NORTHWEST LAB	$ 17,660	$ 20,888	$ 30,232	+ 45
SANDIA NATIONAL LABORATORIES	$ 415	$ 400	$ 1,199	+200

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

Program Activity	FY 1993	FY 1994	FY 1995
Carbon Dioxide Research			
Core Program	Explored natural processes that sequester carbon; acquired emissions data on atmospheric carbon dioxide (CO2) and methane data; implemented operational carbon cycle model to explore relationships between energy emissions and changing properties of the global carbon cycle. Model simulations provided technical guidance of global warming potentials needed for decisions on emissions trading.	Maintain continuity and quality assurance of atmospheric CO2 measurements at Mauna Loa Observatory; provide atmospheric CO2 projections derived from coupled atmosphere-ocean-terrestrial carbon cycle models; and analyze effects of terrestrial carbon storage on atmospheric CO2 concentration.	Continuity and quality assurance of atmospheric CO2 measurements at Mauna Loa Observatory will be maintained. 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.
	Initiated second phase of international comparison of model 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; analysis of traditional climate data used advanced statistical techniques to assess multi-variate climate change.	Continue the international comparison of models and observed natural variability of climate; operate model diagnostic center at LLNL concentrating on increased model resolution using advanced modeling concepts such as nested fine model grids; develop advanced diagnostic techniques; analysis of traditional climate data will use 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. Ocean modeling will commence and advanced statistical techniques to assess multi-variate climate change will be undertaken.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Core Program (Cont'd)	Obtained experimental field measurements and model results to understand the simultaneous effects of increased CO2 and climate change on selected plants with continued focus on photosynthesis and growth. Research on processes will improve scientific understanding of the potential of vegetation for fixing carbon photosynthetically, and slowing the rise of atmospheric CO2.	Jointly with USDA, complete 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. Emphasize 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. Mechanisms that remove CO2 from the atmosphere will be emphasized and process models of the terrestrial carbon cycle will be developed.
	$ 19,476	$ 16,066	$ 17,055
Information & Integration	Operated the ORNL Carbon Dioxide Information Analysis Center including preparations to become a World Data Center under UN auspices. Conducted quality audits on global and regional data sets.	Operate the ORNL Carbon Dioxide Information Analysis Center including preparations to become a World Data Center under UN auspices. Conduct 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.
	$ 2,255	$ 2,233	$ 2,110
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	Pursued development of the Advanced Climate Model CHAMMP to expand use of advanced computer architecture and software applications in concert with advanced model algorithms; fully implemented a conventional climate model on a massively parallel computer architecture.	Implement climate models and execute simulations on massively-parallel scientific supercomputers that achieve throughput speeds 100 times greater than was possible in 1990 on a conventional vector supercomputer. Conduct 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. Simulations and analytical studies to further define the theoretical limits to climate predictability will be conducted. 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

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP) (Cont'd)			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.
	$ 10,895	$ 11,622	$ 11,190
Quantitative Links	Experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases continued.	Complete 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.
	$ 4,820	$ 4,707	$ 3,071
Atmospheric Radiation Measurement (ARM)	Continued ARM operation through planned program growth. First ARM site fully operational. ARM scientists participated in selected national and international field experiments to assess cloud radiative interactions and cross-grid variability studies for climate model parameterization development. The first ARM site also served as a catalyst for participation by other national and international programs in a range of atmospheric and multidisciplinary global change disciplines. An experiment was conducted in the Tropical Western Pacific as a pre-second site activity and will support the studies of the international Tropical Ocean Global Atmosphere (TOGA) program. Preparations for the second and third ARM site continued.	Increase ARM operation consistent with planned program growth. Begin operations at the second ARM site in the tropical western Pacific. Conduct one or two major campaigns at the first and second ARM sites in conjunction with USGCRP partners and other national and international interests. Continue preparation of the third ARM site, in the north slope region of Alaska. Preparations for the fourth and fifth ARM ground site will continue, with scientific, environmental, and logistics studies.	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 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 and demonstration of a radioacoustic sounding system.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Atmospheric Radiation Measurement (ARM) (Cont'd)	$ 25,904	$ 29,642	$ 31,166
Oceans Research	Continued and expanded participation in ocean measurements as part of the global survey of CO2 in the oceans; expanded process modeling including deep convection and the surface mixed to layer to understand the exchange of heat and carbon with the atmosphere.	Continue ocean measurements as part of the global survey of CO2 in the oceans including the Indian Ocean; conduct 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.
	$ 5,408	$ 5,057	$ 5,051
National Institute for Global Environmental Change (NIGEC)	NIGEC continued to support the high priority research areas in global and regional climate change predictions.	NIGEC will continue 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 will focus on global and regional climate predictions, sources and sinks of carbon dioxide, and the consequences of atmospheric and climatic changes on terrestrial ecosystems.	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 on improving global and regional climate prediction, determining the effects of clouds and aerosols on the Earth's radiation balance, quantifying the major sources and sinks of CO2 and other energy-related greenhouse gases, and determining the economic and environmental consequences of human-induced atmospheric and climatic changes.
	$ 10,863	$ 11,228	$ 11,521

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Unmanned Aerospace Vehicles	No activity.	Limited use of available UAVs and instrumentation in support of ARM-CART (cloud and radiation test bed) program. Current UAVs and available instrumentation will provide a measure of support for the program but are significantly less than required by the program, e.g., currently available UAVs cannot provide a platform at the tropopause height (15-20 km) for at least a diurnal period as is needed for ARM measurement programs. Development of technology requirements will be explored.	The use of available leased UAVs and instrumentation developed under the DoD Strategic Environmental Research and Development Program (SERDP) will continue to support ARM, the Atmospheric Chemistry Program's Ozone thrust and other climate research projects. The limited number and capability of available UAVs constrains the range of investigations but the most critical questions within the capabilities of available platforms will be addressed. Development of technology requirements will be continued and opportunities for interagency collaboration will be explored.
	$ 0	$ 0	$ 1,047
Global Change Integrated Assessment Research	DOE conducted economics research to help build the economics knowledge base for the sound policy analysis of global change issues. This research is directed to contribute to future integrated assessments that would evaluate the benefits and costs of various policy options. Two areas of particular focus for 1993 were: (1) understanding the innovation and diffusion of technology as it relates to predicting emissions and adaptation, and (2) developing indices for policies that would allow for emission exchanges among greenhouse gases. Four broader areas of concentration are: (1) understanding the underlying economic forces that drive global change and that form a foundation for most economic modeling of global change, (2) helping provide information on topics that arise in the context of integration, (3) determining greenhouse gas emissions and potential	Multi-year research grants initiated in FY 1993 will continue 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 greenhouse gases simultaneously. New research will also be 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 would include such topics as the fundamental economic driving forces, for instance international GDP	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 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

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Global Change Integrated Assessment Research (Cont'd)	consequences, and (4) understanding the international flow of economic goods and policy instruments for influencing change in other countries.	forecasts, population growth, international trade, impacts of climate change, and economic tradeoffs between generations.	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.
	$ 1,710	$ 1,710	$ 3,476
Education	Continued to foster the cross-disciplinary training of exceptional young scientists in global change research and to provide opportunities for these young scientists to gain access to the state-of-the-art facilities and the outstanding professional staff at the DOE National Laboratories. Organized and conducted a special DOE Global Change Fellowship Program Symposium which will allow the fellowship recipients to present their research results and professionally interact, and to showcase the program. The total number of fellowships awarded will no longer increase.	Maintain tuition and stipend support for training the next generation of energy-related global change scientists. Award 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 to 60 graduate students and 2-year research support to about 25 post-doctoral fellows will be maintained. The graduate-level fellowship program will be modified to provide 4 years of DOE support over a span of 5 years will be modified, by negotiating 1 year of support for DOE Fellows from respective universities. 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.
	Funding in the amount of $1,229,000 has been transferred to the SBIR program.	Funding in the amount of $1,264,000 has been budgeted for the SBIR program.	Funding in the amount of $1,769,000 has been budgeted for the SBIR program.
	$ 2,929	$ 2,865	$ 2,749
Carbon Dioxide Research	$ 84,260	$ 85,130	$ 88,436

DEPARTMENT OF ENERGY
FY 1995 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 and medicine. 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, and maintaining U.S. world competitiveness through advances in biotechnology.

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

Program Activity	FY 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Salaries and Expenses	$ 5,207	$ 6,010	$ 6,615	+ 10
Other	1,393	1,090	885	- 19
Total, Biological and Environmental Research Program Direction	$ 6,600	$ 7,100	$ 7,500	+ 6

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

Program Activity	FY 1993	FY 1994	FY 1995
Biological and Environmental Research Program Direction			
Salaries and Expenses	Provided funds for salaries, benefits, and travel for 61 full-time equivalents (FTEs) in the Office of Health and Environmental Research and for related program and management support.	Provide funds for salaries, benefits, and travel for 63 FTEs, an increase of four FTEs over the FY 1994 budget.	Provide funds for salaries, benefits, and travel for 62 FTEs, a reduction of one FTE from the revised FY 1994 level. Provide for three additional FTEs over the FY 1994 budget level and pay increases resulting, for example, from locality pay and normal within-grade increases.
	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 planned growth in the areas of structural biology, environmental sciences, and health effects research. Provided environment, safety and health (ES&H) management capability for the safe operation of program facilities. Managed the joint DOE/NIH human genome effort and expanded global climate change research. Managed efforts in health and environmental effects of radiation and toxic chemicals, subsurface environmental biotechnology, atmospheric chemistry research in support of environmental restoration and waste management, and new approaches to nuclear medicine based on advances from the genome and structural biology program. Provided program management, oversight and accountability of contractor	Continue program management with an increase of two FTEs over the FY 1994 budget. Additional staff is required to support planned growth by 75-100 active research projects in atmospheric science (ozone) and subsurface microbiology, structural biology, the human genome, and global climate change programs; provide for the added reporting and analysis requirements of the Energy Policy Act; support the Strategic Environmental Research and Development Program (SERDP) industrial energy and waste minimization efforts; SBIR and the ER Laboratory Technology Transfer Program for the cost shared spinoff CRADAs from non-defense laboratories; and increase support for the Environmental and Molecular Sciences Laboratory (EMSL). Manage efforts in analytical technology, health and environmental effects of radiation and toxic chemicals, and molecular nuclear medicine. Continue 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	Continue program management for ongoing activities as in FY 1994 at the revised FY 1994 FTE level with two FTEs over the FY 1994 budget. Support increased emphasis on information infrastructure for structural biology and genetics, large-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, including development of a new initiative in advanced biomedical technology to exploit dual use resource capabilities with Defense Programs and Department of Defense programs. 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

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

Program Activity	FY 1993	FY 1994	FY 1995
Salaries and Expenses (Cont'd)	operations. Closely coordinated activities with other DOE programs, Federal agencies, and international bodies.	Northwest Laboratory (PNL), and the upgrade of the Brookhaven Linac Isotope Producer at Brookhaven National Laboratory (BNL). Continue liaison with other DOE programs to facilitate technology and information transfer, and with other Federal agencies and international bodies.	information transfer, and with other Federal agencies and international bodies. Manage program development for enhancing future manpower in health and environmental sciences including new programs for HBCUs.
	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 to provide program and management support as in FY 1993, with an increase of two FTEs over the FY 1994 budget to reflect an internal redistribution of Energy Research resources.	Provide program and management support as in FY 1994, with a reduction of one FTE from the revised FY 1994 level and a net increase of one FTE over the FY 1994 budget.
	$ 5,207	$ 6,010	$ 6,615
Other	Provided a variety of program support such as printing and editing and contractual services, including timesharing on various information systems and communication networks; Automated Office Support Systems (AOSS) Workstations; and environmental, safety and health support.	Continue, at a reduced level, the variety of program support required in FY 1993.	Provide at a reduced level the variety of program support required in FY 1993 and FY 1994.
	$ 1,393	$ 1,090	$ 885
Biological and Environmental Research Program Direction	$ 6,600	$ 7,100	$ 7,500

DEPARTMENT OF ENERGY
FY 1995 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 1993 Enacted	FY 1994 Enacted	FY 1995 Request	% Change
Capital Equipment	$ 20,500	$ 21,600	$ 25,701	+ 19
Construction	5,900	49,300	70,700	+ 43
Total, Facilities Operations	$ 26,400	$ 70,900	$ 96,401	+ 36

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LAB (EAST)	$ 1,062	$ 4,400	$ 7,078	+ 61
BROOKHAVEN NATIONAL LAB	$ 3,835	$ 6,400	$ 1,895	- 70
ENVIRONMENTAL MEASUREMENTS LAB	$ 225	$ 200	$ 189	- 6
INHALATION TOXICOLOGY RESEARCH INSTITUTE	$ 1,080	$ 500	$ 489	- 2
RADIOBIOLOGY AND ENVIRONMENTAL HEALTH LAB	$ 110	$ 100	$ 94	- 6
LAWRENCE BERKELEY LAB	$ 2,503	$ 4,200	$ 24,007	+472
LAWRENCE LIVERMORE NATIONAL LAB	$ 1,178	$ 800	$ 1,252	+ 57
LOS ALAMOS NATIONAL LABORATORY	$ 1,596	$ 600	$ 1,357	+126
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 68	$ 0	$ 0	0
OAK RIDGE NATIONAL LAB	$ 805	$ 1,000	$ 1,090	+ 9
PACIFIC NORTHWEST LAB	$ 10,375	$ 43,100	$ 53,567	+ 24
STANFORD SYNCHROTRON RADIATION LAB	$ 3,523	$ 3,000	$ 1,990	- 34

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

Program Activity	FY 1993	FY 1994	FY 1995
Facilities Operations			
Capital Equipment	Supported capital equipment budget for the core program. ($5,325)	Maintains capital equipment budget for the core program to provide state-of-the-art instrumentation. ($5,300)	Maintains capital equipment budget for the core program to provide state-of-the-art instrumentation. ($3,366)
	Supported capital equipment for structural biology. New funds were requested for: (1) computer and detector upgrades of the crystallography station on beamline X-12C at the National Synchrotron Light Source (NSLS), a heavily utilized user facility; (2) equipment to develop Laue diffraction capability at the NSLS; (3) upgrade and maintenance of the crystallography and small angle scattering stations operated as national user facilities at the HFBR; (4) at the 1-2 GeV Advanced Light Source (ALS) synchrotron, development and fabrication of an undulator beamline, an x-ray scanning microscope capable of investigating subcellular structures with the unique low emittance soft x-ray beams. ($5,855)	Complete development and fabrication of x-ray microscopes (scanning and imaging) at the ALS begun in FY 1993 (TEC $4.1M); initiate development of beam line 9 at SSRL with stations for all major x-ray technologies needed for structural biology (TEC $7.5M); initiate development of a new station at the HFBR for high-speed neutron crystallography (TEC $2.9M); fund final stage of upgrade of existing stations at NSLS (TEC $1.0M). ($6,000)	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. ($9,060)
	Supported genome capital equipment needs. ($2,420)	Supports genome needs for replacement of capital equipment to maintain existing capability. ($2,300)	Supports genome needs for replacement of capital equipment to maintain existing capability. ($2,845)
	Enhanced base capital equipment for carbon dioxide research and acquire the appropriate Unmanned Aerospace Vehicle (UAV) platform to fulfill the ARM needs following the review of all UAV candidates. Funds were also requested for sensors and data collection and processing equipment for the UAVs including radiometers and lidars. Funds were provided for a Measurement Data Archive System at ORNL. ($6,900)	Supports 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	Supports capital equipment needs for global climate change, primarily ARM: (1) upgrading and/or replacing selected instrumentation at the first ARM site, in Oklahoma-Kansas, and (2) necessary information for two transportable Atmospheric Radiation and Cloud Stations (ARCS) at the second ARM site, in the Tropical Western Pacific Ocean locale. ($10,430)

III. Facilities Operations (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Capital Equipment (Cont'd)		surface radiometers, cloud imagers and water vapor profilers. Funds are also provided for a measurement Data Archive System at ORNL; capital for this includes hardware for a high speed data processing and storage capability. ($8,000)	
	$ 20,500	$ 21,600	$ 25,701
Construction	Maintained general plant projects at the FY 1992 level. ($3,500) The synchrotron light source facilities in place at BNL offer opportunities for forefront structural biology research opportunities. Effective utilization of the facility by numerous biomedical research teams was limited by lack of adequate laboratory space adjacent to the beam lines. New laboratory space was urgently needed if the capabilities of NSLS to support user programs for structural biology research were to be realized ($1,800).	Maintains general plant projects at the FY 1993 funding level. ($3,500) Initiate construction of user center for structural biology at ALS, containing laboratories for sample preparation, characterization and storage, offices for permanent staff of beam lines 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. ($600) Initiate construction of the Structural Biology Center at ANL, including new laboratories and experimental facilities at the APS 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. ($4,000)	Maintains general plant projects at the FY 1993 funding level. ($3,500) Continue construction of user center for structural biology at ALS, containing laboratories for sample preparation, characterization and storage, offices for permanent staff of beam lines 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) Continue construction of the Structural Biology Center at ANL, including new laboratories and experimental facilities at the APS 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)

III. Facilities Operations (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Construction (Cont'd)	The Biomedical Isotope Facility at LBL involved the acquisition of a small, 11 MeV negative ion cyclotron and renovation of Building 56 for housing the cyclotron to produce short-lived radionuclides in cyclotron targets. This project was be completed in FY 1993. ($600)	No activity.	No activity.
	Support for construction of the Environmental and Molecular Sciences Laboratory (EMSL) at PNL was provided by the Environmental Restoration and Waste Management Program.	Continue support, provided previously by the Restoration and Waste Management program, for construction of the 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	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)

III. Facilities Operations (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Construction (Cont'd)		support educational and technology transfer initiatives. ($33,000)	
	No activity.	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. ($6,000)	No activity.
	No activity.	Initiate 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	Continue construction of the Human Genome Laboratory at LBL to provide a state-of-the-art facility for molecular genetics research. ($15,800)

III. Facilities Operations (Cont'd):

Program Activity	FY 1993	FY 1994	FY 1995
Construction (Cont'd)		associates, graduate students, technicians and support personnel. Research at the Human Genome Laboratory will directly support the needs of the 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. ($2,200)	
	$ 5,900	$ 49,300	$ 70,700
Facilities Operations	$ 26,400	$ 70,900	$ 96,401

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1994 Congressional Budget Request are denoted with a veritcal 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	Previous Obligations	FY 1993 Adjusted	FY 1994 Request	FY 1995 Request	Unappropriated Balance	TEC
GPE-120	General Plant Projects	$0	$3,500	$3,500	$3,500 *	$0	$3,500 *
94-E-339	Human Genome Laboratory, LBL	0	0	2,200	15,800	6,700	24,700
94-E-338	Structural Biology Center, ANL	0	0	4,000	6,700	4,295	14,995
94-E-337	ALS Structural Biology Support Facilities, LBL	0	0	600	4,700	2,600	7,900
94-E-35	BLIP Facility Upgrade	0	0	6,000	0	0	6,000
93-E-337	Structural Biology Addition at NSLS, BNL	0	1,800	0	0	0	1,800
91-EM-100	Environmental & Molecular Sciences Lab., PNL	0 a/	0 a/	33,000	40,000	84,130	207,900
91-E-310	Biomedical Isotope Facility at LBL	1,700	600	0	0	0	2,300
Total Biological and Environmental Research		$1,700	$5,900	$49,300	$70,700	$97,725	$269,095

a/ $22,270 prior year funding and $28,500 FY 93 funding provided by Environmental Restoration and Waste Management Program.

* TEC of FY 1995 GPP B/A request only.

IV. B. Construction Funded Project Descriptive Summary

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

TEC: $ 3,500
TPC: $ 3,500

Start Date: 2nd Qtr. FY 1995 Completion Date: 4th Qtr. FY 1996

2. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1993	FY 1994	FY 1995	After FY 1995
Previous	XXXXXXXX	$ 2,924	$ 1,886	$ 1,006	$ 0
FY 1993 Projects	3,500	401	1,026	1,228	845
FY 1994 Projects	3,500	0	413	691	2,396
FY 1995 Projects	3,500	0	0	500	3,000

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 are 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.

4. Total Project Funding (B/A):

	Prior Years	FY 1993	FY 1994	FY 1995 Request	To Complete
Construction.....	$ xxx	$ 3,500	$ 3,500	$ 3,500	$ XXX

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: $ 24,700
TPC: $ 25,000

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

2. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
FY 1994	$ 2,200	$ 2,200	$ 1,280
FY 1995	15,800	15,800	4,970
FY 1996	5,700	5,700	9,850
FY 1997	1,000	1,000	8,600

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 1993	FY 1994	FY 1995 Request	To Complete
Construction.....	$ 0	$ 0	$ 2,200	$15,800	$ 6,700
Capital Equipment.....	0	0	0	0	0
Operating Expenses.....	170	0	130	0	0

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: $ 14,995
TPC: $ 21,715

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

2. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
FY 1994	$ 4,000	$ 4,000	$4,000
FY 1995	6,700	6,700	6,700
FY 1996	4,295	4,295	3,700
FY 1997	0	0	595

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 1993	FY 1994	FY 1995 Request	To Complete
Construction.....	$ 0	$ 0	$ 4,000	$ 6,700	$ 4,295
Capital Equipment.....	0	0	0	0	600
Operating Expenses.....	418	425	780	830	3,667

IV. B. Construction Funded Project Decriptive Summary

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

TEC: $ 7,900
TPC: $ 8,000

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

2. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
FY 1994	600	600	500
FY 1995	4,700	4,700	2,300
FY 1996	2,600	2,600	5,100

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 1993	FY 1994	FY 1995 Request	To Complete
Construction.....	$ 0	$ 0	$ 600	$ 4,700	$ 2,600
Capital Equipment.....	0	0	0	0	0
Operating Expenses.....	100	0	0	0	0

IV. B. Construction Funded Project Descriptive Summary

1. Title and Location of Project: Project 91-EM-100, Environmental and 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 1996

2. Financial Schedule:

Fiscal Year	Appropriation a/	Adjustment	Obligations a/	Costs
1991	$ 5,200	-30	$ 5,170	$ 1,500
1992	17,100 b/	0	17,100 b/	3,300
1993	28,500	0	28,500	13,200
1994	33,000	0	33,000	52,400
1995	40,000	0	40,000	43,400
1996	50,000	0	50,000	53,600
1997	34,130	0	34,130	36,700
1998	0	0	0	3,800

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 1993	FY 1994	FY 1995 Request	To Complete
Construction.....	$22,270	$28,500	$33,000	$40,000	$ 84,130
Capital Equipment	1,580	3,510	50	0	0
Operating Expenses	5,440	1,750	1,150	2,050	6,470

a/ Funds provided by Environmental Restoration and Waste 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 1992.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST

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

Biological and Environmental Research

1. Title and Location of Project: General Plant Projects

2a. Project No. GPE-120
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 1st Qtr. FY 1994

3b. A-E Work (Title I & II) Duration: 6-12 Months

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- None
Total Project Cost (TPC) -- None

4a. Date Physical Construction Starts: 2nd Qtr. FY 1995

4b. Date Construction Ends: 4th Qtr. FY 1996

6. Current Cost Estimate:
TEC -- $ 3,500
TPC -- $ 3,500

7. Financial Schedule:

		Costs			
Fiscal Year	Obligations	FY 1993	FY 1994	FY 1995	After FY 1995
Previous	XXXXXXXX	$ 2,924	$ 1,886	$ 1,006	$ 0
FY 1993 Projects	$ 3,500	401	1,026	1,228	845
FY 1994 Projects	3,500	0	413	691	2,396
FY 1995 Projects	3,500	0	0	500	3,000

8. Brief Physical Description of Project

This estimate is for minor new construction and other capital alterations to land, buildings, and utilities systems. The estimate also includes the cost of installed equipment which is an integral part of the general plant subprojects.

1. Title and location of project: General Plant Projects	2a. Project No. GPE-120 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

Although it is difficult to identify particular projects in advance, all of the subprojects identified below are currently being considered for FY 1995 support. The estimated costs for each of the subprojects are preliminary in nature, with a project limitation of $2,000,000, and primarily indicative of the size of the project. Since needs and priorities may change, other projects may be substituted for the examples listed below, and some of these may be located on non-Government owned property. These general plant projects will provide facilities for conducting critical research programs, contribute to greater efficiency, eliminate health and safety hazards, and will reduce maintenance and operational costs.

The estimate is based on requirements by office as follows:

Summary by Office	
Albuquerque Field Office.....	$ 900
Richland Field Office.....	2,000
San Francisco Field Office	400
Washington Headquarters	200
Total.....	$ 3,500

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

The following is a tentative tabulation of the major projects to be performed at the various laboratories under the operations office listed.

Albuquerque Field Office	
Inhalation Toxicology Research Institute.....	$ 300

Activities to meet facility safety and health codes, and to upgrade various central plant and utility systems. Included are such projects as standby generator exhaust stacks, replacement and modification of hot water boiler system, office renovations and laboratory renovations.

1. Title and location of project: General Plant Projects

2a. Project No. GPE-120
2b. Construction Funded

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

Los Alamos National Laboratory..... 600

Modify biosciences laboratory/office building to provide needed space for expanded or changed programmatic goals or to meet new standards established by DOE and others, and to maintain or improve upon existing levels of plant efficiency.

Richland Field Office
Pacific Northwest Laboratory..... 2,000

Miscellaneous capital work orders, e.g., alterations, laboratory additions, improvements and modifications to buildings and operating systems.

San Francisco Field Office
Lawrence Livermore National Laboratory..... 400

Capital improvements, modification and upgrading facilities to correct inadequacies in existing facilities and to meet new programmatic requirements as they develop.

Washington Headquarters 200

Unanticipated capital work modifications.

10. Details of Cost Estimate

Based on preliminary conceptual design.

11. Method of Performance

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

1. Title and location of project: General Plant Projects

2a. Project No. GPE-120
2b. Construction Funded

12. Schedule of Project Funding and Other Related Funding Requirements

Not required.

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

Not required.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1994 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.)

Biological and Environmental Research

1. Title and location of project: Human Genome Laboratory
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

2a. Project No. 94-E-339
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 2nd Qtr. FY 1994

3b. A-E Work (Title I & II) Duration: 15 Months

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- $24,900
Total Project Cost (TPC) -- $25,200

4a. Date Physical Construction Starts: 4th Qtr. FY 1995

4b. Date Construction Ends: 4th Qtr. FY 1997

6. Current Cost Estimate:
TEC -- $24,700
TPC -- $25,000

7. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 2,200	$ 2,200	$1,280
1995	15,800	15,800	4,970
1996	5,700	5,700	9,850
1997	1,000	1,000	8,600

1. Title and location of project:	Human Genome Laboratory Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-339 2b. Construction Funded

8. Brief Physical Description of Project

Updated escalation rate resulted in a reduction in the Total Project Cost from $25,200,000 to $25,000,000. The TEC has been reduced from $24,900,000 to $24,700,000.

The proposed Human Genome 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. It will be located at the Lawrence Berkeley Laboratory (LBL) near the existing Biomedical Laboratory and the Cell Culture Laboratory.

The project was designed and sited in general conformance with the Long Range Development Plan approved by the U.C. Board of Regents in 1987 and with the LBL Site Development Plan approved by DOE in 1991. The conceptual design documents and cost estimate for the project were prepared from design criteria submitted by the Life Sciences Directorate and Human Genome Center staff.

The structure will be comprised of a braced steel frame with concrete floors and roof supported on metal deck, and exterior glass fiber reinforced concrete panel walls. An HVAC system with 100% outside air supply will be provided. The building will be protected by a fire sprinkler system connected to the LBL alarm system. Fire alarm stations will be provided on each floor with smoke detectors in all corridors and other areas where required. All utilities are available at the site except for a required substation to step down the available 12 kV from a new LBL substation. Fifty foot-candle lighting in laboratories will be provided by fluorescent fixtures with high frequency electronic ballasts. Access to the site is available via existing Cyclotron Road. Parking will be provided adjacent to the front entry and in the new 20 car parking area behind the Biomedical Laboratory.

Functionally, the Human Genome Laboratory is designed to provide a state-of-the-art facility for molecular genetics research. Each floor will house open laboratory areas furnished with modular wet benches and desks for maximum flexibility. This design will accommodate future modifications required by scientific investigations or changes in program.

Adjacent to laboratory areas will be a core of support facilities including cold rooms, dark rooms, cell tissue rooms, autoclaves and laboratories for robotics, instrumentation and computation. Laboratory offices and secretarial stations will be comprised of demountable open space workstations. To facilitate the interaction between researchers, a small shared conference room will be provided on each floor and a large conference room seating 25-30 people and combined with library is located on the first level.

1. Title and Location of Project:	Human Genome Laboratory Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-339 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

The building is designed in compliance with the requirements for H-7 occupancy as defined by the Uniform Building Code. All code stipulated provisions for handling and storage of hazardous materials are incorporated.

These new government-owned facilities will be located on land owned by the University of California and will serve or be operated in conjunction with other government-owned facilities at the Lawrence Berkeley Laboratory.

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

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--the genetic basis of susceptibility to disease causing agents--for use in defining risk and providing health protection. To achieve these objectives will require the Human Genome Laboratory to be directed towards the goals of identifying the variability in genetic information encoded in deoxyribonucleic acid (DNA) and mapping its arrangement on the 23 pairs of human chromosomes. The long-term goal of the national program is to support the determination of the sequence--and variation--of the approximately three billion DNA bases that comprise the total chromosome material of human cells.

The Human Genome Laboratory requires 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 (the Biomedical Laboratory Building and the Cell Culture Laboratory) that are used for related research on gene expression and physiology. This and other light laboratory space at Lawrence Berkeley Laboratory 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 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. Program activities conducted in the laboratory building will facilitate and improve mapping of selected human chromosome fragments; establish selected libraries of DNA nucleotide bases

1. Title and Location of Project:	Human Genome Laboratory Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-339 2b. Construction Funded

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

(complementing other libraries of cloned genes); conduct pilot nucleotide base sequencing of sections of continuous megabase-length DNA; develop data banks and analysis software; improve and develop new automation of mapping and sequencing techniques; and develop innovative methods for detecting gene fragments, sequences and variation. An important corollary activity is to provide requested services to universities and industry, including cloned DNA material, cell lines, and data. The program will contribute information to national gene banks and computational centers and utilize chromosomal material from sorting centers at other national laboratories.

The Human Genome Laboratory will provide light laboratories, equipment rooms, and office space required for the conduct of the integrated mapping, sequencing and analytical support programs. These needs include, for example, biochemistry bench space, controlled environmental chambers, tissue culture facilities and fermenters, and necessary instrumentation areas and utilities for DNA sequencers, gel scanners for separations, oligonucleotide synthesizers to prime fragment analysis, radiotracer counters, and basic preparative and analytical equipment. Special requirements include the control of biological materials and chemicals through laminar flow hoods and non-vented cabinets. Common ducting will be used for all chemical fume hoods and laminar flow cabinets.

10. Details of Cost Estimate a/

	Item Cost	Total Cost
a. Design and management costs		$ 2,330
1. Engineering design and inspection at 16 percent of construction costs..	$ 2,330	
b. Construction Costs		14,540
1. Improvements to Land	$ 1,680	
2. Buildings (37,000 GSF at approximately $259/sq. ft.)	11,120	
3. Special Facilities	1,520	
4. Utilities	220	
5. Project Management		1,020
c. Standard Equipment		3,080
d. Relocations		300
Subtotal		$21,270
e. Contingencies at approximately 16 percent of above costs		3,430
Total line item cost		$24,700

a/ Construction costs have been escalated at 2.1% for FY 1992; 3.4% for FY 1993; 4.3% for FY 1994; 4.5% for FY 1995 and 4.7% for FY 1996, compounded to midpoint of construction, August 1996.

1. Title and Location of Project: Human Genome Laboratory
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

2a. Project No. 94-E-339
2b. Construction Funded

11. Method of Performance

Design will be accomplished by means of a negotiated architect-engineer subcontract. Construction and procurement will be accomplished by fixed price subcontract awarded on the basis of competitive bidding.

12. Schedule of Project Funding and Other Related Funding Requirements

	Previous Years	FY 1994	FY 1995	FY 1996	FY 1997	Total
a. Total project costs						
1. Total facility costs						
(a) Line item	$ 0	$ 1,280	$ 4,970	$ 9,850	$ 8,600	$24,700
2. Other project costs						
(a) Conceptual design costs	$ 70	$ 0	$ 0	$ 0	$ 0	$ 70
(b) Environmental and safety documentation costs	100	130	0	0	0	230
Total project costs (TPC)	$ 170	$ 1,410	$ 4,970	$ 9,850	$ 8,600	$25,000

b. Related annual funding requirements in FY 1998 dollars

1. Facility operating costs	$ 470
2. Programmatic operating expenses for research	12,200
3. Capital equipment required for programmatic research	530
Total related annual costs in FY 1998 dollars	$13,200

1. Title and Location of Project:	Human Genome Laboratory Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-339 2b. Construction Funded

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

a. Total project funding

1. Total facility costs
The major elements of the Human Genome Laboratory have been described in Item 8.

The construction funding profile has been determined after analysis and review of a comprehensive project schedule, taking into account the earliest anticipated receipt of fiscal year funding, A/E selection time frame, general weather conditions for both site work and structure generally encountered in the San Francisco Bay area.

2. Other project costs
(a) Conceptual design costs--Includes costs for preparation of conceptual design report (CDR) by LBL personnel.
(b) Environmental (NEPA) and Safety (SAR) documentation costs--Includes costs for environmental evaluation and, if required, preparation of an Environmental Assessment (EA). Safety documentation includes preparation of preliminary safety analysis documents (PSAD).

b. Related annual funding

1. Facility operating costs
Includes estimated cost for maintenance, custodial service, and utilities such as light, heat and water.

2. Programmatic operating expenses for research
The annual costs of the scientific program are increased progressively to assemble a high-quality research staff for the Human Genome Laboratory consistent with the national program. Funding in the early years of the project will attract senior scientists to lead the new scientific programs described in Item 9. These researchers can be housed initially in leased facilities if necessary until the Human Genome Laboratory is completed. The programs will expand to include the full complement of scientists and technicians upon project completion.

1. Title and Location of Project:	Human Genome Laboratory Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-339 2b. Construction Funded

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

3. Capital equipment required for programmatic research
The capital equipment needs related to this research staffing profile reflect program requirements and experience that equipment items will be needed at the level of approximately 20% of the operating program budget. These amounts are augmented in the initial years for specialized capital equipment start up costs.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1994 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.)

Biological and Environmental Research

1. Title and Location of Project: Structural Biology Center
Argonne National Laboratory (ANL)
Argonne, IL

2a. Project No. 94-E-338
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 1st Qtr. FY 1994

3b. A-E Work (Title I & II) Duration: 15 Months

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- $15,193
Total Project Cost (TPC) -- $21,561

4a. Date Physical Construction Starts: 2nd Qtr. FY 1995

4b. Date Construction Ends: 2nd Qtr. FY 1997

6. Current Cost Estimate:
TEC -- $14,995
TPC -- $21,715

7. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 4,000	$ 4,000	$4,000
1995	6,700	6,700	6,700
1996	4,295	4,295	3,700
1997	0	0	595

1. Title and Location of Project:	Structural Biology Center Argonne National Laboratory (ANL) Argonne, IL	2a. Project No. 94-E-338 2b. Construction Funded

8. Brief Physical Description of Project

Due to an inflation rate adjustment, the cost estimate has been revised. The TEC has been decreased from $15,193,000 to $14,995,000. The TPC has been increased from $21,561,000 to $21,715,000.

a. Technical facilities
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. The insertion-device line will be equipped to function in two alternative configurations: one with 6-7 Gev-designed undulator A and the other with the 6-7 GeV-designed wiggler A.

1. Insertion-Device Beamline
A pair of multilayers in nondispersive orientation will be the first optical element in the beam (apart from filters, Beryllium window, and apertures), which has to withstand a very high heat load. This pre-monochromator is followed by a nondispersive double crystal monochromator with constant height of the exit beam. The next components are two cylindrically bendable plane mirrors used to focus the beam in the horizontal and vertical directions and to eliminate harmonic contaminations.

To avoid absorption and scattering of the radiation in the long beam transport sections, all optical elements and the beam transport up to an exit window in the hutch will be in high vacuum. Ultra high vacuum (UHV) technology will be used to avoid the possibility of deposits on the optical elements. The beamline vacuum will be separated from the ultrahigh vacuum of the ring by a Be-window.

With the small source size and the relatively long distances between the optical elements and the focus, vibrations are a major concern. All mirrors and monochromators will have individual vibration isolation bases as a support. All optical elements will be isolated from their vacuum enclosure by flexible bellows feedthroughs. The vacuum enclosures will have separate supports.

The front end of the beamline is composed of an all-metal UHV isolation valve followed by a set of heat absorbers, the first Beryllium-window, and beam diagnostic tools. These components are located at about 27 to 29 meters from the source.

8. Brief Physical Description of Project (Continued)

All optical elements, such as mirrors and monochromators, will be placed close to the 6-meter long experimental hutch. The primary aperture will be located at 40 meters. The tank of the toroidal mirror will extend from 41 meters to 43 meters. The 2-meter long tank of the multilayer monochromator will begin at 44 meters. The double crystal monochromator tank will extend from 47 meters to 48 meters. The horizontally focusing mirror tank will begin at 49 meters and end at 51 meters. The vertically focusing mirror tank will extend from 52 meters to 54 meters. The nominal position of the focus will be at 58 meters. The 6-meter long hutch will begin at 56 meters from the source. The photon shutter will be placed in front of the hutch at 55 meters. The beamline vacuum system will be sealed off by a Be-window immediately after the beam pipe enters the hutch. The beam then will enter the hutch vacuum system enclosing the guard slits and ending in front of a pinhole located at the focus at 58 meters.

2. Bending-Magnet Beamline
The bending-magnet beamline will have the same general optical layout, except that sagittal focusing by the second stage of the crystal monochromator will be used for horizontal focusing instead of the horizontally deflecting mirror. Further differences are that the horizontal width of all components will be made sufficiently large to intercept the 4-milliard horizontal divergence available at the port and that the cooling requirements for the first and second elements in the beam are much less demanding.

The considerations discussed above about focal length and vibration isolation for the insertion-device beamline also apply to the bending-magnet beamline.

The floor layout and requirements of access to the storage ring do not allow contiguous placement of components before 36 meters from the source. The area from 23 to 31 meters can be used for components that can be detached from the rest of the optical elements and do not need much lateral space.

The locations of the individual components will be as follows: the front end, comprising the UHV-isolation value, the Beryllium-window, and the beam diagnostic device, from 23 to 25 meters; the primary aperture at 35 meters; the toroidal mirror from 36 to 38 meters; the multilayer monochromator from 39 to 41 meters; the crystal monochromator from 42 to 43 meters; the vertically focusing mirror from 44 to 46 meters; the photon shutter at 47 meters; and the hutch from 48 to 54 meters. The nominal focus will be at 50 meters from the source.

1. Title and Location of Project: Structural Biology Center
Argonne National Laboratory (ANL)
Argonne, IL

2a. Project No. 94-E-338
2b. Construction Funded

8. Brief Physical Description of Project (Continued)

3. Experimental Hutch and Detectors

Each beamline of the SBC (bending-magnet beamline and insertion-device beamline) will be fitted with a single 6-meter long experimental enclosure ("hutch"). These two hutches will be identical. On the bending-magnet beamline, the proximal end will be at the 48-meter point; on the insertion-device beamline, the proximal end will be at the 56-meter point. The point of X-ray focus in each case will be 2 meters inside the proximal end of the hutch--at the 50-meter point on the bending-magnet beamline and at the 58-meter point on the insertion-device beamline.

Each hutch will consist of two chambers, or rooms: the main room and the staging room. The main room will be 2 meters wide and is designed as the exposure room into which the X-ray beam will be focused. To its side will be the staging area, a room 1.5 meters wide connecting to the main room through a door and through a window. The floor will be interlocked in the standard manner to restrict pedestrian access to the main room. The window between the rooms will be spanned by an experimental table, designed to have a smooth, strong surface on which goniostats may be slid (probably on air bearings) into and out from the location for crystal exposures.

The hutches will be made of steel and clad with lead sheets sufficient to satisfy all shielding requirements called for because each beamline will be capable of operating with "white" (non-monochromated) X-ray beams. A double access door to the main room, permitting access for bulky or heavy objects such as lift tables and goniostats, will normally be closed and sealed during operation. A single door opening in the distal end of the staging room will be available for access to that room. The window between staging and main rooms will be closed between exposures by a leaded-glass shutter with interlock safety protocols.

The hutch will be kept cool by its own separate air supply which can be completely dehumidified (dew point -- 190°C), to permit operation of crystal flash-freezing procedures without enclosures or cumbersome manipulations of crystals. A crystal cooling (FTS) apparatus and crystal freezing apparatus (e.g., Siemens LT2) will be operational in both hutches. Racks will be available for electronic and biochemical apparatus, such as laser power supplies, peristaltic pumps for flow cells, UV monitors, Kiethly micrometers, and other such items.

1. Title and Location of Project:	Structural Biology Center Argonne National Laboratory (ANL) Argonne, IL	2a. Project No. 94-E-338 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

b. Conventional Facilities

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. The SBC will operate and staff a computer complex with the ability to process data being collected on its 6-7 GeV beamlines, and these data processing services will be made available to outside users. Alternatively, data may be passed over networks or by physical media such as tape or optical disk to the user's home laboratory. The SBC will support software used for data collection and processing, and SBC staff will be actively engaged in the development and improvement of such software.

The conventional facility work required to accommodate the proposed Structural Biology Center will involve the renovation of D-Wing and Q-Wing in the existing Biology Building 202, and the fit-out of one 6-7 GeV lab/office module shell space.

The planned renovation in Building 202 will encompass a total of 5,670 square feet. This will consist of:

1. D-Wing--The existing 990 square foot of carcinogen lab will be modified to create a biohazard laboratory, and an adjacent 990 square feet will be renovated to create three new offices and connecting corridor spaces to Q-Wing. The existing constant volume mechanical system will be modified into an energy-efficient variable air volume system. Additional controls will be included to control supply air and level of exhausts. New light features will be provided in reconfigured lay-in ceilings. General construction will include new masonry partitions, doors and frames.

2. Q-Wing--The existing 3,960 square feet of laboratory spaces will be modified to reconfigure the space into three new laboratories and eight new offices and one conference room. The work will include new work counters and cabinets, masonry partitions, resilient floors and lay-in ceiling. The existing variable air volume mechanical system will be titled to serve the finished spaces.

1. Title and Location of Project: Structural Biology Center
Argonne National Laboratory (ANL)
Argonne, IL

2a. Project No. 94-E-338
2b. Construction Funded

8. Brief Physical Description of Project (Continued)
b. Conventional Facilities (Continued)

3. 6-7 GeV Lab/Office Module Sector

The base plan of the shell space for the 6-7 GeV sector laboratories contains minimal casework for the laboratory designed to accommodate an "electronics type" of function. The second laboratory, set up for a "chemistry type" of function, will have a 6 foot fume hood, one island, and two end wall counters with base cabinets below and wall cabinets above the counter. The laboratory area is designed to include two 600 square foot laboratories. Each laboratory shell has four walls and two main doors, with one vision panel to the experiment hall and one overhead ceiling door for equipment access to the main aisle of the experimental hall. The wall separating the laboratories from the experimental hall requires fire shutters on door and window openings, to be located on the inside of the experiment hall.

The 6-7 GeV sector is shell space and will be equipped to meet the specific requirements of the user group. Additions to the electronics laboratory will include an island with sink and peg drain board and a 6 foot hood. Modifications to the chemistry laboratory will add a sink and peg drain board to the work island. The fume hood planned for this laboratory will be replaced with a different type of hood (biological safety cabinets). Laboratory counterparts will be made of white teflon. Additional emergency shower and eyewash facilities will be added to the electronics laboratory. Office areas will be constructed of full-height gypsum board partitions on metal studs as opposed to an open office arrangement. The layout of the office area will yield eight offices, a conference room, a secretarial area, and two small closets. The existing 2x2 ceiling grid in the office areas will be reconfigured to facilitate placement of office partitions. Existing lights, diffusers, vents, and fire sprinklers will be relocated and/or added as required. No special requirements to achieve a BL-3 safety rating is required in the laboratory areas.

For all areas, interior materials have been selected based upon installed costs, user requirements, and durability. The staff office areas will have vinyl composition tile floors, painted drywall or concrete block partitions (depending on location), and lay-in acoustical ceilings. The laboratory areas will be finished with sheet vinyl flooring and painted concrete block partitions. Corridors will be finished with vinyl composition flooring. Interior doors and frames will be painted hollow metal.

The available 6-7 GeV utilities will be extended to provide compressed air, water and waste in the laboratories. The available electrical system will be extended to provide lighting and power.

1. Title and Location of Project:	Structural Biology Center Argonne National Laboratory (ANL) Argonne, IL	2a. Project No. 94-E-338 2b. Construction Funded

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

Protein crystallography allows the precise determination of atomic structures of large biological molecules such as all enzymes; many nucleic acids (DNA or RNA); metabolic control proteins like DNA-binding proteins or hormone receptors; and other important molecules. Structural analysis of these large molecules is of central importance in molecular biology, and also plays a central role in the newly developing discipline of "protein engineering." Protein engineering seeks to modify existing enzymes or structural proteins to produce new proteins with desired chemical, physical, or kinetic properties. These modified proteins may be studied to learn the precise nature of the function of the original proteins, or they may be modified to create economically useful proteins, either for industrial purposes or for drug design. Therefore, protein crystallography is crucially important in basic and applied research.

As currently practiced, diffraction data collection for protein crystallography is usually a tedious, slow process. It can be substantially improved by proper design and implementation of data collection facilities at synchrotron radiation centers. Efforts along the lines of data collection speed and quality enhancement are now going on at Stanford's SSRL facility; Cornell's CHESS facility; and Brookhaven's NSLS facility. The 6-7 GeV Storage Ring will be even more powerful than any of these existing facilities, and crystallographic data collection at the 6-7 GeV should be extremely fast. In addition, we at Argonne are designing and testing the CCD detector system. This device will accelerate data collection very significantly.

The proposed protein crystallography beamlines on the 6-7 GeV Storage Ring are conceived with rapid, accurate data collection in mind. Furthermore, multiple-energy anomalous dispersion data collection may ultimately lead to protein crystal structure determinations that can be carried out in a manner approaching a "routine." The bending magnet beamline has been designed with the idea that a complete high-resolution data set could be collected from a "standard" protein crystal in 10-100s; the reduction and analysis of these data may take several days more, but the essential intent is to drastically reduce the effort needed for data collection.

1. Title and Location of Project:	Structural Biology Center Argonne National Laboratory (ANL) Argonne, IL	2a. Project No. 94-E-338 2b. Construction Funded

10. Details of Cost Estimate a/

	Item Cost	Total Cost
a. Design and management costs		$ 1,718
1. Engineering design and inspection at approximately 16 percent of construction costs...	$ 1,718	
b. Project costs		10,677
1. Special Facilities	8,932	
2. Construction Management	32	
3. Project Management	1,713	
Subtotal		12,395
c. Contingencies at approximately 24 percent of above costs		2,600
Total line item cost		$14,995

a/ Construction costs have been escalated at 3.9% for FY 1993; 4.7% for FY 1994; 4.8% for FY 1995; and 3.7% for FY 1996, compounded to midpoint of construction, July 1995.

11. Method of Performance

Engineering, design and inspection will be accomplished by laboratory personnel. Procurement will be fixed-priced contracts awarded on the basis of competitive bids, where applicable. Where practicable, construction and installation will be by outside construction contracts.

1. Title and Location of Project: Structural Biology Center
Argonne National Laboratory (ANL)
Argonne, IL

2a. Project No. 94-E-338
2b. Construction Funded

12. Schedule of Project Funding and Other Related Funding Requirements

	Previous Years	FY 92	FY 93	FY 94	FY 95	FY 96	FY 97	Total
a. Total project costs								
1. Total facility costs								
(a) Line item	$ 0	$ 0	$ 0	$4,000	$6,700	$3,700	$ 595	$14,995
(b) Operating expenses funded equipment	0	0	0	0	0	200	400	600
(c) Inventories	0	0	0	0	0	200	100	300
Total direct costs	0	0	0	4,000	6,700	4,100	1,095	15,895
2. Other project costs								
(a) R&D necessary to complete construction	0	385	425	780	830	872	0	3,292
(b) Conceptual design costs	8	25	0	0	0	0	0	33
(c) Other project-related costs	0	0	0	0	0	0	2,495	2,495
Total other project costs	$ 8	$ 410	$ 425	$ 780	$ 830	$ 872	2,495	$ 5,820
Total project costs (TPC)	$ 8	$ 410	$ 425	$4,780	$ 7,530	$ 4,972	$3,590	$21,715

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

1. Facilities operation costs	$3,000
2. Facilities maintenance	500
3. Capital equipment	400
Total related annual costs	$3,900

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

a. Total project funding
(1) Total facility costs
(a) Construction line item - No narrative required.
(b) Inventories
The spare parts inventory consists of specialized technical components which are not readily available "off-the-shelf" and have long lead times for procurement. Therefore, they are purchased in advance and maintained in inventory to avoid shutdowns in the event of component failure.

1. Title and Location of Project:	Structural Biology Center Argonne National Laboratory (ANL) Argonne, IL	2a. Project No. 94-E-338 2b. Construction Funded

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

a. Total project funding
   2. Other project funding
      (a) R&D necessary to complete construction
      These costs represent the R&D necessary to assure the best possible performance of the facilities, to optimize designs, and to develop the quality assurance plans for the testing of all hardware. The R&D plan includes accelerator physics, component prototyping and testing, designs for beamline components, and detector development. Detector development is not essential in order to complete construction and to operate the facility successfully, but it is necessary in order to realize the full performance potential of the brilliant 6-7 GeV source in the Structural Biology Center.
      (b) Other project related funding
      These costs support the hiring and training of staff that will operate the SBC beginning in FY 1997 and the initiation and acceleration of operations at the beamlines in anticipation of full-scale operations.

b. Related annual funding
   1. Operating costs and programmatic operating expenses are estimated at about $3.9M per year (in FY 1997 dollars). This includes a "full-service" complement of about 16 FTEs for operation of the beamlines and liaison with users. This facility does not replace any other existing facility.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST

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

Biological and Environmental Research

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

2a. Project No. 94-E-337
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 2nd Qtr. FY 1994

b. A-E Work (Title I & II) Duration: 10 Months

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- $7,900
Total Project Cost (TPC) -- $8,000

4a. Date Physical Construction Starts: 2nd Qtr. FY 1995

4b. Date Construction Ends: 3rd Qtr. FY 1996

6. Current Cost Estimate:
TEC -- $ 7,900
TPC -- $ 8,000

7. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 600	$ 600	$ 500
1995	4,700	4,700	2,300
1996	2,600	2,600	5,100

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

2a. Project No. 94-E-337
2b. Construction Funded

8. Brief Physical Description of Project

The ALS Structural Biology Support Facilities will support life sciences research activities at the Advanced Light Source, a high-brightness 1-2 GeV synchrotron radiation source now under construction at the Lawrence Berkeley Laboratory. The facilities will consist of (i) improvements to existing space to provide 11,100 gross square feet of support laboratories and offices, located in the ALS building and in an existing adjacent structure, and (ii) standard laboratory and office equipment. 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.

These new government-owned facilities will be located on land owned by the University of California and will serve or be operated in conjunction with other government-owned facilities at the Lawrence Berkeley Laboratory.

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

Important new research opportunities in the life sciences will come about as a result of the construction, now under way, of the Advanced Light Source at the Lawrence Berkeley Laboratory. A central feature of this new radiation source will be its ability to generate remarkably bright, coherent beams of relatively low-energy x-ray photons--so-called soft x-rays--by means of insertion devices known as undulators. The ability to deposit a large number of x-rays of chosen energy in a very small specimen area is one of the hallmarks of undulator radiation. In addition, the energy range of the Advanced Light Source encompasses the absorption edges of many elements of biological interests, and it includes the "water window," where carbon and nitrogen strongly absorb but water is relatively transparent. For these reasons also, the Advanced Light Source offers unique opportunities for research in the life sciences. In addition, though, the Advanced Light Source will produce radiation useful for life sciences research from wigglers and bending magnets--radiation of high flux at energies up to at least 10 keV.

In early 1988, a workshop organized for the purpose identified the greatest opportunities that the Advanced Light Source will offer life scientists. Based on their conclusions, as well as those of participants at other workshops and meetings held since 1987, the three areas of emphasis at the Advanced Light Source will be microscopy, spectroscopy, and diffraction and scattering.

1. Title and Location of Project:	ALS Structural Biology Support Facilities Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-337 2b. Construction Funded

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

X-Ray Microscopy. One of the unique scientific opportunities for life scientists at the Advanced Light Source will be the ability to use soft x-ray microscopy and associated imaging techniques to view biological material in its natural state, at resolutions approaching 20 nanometers. X-ray imaging techniques offer an important opportunity, not duplicated by any other technique, for biologists to advance toward fulfilling their dreams of visualizing the cell and its molecular, supramolecular, and organellar contents at high resolution, of mapping the cell's elemental content, and of studying biological processes in living cells.

X-Ray Spectroscopy. The Advanced Light Source offers great promise for biological x-ray spectroscopy, especially at relatively low energies and for spatially localized studies. Two spectral regions are of particular interest: the region between 0.3 and 1.2 keV, where one finds the L-edges of the first series of transition elements, almost all of which are biologically important, as well as the K-edges of important light elements; and the region between 2 and 4 keV, which contains the K-edges of phosphorus, sulfur, potassium, calcium, and chlorine, all of great importance and interest in biology. In addition, the Advanced Light Source offers the potential for spatially resolved spectroscopy--a merger of imaging and spectroscopy that will offer the possibility for a wholly new dimension to biological investigations.

X-Ray Diffraction and Scattering. Despite being optimized at soft x-ray wavelengths, the Advanced Light Source is nonetheless well-suited for x-ray diffraction studies at the energies (about 10 keV) required for good resolution of macromolecules. Soft x-ray scattering studies are also of great interest, as the wavelength can be matched to the characteristic dimensions of various biological structures. Polarization-dependent scattering can also be developed as a valuable means of identifying polarized structures with periods in the soft x-ray--far UV size domain.

For life scientists, however, the use of synchrotron radiation is typically only one aspect of a complex experimental program that may require preparation of fresh specimens, use of complex sample-handling systems, and evaluation of samples before and after the measurements on the beamline. Therefore, to make available the full range of biological research opportunities offered by the Advanced Light Source -- at the atomic, molecular, supramolecular, cellular, and tissue levels--dedicated life sciences facilities, both for sample preparation and for specimen evaluation and characterization, will be required. No such biology facilities now exist in the U.S. and, as a result, synchrotron radiation sources remain essentially unavailable to many life scientists. Indeed, most biological research with synchrotron radiation has been limited to the study of relatively stable

1. Title and Location of Project:	ALS Structural Biology Support Facilities Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-337 2b. Construction Funded

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

biochemicals in solution, in suspension, or in crystalline form.

The needed support facilities must include a cell and tissue culture lab, a biochemical lab with a range of spectrometers and a full complement of physical and chemical separation equipment, state-of-the-art light and electron microscopes, an animal surgery station, and powerful computers--all efficiently maintained for the 1-2 GeV life sciences user community. The need for such facilities is underscored by the promise of x-ray microscopy and other imaging methods, which demand on-site preparation of cells and subcellular components.

The ALS Structural Biology Support Facilities will be operated as a national user resource, available to all qualified 1-2 GeV users, in accordance with the 1-2 GeV User Policy. The community of researchers is likely to comprise (i) Lawrence Berkeley Laboratory scientists, some of whom will have offices and laboratories in the new facilities, (ii) a national contingent of life scientists who are committed to long-term research programs centered around the use of synchrotron radiation, usually as members of insertion device teams, and (iii) general life sciences users from within and outside the laboratory who have shorter-term interests in the use of synchrotron radiation.

Estimated operating and maintenance costs associated with the ALS Structural Biology Support Facilities are given in item 12.

1. Title and Location of Project:	ALS Structural Biology Support Facilities Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-337 2b. Construction Funded

10. Details of Cost Estimate a/	Item Cost	Total Cost
a. Design and management costs		$ 560
1. Engineering design and inspection at approximately 15 percent of construction costs item b	$ 560	
b. Construction costs		3,960
1. Improvements to land	$ 14	
2. Building 80 improvements (6,000 GSF at $236/sq.ft.)	1,417	
3. Building 6 improvements (5,100 GSF at $176/sq.ft.)	900	
4. Special facilities	1,279	
5. Utilities	100	
6. Project management	250	
c. Standard equipment		2,230
Subtotal		6,750
d. Contingencies at approximately 17 percent of above costs		1,150
Total line item cost		$ 7,900

a/ Construction costs have been escalated at 2.1% for FY 1992; 3.4% for FY 1993; 4.3% for FY 1994; and 4.5% for FY 1995; and 4.7% for FY 1996.

11. Method of Performance

Conventional facilities engineering design will be performed under a negotiated architect-engineer subcontract. Inspection and some engineering will be done by LBL personnel. Construction and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bids. Technical components and standard equipment for the facility will be procured by fixed-price subcontracts awarded on the basis of competitive bids.

1. Title and Location of Project:	ALS Structural Biology Support Facilities Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-337 2b. Construction Funded

12. Schedule of Project Funding and Other Related Funding Requirements

	Prior Yrs.	FY 1994	FY 1995	FY 1996	Totals
a. Total project costs					
1. Total facility costs					
(a) Line item	$ 0	$ 500	$ 2,300	$ 5,100	$ 7,900
2. Other project costs					
(a) Conceptual design costs	50	0	0	0	50
(b) Environmental compliance documentation costs	50	0	0	0	50
Total project costs (TPC)	$ 100	$ 500	$ 2,300	$ 5,100	$ 8,000

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

1. Facility operating costs	$ 1,000
2. Capital equipment related to operations	100
3. Programmatic operating expenses for research	4,300
4. Capital equipment for programmatic research	500
5. Maintenance, repair, GPP, or other construction related to programmatic research	100
Total related annual funding	$ 6,000

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

a. Total project funding
1. Total facility costs
(a) Line item -- The major elements of the ALS Structural Biology Support Facilities are described briefly in item 8. The construction funding profile was determined after analysis and review of the 1-2 GeV construction schedule. Account has also been taken of the earliest date of anticipated funding and the time required for A/E selection. Construction would begin in the second quarter of FY 1995.

1. Title and Location of Project:	ALS Structural Biology Support Facilities Lawrence Berkeley Laboratory (LBL) Berkeley, California	2a. Project No. 94-E-337 2b. Construction Funded

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

b. Related annual funding

1. Facility operating costs estimated on the basis of experience with comparable research facilities. Funding would support operation of the laboratories and administration of the facilities as a national resource, available to users of life sciences beamlines at the 1-2 GeV. The annual cost of associated capital equipment was estimated at about 10% of the facility operating costs.

2. Estimates for operating expenses and capital equipment costs for life sciences research at the 1-2 GeV, in support of which these facilities are being proposed, were based on costs of research currently being carried out at other synchrotron radiation facilities, especially the National Synchrotron Light Source at Brookhaven. The estimates assume that most of the life sciences research carried out at the 1-2 GeV will be funded by the Department of Energy. If significant funding is obtained from other agencies or from industrial sources, the costs to the DOE could be less.

3. The cost of maintenance and related activities was estimated at about $10 per gross square foot.

4. This facility will not replace any currently funded facility.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1994 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.)

Biological and Environmental Research

1. Title and Location of Project:	Environmental and Molecular Sciences Laboratory Pacific Northwest Laboratory Richland, Washington	2a. Project No. 91-EM-100 2b. Construction Funded

SIGNIFICANT CHANGES

- FY 1995 request reduced from $75,000,000 identified in the FY 1994 President's Budget Request to $40,000,000, with FY 1996 and FY 1997 funding revised to accommodate the reduction.
- The FY 1995 reduction results in the TPC increasing from $217,800,000 to $229,900,000 and the TEC increasing from $196,300,000 to $207,900,000.
- The project schedule for construction completion slips from the 1st quarter FY 1996 to the 4th quarter FY 1996.

DEPARTMENT OF ENERGY
FY 1995 CONGRESSIONAL BUDGET REQUEST

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

Biological and Environmental Research

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

2a. Project No. 91-EM-100
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 2nd Qtr. FY 1991

3b. A-E Work (Titles I & II) Duration: 13 months

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- $196,300
Total Project Cost (TPC) -- $217,800

4a. Date Physical Construction Starts: 2nd Qtr. FY 1994

4b. Date Construction Ends: 4th Qtr. FY 1997

6. Current Cost Estimate:
TEC -- $207,900
TPC -- $229,900

7. Financial Schedule

Fiscal Year	Appropriation a/	Adjustments	Obligations a/	Costs
1991	$ 5,200	-30 b/	$ 5,170	$ 1,500
1992	17,100 c	0	17,100 c/	3,300
1993	28,500	0	28,500	13,200
1994	33,000	0	33,000	52,400
1995	40,000	0	40,000	43,400
1996	50,000	0	50,000	53,600
1997	34,130	0	34,130	36,700
1998	0	0	0	3,800

a/ Funds provided by the Defense Environmental Restoration and Waste Management program for FY 1991 through FY 1993.
b/ Adjustments reflect a $30,000 general reduction.
c/ Excludes $20,000,000 provided by the Department of Defense per the Defense Appropriation Act of FY 1992.

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

2a. Project No. 91-EM-100
2b. Construction Funded

8. Brief Physical Description of Project

As described previously under "significant changes," due to the reduced FY 1995 funding for this project, the completion date has been changed from the 1st Quarter FY 1996 to the 4th Quarter FY 1997 resulting in an attendant increase in the TEC and TPC. The TEC has increased from $196,300,000 to $207,900,000. The TPC has increased from $217,800,000 to 229,900,000.

The Environmental and Molecular Sciences Laboratory (EMSL) 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 Hanford site-specific environmental restoration and waste management problems for the full duration of site clean-up. The new facility will be located at the north end of a technology corridor at the Hanford site, enhancing the interaction with existing radiological facilities (hot cells and laboratories). This strategic location will facilitate linking Hanford problems to technology needs and facility requirements as well as provide dedicated laboratory capability at the Hanford Site for the full duration of site environmental restoration efforts.

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 and graphics rooms, library, ~~lunch area~~ 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.

Laboratory equipment consists of the research equipment and computer systems required to achieve planned research and technology development objectives. Key laboratory equipment includes molecular-level surface chemistry equipment, laser-based spectroscopy equipment, advanced processing equipment, sensor development and evaluation equipment, material testing and evaluation equipment, Ultra High Field Nuclear Magnetic Resonance System, advanced mass spectrometers, data base computer, high performance computer and an advanced computer information system.

The FY 1995 funds requested will be used for project management and support, continued construction of the laboratory facility, and continued acquisition of research and computer equipment.

1. Title and Location of Project:	Environmental and Molecular Sciences Laboratory Pacific Northwest Laboratory Richland, Washington	2a. Project No. 91-EM-100 2b. Construction Funded

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

The purpose of the Environmental and Molecular Science Laboratory (EMSL) is to provide technology solutions to current and future Hanford site-specific environmental restoration and waste management problems. Mission need for EMSL is based on Hanford site-specific technology development needs defined in detailed technology logic diagrams. These logic diagrams link Hanford site-specific problems to technology needs and facility requirements; define the role of existing, modified, and new facilities at the Hanford site, including EMSL; and provide a basis for defining and integrating EM technology development needs on a national scale.

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.

10. Details of Cost Estimate a/	Item Costs	Total Cost
a. Design and cost management		$ 49,920
1. Facility engineering, design, and inspection at approximately 16 percent of construction costs item c	$ 7,360	
2. Research & computer equipment engineering, design and inspection	37,570	
3. Construction management at approximately 8 percent of items c & d	4,990	
b. Land and land rights	0	48,750
c. Construction costs		
1. Improvements to land	1,770	
2. Buildings ($202/sq ft based on 201,000 gross sq ft)	40,590	
3. Utilities (including water electrical power and sewers)	1,420	
4. Special facilities	4,970	
d. Standard equipment (furnishing and standard lab and shop equipment)		2,240

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

2a. Project No. 91-EM-100
2b. Construction Funded

10. Details of Cost Estimate (Continued) a/

	Item Costs	Total Cost
e. Computer equipment (see next page for details)		21,140
f. Research equipment		46,060
g. Project management		19,360
Subtotal b/		187,470
h. Contingency at approximately 10.9 percent of all above costs		20,430
Total line item cost		$207,900

a/ This estimate is based on a completed Conceptual Design Report dated March 1989 and a completed Advanced Conceptual Design Report Dated April 1990, a completed Definitive Design Program dated June 1991, and replan to accommodate schedule delay and scope reduction to maintain TPC of $217.8M.

b/ Includes escalation applied to facility construction at the rates of 0.8% (FY 1990), 2.0% (FY 1991), and 4.4% (FY 1992), 4.8% (FY 1993), 5.2% (FY 1994), 6.0% (FY 1995), 6.0% (FY 1996) to midpoint of construction and procurement.

1. Title and Location of Project:	Environmental and Molecular Sciences Laboratory Pacific Northwest Laboratory Richland, Washington	2a. Project No. 91-EM-100 2b. Construction Funded

10. Details of Cost Estimate (Continued)

Item e. Computer Equipment Details	Qty	Unit Cost	Total
High Performance Production Computer System	1	$ 12,100	$ 12,100
High Performance Research Computer System	1	1,680	1,680
Data Base/Archive Production Computer System	1	3,440	3,440
Items with Unit Cost Less than $100K	-	-	3,680
Operating Software	-	-	210
Installation Cost for Above Hardware	-	-	30
Total			$ 21,140

11. Method of Performance

Conventional facility design and inspection will be completed under a negotiated architect-engineer (AE) contract. Facility construction and procurement will be accomplished by fixed-price contracts awarded on the basis of competitive bidding. Most research equipment and computers will be procured on a competitive bid basis by PNL. Approximately 10% of the research and computer equipment does not exist in the current commercial market and will be provided by PNL.

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

2a. Project No. 91-EM-100
2b. Construction Funded

12. Schedule of Project Funding and Other Related Funding Requirements

	Prior Years	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	TOTAL
a. Total project costs										
1. Total facility costs										
(a) Construction line item..	$ 0	$ 1,500	$ 3,300	$13,200	$52,400	$43,400	$53,600	$36,700	$ 3,800	$207,900
(b) PE&D.....	0	0	0	0	0	0	0	0	0	0
(c) Inventories.....	0	0	0	0	0	0	0	0	0	0
(d) Non-Federal Contribution.....	0	0	0	0	0	0	0	0	0	0
Total Estimated Cost.....	$ 0	$ 1,500	$ 3,300	$13,200	$52,400	$43,400	$53,600	$36,700	$ 3,800	$207,900
2. Other project costs										
(a) R&D required for construction.....	$ 0	$ 0	$ 2,160	$ 2,600	$ 1,700	$ 900	$ 800	$ 410	$ 50	$ 8,310
(b) Conceptual design costs.	1,540	0	0	0	0	0	0	0	0	1,500
(c) Other project related costs.....	0	0	0	200	350	500	1,500	3,700	600	7,050
(d) Capital equipment.....	0	0	240	2,080	2,670	0	0	0	0	$ 5,140
Total other project cost....	$1,540	$ 0	$ 2,400	$ 4,880	$ 4,720	$ 1,400	$ 2,300	$ 4,110	$ 650	$ 22,000
Total project costs (TPC)...	$1,540	$ 1,500	$ 5,700	$18,080	$57,120	$44,800	$55,900	$40,810	$ 4,450	$229,900

b. Related annual funding (Estimated Life of Facility: 40 years)a/

1. Facility operating costs	$ 28,000
2. Programmatic costs directly related to the facility	35,000
3. Capital equipment required to maintain state-of-the-art capability	2,000
4. GPP or other construction related to programmatic effort in the facility	500
Total related annual costs	$ 65,500

a/ Estimated costs in thousands escalated to FY 1997 dollars.

1. Title and Location of Project:	Environmental and Molecular Sciences Laboratory Pacific Northwest Laboratory Richland, Washington	2a. Project No. 91-EM-100 2b. Construction Funded

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

a. Total project funding
   1. Total facility costs
      (a) Construction line item -- Includes estimated cost for conventional facility design and construction, initial complement of research equipment and computers, and project management -- $207,900,000
      (b) Operating Expense Funded Equipment -- None
      (c) Inventories -- Inventories necessary to put the facility into use are included in operating costs.
      (d) Non-Federal Contribution -- None.
   2. Other project costs
      (a) R&D necessary to complete construction -- Includes the conceptual design and prototype development of specific items of the research and computer equipment required to permit specification of the final equipment to be procured and installed in the EMSL -- $8,620,000
      (b) Conceptual design was completed during FY 1988 and revised in FY 1989 to incorporate DOE comments. An alternate design was developed during FY 1990 for a total of -- $1,540,000
      (c) Other project related costs -- Includes the estimated operating contractor costs associated with the construction line item for the following: (a) operational readiness review, (b) relocation of R&D equipment, and (c) software required for fully functional facility computer system --$6,850,000
      (d) Non-Federal Contribution -- None
      (e) Programmatic capital equipment includes research and computer equipment necessary for R&D required for construction -- $4,990,000

b. Other related annual costs

Annual related funding requirements will vary as research and operations are implemented, the new facility is occupied at the end of FY 1996, and steady-state operation is attained in FY 1998. The estimated total related funding requirements are identified in Section 12.B and discussed below:

1. Facility operating costs -- The estimated annual facility operating costs include all personnel, materials, and resources required to support operation of a high technology DOE user facility. The annual facility operating estimate is comprised of the following expense elements:

1. Title and Location of Project:	Environmental and Molecular Sciences Laboratory Pacific Northwest Laboratory Richland, Washington	2a. Project No. 91-EM-100 2b. Construction Funded

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

b. Related annual funding (Continued)

Utilities and building maintenance d/
ADP operations and upkeep:

Maintenance contracts (approximately 10 percent of capital costs)	$ 4,000
Staff operations/support	9,000
Materials and supplies	1,000
Subtotal ADP operations and upkeep	$14,000

Research equipment operations and upkeep:

Maintenance contracts (approximately 10% of capital costs)	$ 7,000
Staff operations/support	4,000
Materials and supplies	3,000
Subtotal research equipment operations and upkeep	$14,000
Total Facility Operating Costs	$28,000

2. Programmatic costs directly related to the facility -- The estimated programmatic operating costs include all personnel, materials, capital equipment and resources required to perform environmental and molecular sciences research for the following customers; DOE Office of Energy Research ($14,000,000), DOE Office of Environmental Restoration and Waste Management ($14,000,000), and other DOE offices ($7,000,000) -- total $35,000,000.

3. Capital equipment required to maintain state-of-the-art capability facility -- To maintain viable research programs, it will be necessary to update research equipment and computers to keep pace with the rapid change of technology in these areas. This estimate includes costs to maintain programmatic related research equipment and computers at state-of-the-art level - $2,000,000.

d/ Utilities and building maintenance estimated cost is $3,000,000. This is an indirect cost recovered via a Buildings & Utility (B&U) overhead applied to all PNL staff working in EMSL and is included in programmatic and facility operating costs.

1. Title and Location of Project:	Environmental and Molecular Sciences Laboratory Pacific Northwest Laboratory Richland, Washington	2a. Project No. 91-EM-100 2b. Construction Funded

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

4. GPP or other construction related to programmatic effort -- It is expected that alterations will be required beginning in FY 1997. This estimate is approximately 1% of the initial facility cost and will be required to make facility modifications to accommodate specific user experiments, relocate and/or modify existing research equipment and install new latest generation research equipment -- $500,000.