DEPARTMENT OF ENERGY
FY 1994 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 also aims at using the scientific knowledge gained to develop technological tools that may be used to mitigate or correct such adverse consequences, and to use the Department's unique multidisciplinary scientific and technological capabilities to solve major scientific problems in biology, medicine and environmental science.

HEALTH RELATED PROGRAMS

The Department's Biological and Environmental Research responsibilities began with the formation of the Atomic Energy Commission in 1946. 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. Positive correlations between radiation exposure and cancer were shown, both in the Japanese population and in experimental animals, which provided a quantitative scientific framework for policy decisions regarding establishment of radiation protection standards.

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 biology 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. Early research on exposure measurement technology provided the personnel and area monitoring capability now employed at national laboratory and commercial nuclear power facilities. Current research will achieve not only more sensitive radiation exposure measurement techniques but also advanced techniques to measure chemical exposures from nuclear and non-nuclear energy operations.

The DOE radiobiology program is the Nation's lead research program for understanding the health consequences of low-level ionizing radiation exposure. Currently, a large component of the program is focused on evaluation of the potential health consequences of indoor radon. Information developed in the program is widely used by standard-setting bodies and in the development of health protection measures. 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 collaborative research in the areas of microdosimetry, radon and DNA repair.

Meeting the mission of this program requires the development of broadly generalizable knowledge and predictive principles that will enable assessment of the potential health consequences of any proposed energy option. This necessitates the use of molecular, biochemical and cellular information obtained from both cell culture and animal systems to establish the fundamental principles underlying the responses to radiation and other energy-related agents. The research involves: elucidating the molecular and cellular events underlying spontaneous and induced genetic and epigenetic events that lead to cancer, heritable mutations, and/or congenital malformations; identifying, isolating and characterizing the genes that govern the repair of DNA damage in human cells; investigating individual differences in susceptibility to exogenous energy-related agents; increasing fundamental knowledge on the physical and chemical processes involved in the initial interactions of radiation with biologically relevant materials and relating those events to the ultimate biological effects; developing the information necessary to predict more accurately the roles of dose, dose rate and ionization density (or linear energy transfer, LET) on the induction of mutations, cancer or heritable damage; and developing a comprehensive approach for evaluating the effects of radon exposure in humans.

The DOE human genome program represents a relatively new effort which supports two of the BER objectives. First, it provides new approaches, based on modern biology and technology, 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 with new resources and technologies. While the DOE program, which is planned and carried out in coordination with the National Institute of Health (NIH), is focused towards developing capabilities and tools, constructing maps and sequencing 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 predominantly in academia.

Structural biology seeks 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 over a wide range of areas of application, from energy production from biomass to environmental remediation. DOE has a special responsibility in structural biology for making available to the national scientific community cutting-edge facilities for research at the Department's major facilities such as synchrotrons and neutron beam sources. The Advanced Light Source at LBL and the Advanced Photon Source at ANL will provide unique capabilities for structural biology experiments using imaging, crystallography, small-angle scattering and spectroscopy with ultra-bright x-ray beams. Workshops and studies carried out by several agencies have reported on the essential role these new facilities will play in the development of structural biology as an enabling foundation for biotechnology and biomedical science and have pointed to the central responsibility DOE's structural biology program has for the facilities. The DOE program envisions increased support for operation of user stations for structural biology at the facilities, but also places a high priority on training of a new generation of biologists in this rapidly evolving field.

ENVIRONMENTAL SCIENCES

The environmental sciences research program of BER addresses the broad DOE mission. The integrated environmental sciences program builds new scientific understanding to support the objectives of the Energy Policy Act of 1992, the continuing National Research Program in global change, and the basic environmental research essential to underpin these activities.

The long-term research base established within the DOE environmental research program has enabled the Department to respond effectively to national environmental concerns. For example, the DOE research in atmospheric chemistry has been a key component in the National Acid Precipitation Assessment Program (NAPAP). The national laboratories and the university community are conducting a series of laboratory and field studies of the processing of sulfur and nitrogen oxides by clouds and precipitation and the mechanisms of their deposition in the environment. In response to the in-depth review of the DOE atmospheric chemistry program by the National Academy of Sciences (NAS), elements of the program have been redirected toward support of the Energy Policy Act of 1992 to focus on nitrogen oxides, ozone, and aerosols. The ozone research program on the production and destruction of ozone in the troposphere/stratosphere and changes of UV-B at the surface will be enhanced. The program will continue to conduct research in cooperation with the International Global Atmospheric Chemistry (IGAC) Program through the Committee on Earth and Environmental Sciences (CEES). In the area of atmospheric transport and diffusion, DOE continues to conduct experiments in complex terrain to provide basic research data that support improved emergency preparedness and emergency response as well as models for global change. Experiments and analyses will continue related to the meteorology near Rocky Flats.

The 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, a factor important both for understanding impact on renewable resources and for global carbon balance evaluation. Through a series of interagency meetings and a BER-sponsored workshop, the Ocean Margins Program has been restructured to better quantify the role of the coastal ocean in the global flux of carbon and 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 restructured ocean margins program are to quantify the mechanisms and processes 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. Initial experiments and technology development will begin to support these objectives.

The Subsurface Science Program includes DOE's only fundamental long-term research related to the geochemistry, hydrology, and microbiology of the subsurface biosphere, including the mobility and stability of natural chemicals and chemical containments in subsoils and groundwater, and insights into the hydrologic cycle. The BER program has developed a plan (5-20 years) for basic long-term research related to environmental restoration, in conjunction with other Departmental elements that are concerned with more immediate, short-term needs in environmental restoration and waste management. Research will be conducted to extend programmatic advances in basic molecular and laboratory-scale research on the geochemical and microbiological mechanisms that control the stability and transport of organic-radionuclide complexes to controlled intermediate scale experimentation using unique facilities that simulate subsurface conditions. Improved predictions about the transport of organic-radionuclide complexes are expected to result from such research. Because the subsurface biosphere tends to be most directly impacted by past DOE waste disposal practices, research in the terrestrial subsurface has become critical as a source of new concepts with long-term benefits related to environmental restoration at DOE sites. One concept that will be addressed is the possible use of genetically modified organisms to bioremediate DOE sites. New concepts and discoveries in such areas as organic-radionuclide contaminant transport and deep microbiology are being transferred rapidly to DOE sites and industry.

In order to substantially expand the fundamental understanding of the subsurface biosphere by the year 2000, a five-year integrated molecular to field-scale biotechnology program has been initiated to determine the origin and 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 for more than 14,000 years. Recent discoveries of anaerobic thermophiles at depths over 3,000 meters were made cooperatively with industry. 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. Research is also being initiated to refine aseptic sampling protocols. A series of controlled, intermediate-scale experiments using unique flow cells will be used to simulate the natural subsurface biosphere with emphasis on bacterial transport and survival on the hydrogeologic-microbiological mechanisms that control chemical transport.

Enhanced research activities in environmental biotechnology will be carried out in several programs. The objective is to use molecular biology in concert with other disciplines to detect and measure significant changes in ecological systems. These include new approaches for detecting stressed states of organisms and understanding the genetic control mechanisms for environmental adaptation and survival used by organisms, particularly terrestrial plants, microorganisms and marine organisms.

The long-term ecosystem studies carried out primarily on the DOE National Environmental Research Parks have provided predictive capability for projecting and assessing future energy-related problems. Research that was started in the 1960s on chemical and water balance in watersheds was important in understanding of the buffering capacity of forested soils to acid rain, and carbon partitioning in the biosphere and geosphere. Today this program is in the forefront of theoretical studies of sustainability of natural resources essential to environmental quality in diverse regions influenced by energy activities ranging from global impacts to local and regional disturbances. Theory is helping to better define opportunities for mitigation and in land-use planning, areas of particular concern to the National Energy Policy Act of 1992. This environmental research, particularly work related to fundamental theory and strategic research at the national laboratories has positioned DOE to carry out research to understand the biological responses in ecosystems to global and regional environmental changes, and ecosystem responses to disturbances resulting from energy related activities. Specific research will be focused on: understanding mechanisms that control these responses; the rates of environmental change; providing the knowledge needed to enhance sustainability of natural and managed ecological systems; obtaining the technology needed to separate biological adjustments to natural environmental changes from adjustments resulting from human-induced environmental changes.

A major environmental concern is possible global warming from the increase of greenhouse gases and especially carbon dioxide (CO_2) in the atmosphere from the burning of fossil fuels. For over fourteen years the Carbon Dioxide Research Program has studied the carbon dioxide interactions with the atmosphere, the biosphere, the oceans and the geosphere and the resultant impacts on critical resources. The Carbon Dioxide Research Program is the principal DOE activity in the U.S. Global Change Research Program coordinated by the Committee on Earth and Environmental Sciences of the Office of Science and Technology Policy. The Secretary of Energy has identified global change as an important

environmental consideration for the Energy Policy Act of 1992. DOE has launched major research initiatives to accelerate progress in the scientific capability to predict global and regional climate change. To provide essential data, the Atmospheric Radiation Measurement (ARM) Program was initiated in 1989. The ARM program will collect data in the five most climatologically significant locales over a period of seven to ten years. ARM began providing data from its first ground site (in the U.S. southern great plains) in the spring of 1992, and will provide data from its second site (in the tropical western pacific ocean) in late 1993 or early 1994, and from its third site (on the north slope of Alaska) in 1995. ARM will quantify accurately the cloud-climate feedback system and improve the corresponding parameterizations in the climate change prediction models. The next component is an effective integration of advanced computer hardware and software with the next generation climate models in order to accelerate computing throughputs by a factor of 10,000 within the next ten years. The program will execute 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 understand the feedbacks among climate processes that result in prediction uncertainties. Funds to continue to utilize Unmanned Aerospace Vehicles (UAVs) to measure cloud-radiation interactions and augment surface based measurements are also requested; small climate satellites for cloud/radiation interaction studies will be delayed. Another component is the need for ocean data to understand ocean circulation and the exchange of carbon dioxide between the open ocean and the atmosphere. Measurements and modeling will continue in conjunction with the International World Ocean Circulation Experiment. The training of the next generation of scientists is also essential to global change, therefore, the fellowship program in global change will continue.

MEDICAL APPLICATIONS

This research program, mandated initially by the Atomic Energy Act of 1946 to promote the use of radioactive materials and radiation for medical applications, has provided the scientific and technological foundation for the establishment of Nuclear Medicine as a major clinical specialty. Research in radioisotope production, radiopharmaceutical chemistry, radioisotope imaging instrumentation together with investigation of a broad range of diagnostic and therapeutic applications not only demonstrated and validated advanced diagnostic and therapeutic capability but also led to the establishment of a vital radionuclide production, radiopharmaceutical development, and 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.

In recent years the medical applications program has become reformulated to address a broad range of clinical research requirements. The current program includes six major areas: (1) research to develop new radioisotopes, (2) development and application of new radiopharmaceuticals, (3) instrumentation, (4) clinical feasibility, (5) exploration of new radiation therapy modalities, with emphasis on Boron Neutron Capture Therapy, and (6) molecular nuclear medicine to apply molecular biology advances to address research needs in nuclear medicine.

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

The DOE program is directed toward development of advanced nuclear medicine technology and initial exploration of its medical applicability. It complements the National Institute of Health (NIH) research programs which are more strongly clinical and disease oriented. Advanced procedures and technologies developed under the DOE program become the province of the NIH when clinical efficacy studies are warranted. Future activities will involve the development of new methods to measure human biochemical and physiological function in normal and diseased states using nuclear medicine methods. A major objective will be to provide new technologies for the study of: the causes of heart disease, such as atherosclerosis or coronary artery disease; the metabolic attributes of human tumor; the study of Alzheimer's disease and other dementias; and the etiology of aging. Methods include external photon detection instrumentation, mathematical modeling, radiopharmaceuticals, synchrotron radiation and lasers.

Summary of FY 1994 Request

FY 1994 emphasis will continue to be placed on supporting small science as called for in the Energy Policy Act of 1992.

-- Continues structural biology research activities to determine macromolecular structure and initiates construction of the Structural Biology Centers at the Argonne National Laboratory and Lawrence Berkeley Laboratory.

-- Initiates limited use of unmanned aerospace vehicles and related instrumentation for extended time observations near the tropopause providing needed and not presently available data on clouds and atmospheric energy balance.

-- Meets the goals of the DOE-NIH 5-year plan for the U.S. national genome program by expanding physical mapping, initiating a proof-of-concept project for large-scale sequencing, and accelerates efforts for computational development to improve handling and analysis of mapping and sequencing data, and initiates construction of the Human Genome Laboratory at Lawrence Berkeley Laboratory.

-- Continues research on interface of nuclear medicine, structural biology, and molecular biology to develop advanced labeling methods for selectively concentrating radiolabeled probes in specific body target sites for the study, diagnosis and therapy of disease. Operational support for the BNL medical reactor will be sustained to meet more stringent Environment, Safety and Health (ES&H) requirements. Begin upgrade of the Brookhaven Linac Isotope Producer and the project definition phase of the National Biomedical Tracer Facility.

-- Assumes responsibility for funding and managing the Environmental and Molecular Sciences Laboratory project at the Pacific Northwest Laboratory.

-- Accelerates research on the potential health consequences of indoor radon, biodosimetry and measurement sciences while phasing out efforts in applied dosimetry research and development.

-- Intensifies research on the biotechnology of microbial organisms for novel applications in bioremediation, new drug development, and biocatalysis.

-- Enhances the research to understand the production/destruction of mid-latitude tropospheric/stratospheric ozone and the trends in surface UV-B.

-- Continues the program for Ecosystem Research supporting the National Global Change Program with research to determine how ecosystems adjust during global climate change and how the adjustment responses are controlled.

-- Continues Global Change research addressing the need for data on cloud-radiation interactions and enhanced predictive models for climate change.

-- Continues the application of molecular biological methods to ecosystems research, with emphasis on subsurface, ocean margins and terrestrial ecosystems.

-- Increased emphasis on energy/environmental policy related to radon, ozone and nitrous oxides.

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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 1992 Adjusted		FY 1993 Appropriation	FY 1993 Adjustment		FY 1994 Request
Biological and Environmental Research	$322,203		$344,700	-$34,760	f/	$338,060
Program Direction	6,100		6,600	0		7,100
Capital Equipment	16,832		27,500	-7,000	g/	21,600
Construction	7,234		5,900	0		49,300
Subtotal, Biological and Environmental Research	$352,369	a/b/c/d/	$384,700	-$41,760		$416,060
Adjustment	0		-28,000	e/ 28,000	e/	0
TOTAL	$352,369		$356,700	-$13,760	f/	$416,060
Summary						
Operating Expenses	$328,303		$330,300	-$13,760		$345,160
Capital Equipment	16,832		20,500	0		21,600
Construction	7,234		5,900	0		49,300
Total Program	$352,369		$356,700	-$13,760	f/	$416,060
Staffing Total FTEs						
Headquarters	58		58	0		59
Field	90		88	0		88
Total	148		146	0		147

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

a/ Total has been reduced by $3,409,000 which has been transferred to the Small Business Innovative Research program.
b/ Reflects transfer of $713,000 to Advisory and Oversight for ES&H activities.
c/ Includes $402,973 which has been transferred to the Office of Space, and $3,034,100 of prior year funds reprogrammed to Project No.'s 91-E-350 and 91-E-310.
d/ Reflects reprogramming of $566,000 to EM.
e/ Program specific general reduction.
f/ Program specific general reduction of $21,000 and general reduction for use of prior year balances of $13,760.
g/ Program specific general reduction.

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SUMMARY OF CHANGES
Biological and Environmental Research

FY 1993 Appropriation	$ 384,700
- Adjustment - Program specific general reduction	-28,000
- Adjustment - General reduction for use of prior year balances	-13,760
FY 1993 Adjusted	$ 342,940
- Decrease analytical technology research	- 1,811
- Increase environmental research efforts including ozone and nitrous oxides	+ 8,910
- Continue construction of the Environmental and Molecular Sciences Laboratory at Pacific Northwest Lab	+ 33,000
- Maintain efforts in health effects research	+ 452
- Increase structural biology research	+ 2,200
- Provide for construction of structural biology centers at ANL and LBL	+ 4,600
- Increase cellular and molecular biology research	+ 800
- Increase human genome research, and provide for construction of genome laboratory at LBL	+ 8,020
- Increase research on molecular nuclear medicine and monoclonal antibodies including National Biomedical Tracer Facility Project definition	+ 3,825
- Completed a biomedical isotope facility at LBL in FY 1993	- 600

- Completed a biomedical isotope facility at LBL in FY 1993	-	600
- Upgrade the Brookhaven Linac Isotope Producer at Brookhaven National Laboratory	+	6,000
- Completed a structural biology addition at the NSLS at BNL in FY 1993	-	1,800
- Support increase in global change research and capital equipment	+	9,024
- Maintain program direction needs	+	500
FY 1994 Congressional Budget Request		$416,060

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ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Analytical Technology

Research supported by the analytical technology program is providing basic information in measurement science for development of instrumentation and techniques for use in a variety of programs supported by Biological and Environmental Research (BER). This information is important and significant for environmental research, health effects studies, structural biology, human genome research and nuclear medicine. Fundamental research in radiation dosimetry and chemical dosimetry technology will provide and improve accuracy in determining human exposure to environmental radiation and chemicals, which in turn should help in correctly evaluating the human health risk. This information may provide a firmer technical and scientifically defensible basis for adjudicating radiation and chemical health effects claims.

The utilization of lasers for characterizing complex chemical mixtures will be developed with emphasis on techniques making use of highly reliable diode lasers. This should provide the needed sensitivity and highly specific measurement of radioisotopes and toxic chemical materials that result from energy production technologies. The program is also supporting development of entirely new concepts for in situ sensing of selected pollutants. Ultimately the new techniques will permit improved accuracy in assessing health and environmental risks from energy related pollutants.

Fundamental research in the field of measurement science and instrumentation will provide significant and critical developments needed for the Department's biotechnology initiative. This initiative is expected to bring about a technological revolution in important areas such as environmental bioremediation, individual health risk assessment, and medical diagnosis and treatment. Important fundamental scientific advances from this program are being utilized by a number of other BER programs and is also being transferred to the private sector for commercial use, helping maintain the international competitive edge for the United States.

II. A. Summary Table: Analytical Technology

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Dosimetry Research	$ 7,577	$ 6,950	$ 4,649	- 33
Measurement Science	5,185	4,625	5,115	+ 11
Total, Analytical Technology	$ 12,762	$ 11,575	$ 9,764	- 16

II. B. Major Laboratory and Facility Funding

	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
AMES LABORATORY	$ 444	$ 425	$ 375	- 12
ARGONNE NATIONAL LABORATORY (EAST)	$ 653	$ 690	$ 660	- 4
BROOKHAVEN NATIONAL LABORATORY	$ 112	$ 90	$ 0	-100
ENVIRONMENTAL MEASUREMENTS LABORATORY	$ 5,015	$ 4,690	$ 3,600	- 23
IDAHO NATIONAL ENGINEERING LABORATORY - EG&G	$ 115	$ 115	$ 115	0
INHALATION TOXICOLOGY RESEARCH INSTITUTE	$ 100	$ 90	$ 90	0
LAWRENCE BERKELEY LABORATORY	$ 1,060	$ 745	$ 715	- 4
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 140	$ 125	$ 125	0
OAK RIDGE NATIONAL LABORATORY	$ 2,005	$ 1,940	$ 1,715	- 12
PACIFIC NORTHWEST LABORATORY	$ 1,005	$ 700	$ 750	+ 7

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

Program Activity	FY 1992	FY 1993	FY 1994
Analytical Technology			
Dosimetry Research	Completion of data on transport, deposition and distribution of radionuclides from the Chernobyl reactor accident updated and revised incorporating additional data from US/USSR collaboration.	No activity.	No activity.
	Fundamental studies of the physical and chemical effects of exposure to ionizing radiation applied in developing new concepts and methods for correctly defining the dose. Maintained research on developing dosimetric techniques for low LET and high LET radiations. Basic dosimetry research on radon and radon daughters continued.	Basic dosimetry research will focus 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 will be conducted. Quality assurance programs to maintain the accuracy of radiation measurements will be 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.

III. Analytical Technology (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Dosimetry Research (Cont'd)	Characterization and measurement of DNA adducts continued with emphasis on indication of very low levels from chemical exposures.	Chemical dosimetry research will concentrate on detecting and characterizing DNA adducts that are potentially biologically significant lesions.	Chemical dosimetry research will emphasize highly selective and sensitive new techniques in mass spectrometry which have the potential of distinguishing indicators of exposure to chemicals.
	$ 7,577	$ 6,950	$ 4,649
Measurement Science	Research on new instrumentation for detection and measurement of very low levels of biological damage due to radiation and chemical exposures continued. Advances in diode laser technology applied to development of simpler, less expensive systems for ultra-sensitive laser techniques which will be explored to study very fast chemical processes caused by radiation exposure. New mass spectrometric instrumentation was evaluated for measurement of biological macromolecules.	New research on laser applications will focus on techniques for combining laser vaporization and mass spectrometry to characterize large organic molecules. Application to protein and DNA sequencing will be evaluated. Electron and photon tunneling microscopy techniques will be explored for imaging biological materials at the cellular and subcellular level. Laser spectroscopy, particularly involving resonance ionization, will be applied to very sensitive and selective measurement of complex, biologically active organic compounds. New types of ion microphobes are under development which will be 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.
	Funding in the amount of $102,000 has been transferred to the SBIR program.	Funding in the amount of $103,000 has been budgeted for the SBIR program.	Funding in the amount of $100,00 has been budgeted for the SBIR program.
	$ 5,185	$ 4,625	$ 5,115
Analytical Technology	$ 12,762	$ 11,575	$ 9,764

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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 abilities of biological systems to adjust to disturbance from energy extraction, supply, and production is also an important aspect of sustaining ecosystem processes and mitigation techniques to control damage. The broadness of this charge 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 processing of pollutants by clouds and precipitation, air-surface exchange, tropospheric and stratospheric ozone and aerosol formation; aerosols are an emerging scientific issue in global change. The second component explores transport and diffusion over complex terrain with a goal of providing research results which would be used by the Department's Assistant Secretaries for Environment, Safety and Health and Defense Programs to enhance the emergency preparedness and response systems at key DOE installations as well as support global change modeling. A major emphasis will be the chemical processes related to the production/destruction of mid-latitude tropospheric/stratospheric ozone and re-analysis of the ozone trend data and surface UV-B data.

The marine program concentrates on the exchange of energy and natural materials between the continental shelf and the open ocean. Close collaboration with other programs working in the open ocean 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 providing important information on carbon flux and may hold the key to the missing component of the world wide carbon budget.

The subsurface science program conducts research on subsurface sediment and groundwater systems, on exploring microbial communities in deep sediments and aquifers, and on the mechanisms that control the mobility of organic-radionuclide complexes. The program seeks to understand 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.

Research for ecosystem functioning and response is focused to provide a 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 some of its environmental/ecological problems and provide a biological basis for making ecological risk and injury assessments. The DOE National Environmental Research Parks will be organized to support specific activities at DOE National Laboratories.

This budget includes $6,600,000 in FY 1993 and $9,600,000 in FY 1994 for the Biotechnology FCCSET initiative.

II. A. Summary Table: Environmental Research

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Atmospheric Science	$ 10,205	$ 10,591	$ 15,792	+ 49
Marine Transport	6,055	7,653	7,608	- 1
Terrestrial Transport	14,061	16,045	20,118	+ 25
Ecosystem Functioning and Response	5,817	6,505	6,186	- 5
Total, Environmental Research	$ 36,138	$ 40,794	$ 49,704	+ 22

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LABORATORY (EAST)	$ 1,357	$ 1,155	$ 1,380	+ 19
BROOKHAVEN NATIONAL LABORATORY	$ 4,046	$ 4,356	$ 4,092	- 6
ENVIRONMENTAL MEASUREMENTS LABORATORY	$ 1,634	$ 1,334	$ 1,334	0
FERMI NATIONAL ACCELERATOR LABORATORY	$ 50	$ 50	$ 50	0
IDAHO NATIONAL ENGINEERING LABORATORY - EG&G	$ 836	$ 884	$ 895	+ 1
LAWRENCE BERKELEY LABORATORY	$ 1,111	$ 1,070	$ 1,020	- 5
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 1,049	$ 1,013	$ 1,023	+ 1
LOS ALAMOS NATIONAL LABORATORY	$ 1,331	$ 1,125	$ 1,060	- 6
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 0	$ 31	$ 0	-100
OAK RIDGE NATIONAL LABORATORY	$ 3,177	$ 2,953	$ 1,895	- 36
PACIFIC NORTHWEST LABORATORY	$ 9,118	$ 8,653	$ 8,663	0
SAVANNAH RIVER ECOLOGY LABORATORY	$ 100	$ 100	$ 300	+200
SAVANNAH RIVER LABORATORY	$ 200	$ 200	$ 200	0

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

Program Activity	FY 1992	FY 1993	FY 1994
Environmental Research			
Atmospheric Science	The multi-laboratory consortium launched a field study in conjunction with the Continental and Oceanic Fate of Energy Related Pollutants Program. The study was coupled with the Committee on Earth and Environmental Sciences (CEES) Global Tropospheric Chemistry Experiment. A university grants program in atmospheric chemistry continued. Laboratory studies of formation and transformation of energy related pollutants of a nitrogen base as well as the role of organics in the transformations continued. The DOE program joined the International Global Atmospheric Chemistry (IGAC) Program.	To address National Energy Strategy environmental objectives, an expanded atmospheric chemistry research program (as recommended by the National Academy of Sciences) will strengthen regional, continental and global dispersion models and enhance studies on ocean-atmosphere exchange processes. The program will improve 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 will continue to focus on continental and oceanic fate of energy related pollutants with a tighter coupling to the CEES North American Regional Experiment (NARE) of the International Global Atmospheric Chemistry (IGAC) Project. Research on midlatitude tropospheric and stratospheric ozone has been initiated. Research includes 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 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.
	Analysis of data from the Kuwait oil fires plume completed with resulting improvements in our understanding of fundamental atmospheric chemistry processes and in the global atmospheric chemistry models.	Data from all researchers of the Kuwait oil fires plume will be utilized in model verification and validation studies.	No activity.

III. Environmental Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Atmospheric Science (Cont'd)	Field studies and numerical modeling of transport and diffusion within the ASCOT Program strengthened the scientific foundation of emergency preparedness and emergency response systems for critical DOE facilities. The focus remained on the Rocky Flats Plant in Colorado. The application of ground based remote sensing instrumentation provided valuable data for validation of models of dispersion in the near field of the Plant (within 10 km).	The second phase of the ASCOT field program around the Rocky Flats Plant will be coordinated with ongoing studies of the Denver "brown cloud". Emphasis will be placed on the influence of larger scale meteorological flows on local circulations. The use of tracers and remote sensing instrumentation will 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 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).
	Development and application of tracer technology proceeded to support the atmospheric dispersion studies. Improved instrumentation aboard the PNL research aircraft met the scientific challenges of both the environmental processes and climate programs.	Funding for the research aircraft will greatly enhance 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.
	$ 10,205	$ 10,591	$ 15,792
Marine Transport	This program was restructured into an Ocean Margins Program (OMP) which is better focussed on quantifying the role of the coastal ocean in the global flux of carbon and on determining whether continental shelves are quantitatively significant in removing carbon dioxide from the atmosphere. Research also addressed whether the CO2 is isolated via burial in sediments or exported to the interior ocean or into estuaries, where it is effectively prevented from recycling to the atmosphere. This program was integrated into the biogeochemical element of the CEES Global Change Research Program. The BER program focused on key physical, chemical and biological processes that control carbon exchange and the fate of contaminants in ocean margins. This	Process research in the cycling of carbon will begin 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 FY1992 will be assessed and incorporated into plans for the new field program. Necessary new projects enabling a more balanced effort and comprehensive analysis will be 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	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. 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 FY 1995 field year. Logistical staging and coordination of program projects will be initiated.

III. Environmental Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Marine Transport (Cont'd)	program was made analytically more discriminating by development of new methods and instruments and new and innovative research approaches to discern the principal pathways and mechanisms by which carbon is assimilated, transformed, and dispersed in the coastal ocean. The factors which control the cycling of carbon dioxide between the atmosphere, the coastal zone, and the open ocean were also evaluated. Studies were initiated to provide early scoping of the likely fate and distribution of organic carbon in estuarine shelf, and offshelf sediments. Instrument manufacturing and logistical staging was conducted for other process studies to be conducted in the first phase of the OMP.	application of molecular techniques for analyzing and quantifying the principal biological reactions and the factors controlling these reactions will be 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.	Notice for additional complementary projects will be promulgated and finalized. Application of molecular biological techniques to biological processes will be expanded.
	$ 6,055	$ 7,653	$ 7,608
Terrestrial Transport	Radon research focused on: (1) defining the availability and emanation potential of radon within the geologic environment, (2) quantifying the mechanisms and environmental variables that control radon transport, and (3) developing predictive models to link radon transport within soils to its entry into homes and buildings. Research emphasis was on basic chemical reactions within soil and rock systems that affect the release of radon. Research findings on radon transport through environmental systems were summarized in a synthesis volume which also contained a bibliography of more than 2,500 entries. New research was initiated in collaboration with the Environmental Protection Agency (EPA) and the United States Geological Survey (USGS) to develop the statistical	Conduct review of environmental radon research. Begin 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. Expand 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). Begin to test protocols and models that correlate environmental data with indoor	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

III. Environmental Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Terrestrial Transport (Cont'd)	protocols necessary for linking geological, soil, and environmental information with indoor radon concentrations. These protocols were necessary for identifying areas with the highest potential for elevated indoor radon concentrations. ($1,781)	monitoring data in Minnesota and New York. ($1,790)	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. ($1,740)
	Accelerated transfer of DOE Deep Subsurface Microbiology Culture Collection to bioremediation industry and university researchers; began to develop CRADA. Novel DOE/OER aseptic sampling methods refined to obtain uncompromised in situ microbial-sediment samples at increased depth. Such methods are needed nationally in microbiological research and for analysis of chemical transport. Preliminary analysis of deep microbial-environmental interactions completed by a consortium of 20 national laboratory and university investigators using data from Savannah River, Hanford, and Idaho research sites, and new samples as part of an integrated Geochemical, Microbiological and Hydrological Experiments (GEMHEX) at Hanford initiated. Molecular biologic methods for rapid identification of subsurface microbial communities expanded. Exploratory research initiated with industry to acquire and analyze microbial communities, if they exist, at depths up to 3000 meters; the origins and capabilities of possibly ancient microorganisms motivated this research. Completed technology transfer plans. ($4,900)	Continue analysis of comparative information base in deep microbiology at DOE Savannah River, Idaho, and Hanford sites. Complete GEMHEX experiment sampling and begin analysis. Maintain research to exploit new molecular biological techniques to evaluate the deep microbiology culture collection. Define 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. Conduct exploratory research on the survival of possibly ancient subsurface microbial communities, cooperatively with Texaco Oil Company. Enhance basic research on microbiological-geochemical interactions, with emphasis on the subsurface environmental variables that control deep microbial populations in ground water. Accelerate technology and information transfer of basic research results to industry and DOE sites, with immediate benefit to bioremediation at DOE sites. Accelerate 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. Prepare research plan and public notice. ($6,000)	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 Geochemical -Microbiological-Hydrological Experiment (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 thru 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. ($8,200) 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

III. Environmental Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Terrestrial Transport (Cont'd)			bacteria to determine unique sequences. ($1,500)
	Research on the hydrologic and geochemical properties of the unsaturated zone and groundwater that control chemical transport continued and initial field injection experiments to determine the stability and transport of organic macromolecules (colloids) under aerobic and anaerobic conditions completed. ($1,580)	Complete field injection experiments at colloid research sites and reduce research in organic colloids. Increase research on the genesis and deposition of inorganic colloids. Terminate 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. ($1,000)	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. ($1,000)
	Laboratory experiments using state-of-the-art molecular spectroscopic techniques focused on quantifying organic chemical-radionuclide interactions and processes important to stabilization of contaminant mixtures. Research to develop new predictive models of how multiple (geochemical-hydrologic -microbial) processes control subsurface contaminant movement continued and prototype geochemical/ hydrological modules of an expert system that allows prediction of mixed chemical stability and mobility completed. ($5,800)	Extend 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. ($4,300)	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. ($4,400)

III. Environmental Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Terrestrial Transport (Cont'd)	No activity.	No activity.	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. ($1,000)
	No activity.	Enhance research on subsurface physical, chemical and microbial heterogeneity at intermediate and full scale collaboratively among PNL, LBL and ORNL. ($2,600)	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 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. ($2,100)
	No activity.	Prepare initial plan for field research experiment in bacterial transport of benefit to research in microbial origins and bioremediation. ($355)	Complete field characterization plan for bacterial transport and GEMS release sites. Begin site selection process. ($178)
	$ 14,061	$ 16,045	$ 20,118

III. Environmental Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Ecosystem Functioning and Response	Research started that focused on understanding the biological reactions of ecosystems to global changes in the environment, and episodic disturbances of ecosystems resulting from energy related activities. The potential for using experimental and physiological methods to investigate the ecosystem reactions to global change explored using a workshop format to define the research elements. Specific objectives of this exploratory research focused on the biological factors essential in maintaining ecosystem sustainability and the capability of measuring the control mechanisms critically enough to monitor biological reactions to environmental changes. This preliminary research established the basis for preparing the research initiatives for the next phase of ecosystem research that is specifically related to mechanistic understanding of ecological processes.	Experimental research will be 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 will begin 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.
	Activities of the DOE National Environmental Research Parks began developing definitions for DOE related environmental problems resulting from natural and anthropogenic disturbances for which ecological research at the parks can provide solutions. Cross-park experimental and descriptive research designed that links theoretical understanding and ecological knowledge with DOE Park related problems. Linkages with national and international programs by ParkNet provided regional and global environmental synthesis and perspectives resulting from changing ecological conditions.	Data analyses from the National Environmental Research Parks interlinked with other networks of ecological research will establish theoretical bases for natural resource management on and off the DOE sites. This research will also provide strategic linkages between environmental problems at the national and regional levels, and the ecological processes needed to insert stability into management decisions. ParkNet will provide 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.

III. Environmental Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Ecosystem Functioning and Response (Cont'd)	Funding in the amount of $423,000 has been transferred to the SBIR program.	Funding in the amount of $589,000 has been budgeted for the SBIR program.	Funding in the amount of $717,000 has been budgeted for the SBIR program.
	$ 5,817	$ 6,505	$ 6,186
Environmental Research	$ 36,138	$ 40,794	$ 49,704

DEPARTMENT OF ENERGY
FY 1994 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 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. Further emphasis is on developing new technologies and biological "markers" (indicators of damage) for detecting, quantifying, and evaluating the effects of low-level exposures on humans.

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 solely on studies of underground miners. However, significant differences exist between the exposure in a mine and in a residence. DOE is carrying out a comprehensive research program aimed at improving the accuracy of the estimates by obtaining data for residential settings, 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. Today, such monitoring methodology depends on instrumentation to measure the condition of the environment. 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 effect of exposure. These factors are important in evaluating 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. These advances have led to new concepts of the processes involved in tumor development. This increased understanding at the molecular and cellular level will also 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. Thus, increased understanding of processes, coupled with new and developing technologies, promise to lead to vastly improved risk estimates, preventive measures, and health care for occupationally exposed individuals and populations.

The budget requested for FY 1994 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 exogenous chemicals into cancer causing molecules and enzymes for repairing DNA. More emphasis needs to be given to transgenic animal systems in which repair-related or cancer-related genes have been transferred and then mutagenized or deleted for investigating the effects of damage to these genes and their role in disease (cancer) development following exposure to energy-related agents.

This budget includes $612,000 in FY 1993 and $485,000 in FY 1994 for the Education FCCSET initiative.

II. A. Summary Table: Health Effects

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Biological Research	$ 29,899	$ 31,700	$ 34,446	+ 9
Radiological and Chemical Physics	5,923	6,700	4,406	- 34
Total, Health Effects	$ 35,822	$ 38,400	$ 38,852	+ 1

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LABORATORY (EAST)	$ 4,717	$ 5,049	$ 4,418	- 12
BROOKHAVEN NATIONAL LABORATORY	$ 570	$ 630	$ 500	- 21
INHALATION TOXICOLOGY RESEARCH INSTITUTE	$ 7,411	$ 7,095	$ 7,039	- 1
LAB OF RADIOBIOLOGY AND ENVIRONMENTAL HEALTH	$ 780	$ 780	$ 1,380	+ 77
LAWRENCE BERKELEY LABORATORY	$ 1,470	$ 1,962	$ 2,020	+ 3
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 820	$ 820	$ 1,415	+ 73
LOS ALAMOS NATIONAL LABORATORY	$ 1,235	$ 1,145	$ 1,430	+ 25
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 1,255	$ 1,180	$ 1,075	- 9
OAK RIDGE NATIONAL LABORATORY	$ 5,931	$ 5,529	$ 4,413	- 20
PACIFIC NORTHWEST LABORATORY	$ 4,775	$ 4,217	$ 3,248	- 23

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

Program Activity	FY 1992	FY 1993	FY 1994
Health Effects			
Biological Research	New animal experiments were initiated with the aim of obtaining information regarding the underlying molecular mechanisms of radiation-induced cancer. Continued consolidation and orderly reduction of animal experiments which primarily focused on dosing animals and determining how many tumors develop. Life-span experiments at PNL on the tumorigenic effects of inhaled plutonium oxide and plutonium nitrate entered the analysis phase upon the death of the last remaining dogs. Other experiments at BNL investigating the tumorigenic effects of neutrons entered their final phase. Animal experiments with neutrons are particularly important because human data on neutron effects are very meager. Studies designed to provide an estimate of the relative biological effectiveness of neutrons for producing cataracts continued. Studies on the carcinogenic effects of other inhaled radionuclides, including radon and radon daughters, also continued.	Continue 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. Maintain funding and oversight of the radiation biology archive and data analysis of dose-response, life-span studies. Initiate new carcinogenesis experiments, using the much studied mouse as a model system for experiments aimed at understanding genetic mechanisms that are involved in tumorigenesis. Complete experiments on neutron tumorigenesis and experiments to estimate the relative biological effectiveness of neutrons for producing cataracts. Initiate new experiments aimed at better understanding the genetic and physiological factors that determine individual susceptibility to radiation and/or chemical carcinogens. Develop 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. Facilitate bridging the gaps between animal and human investigations. Initiate studies to identify markers that foretell the development of tumors to allow rapid and precise detection of early events leading to cancer.	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 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.

III. Health Effects (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Biological Research (Cont'd)	$ 29,899	$ 31,700	$ 34,446
Radiological and Chemical Physics	Research into the fundamental physical processes involved with interaction of ionizing radiation with matter continued. Information obtained from this research will be used to enhance understanding of radiobiological effects at low doses and dose rates. Continued emphasis placed on the study of interaction processes in condensed phase, particularly those materials which may have biological significance. Theoretical and computational studies continued on the conformational and structural changes in biomolecules produced by ionizing radiation. A correlation between these changes and ultimate biological effects will be investigated.	Basic research on the fundamental physical processes involved in the interaction of ionizing radiation with biological tissue will focus 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 will include energy deposition measurement, energy transfer processes in biological media and interactions that produce DNA damage. The role of structural and conformational changes will begin to be explored. Both experimental and theoretical techniques will be applied to identify the nature of radiation specific molecular lesions. The effects of chemical agents at the molecular level will also be explored. Research will include characterization of molecular level damage caused by different types of radiation (molecular signatures), and identification of critical physical mechanisms underlying cancer induction.	Multi-disciplinary research to elucidate and understand in detail initial physical and chemical interactions between biomolecules and ionizing radiation and chemicals will be sustained. 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 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.
	Basic mechanisms involved in energy transfer processes in biologically relevant macromolecules and model liquids continued. Understanding of these mechanisms coupled with the physical mechanisms of interaction of radiation with matter provides a sound scientific basis to relate initial damage to the production of ultimate health effects such as cancer. Theoretical research continues to better understand and define the structure-activity relationship in	Fundamental energy transfer mechanisms and pathways in model liquids, which are biologically relevant, will be 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

III. Health Effects (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Radiological and Chemical Physics (Cont'd)	model liquids. This information will be further extended to realistic biological systems.		effects such as cancer.
	Funding in the amount of $445,000 has been transferred to the SBIR program.	Funding in the amount of $576,000 has been budgeted for the SBIR program.	Funding in the amount of $583,000 has been budgeted for the SBIR program.
	$ 5,923	$ 6,700	$ 4,406
Health Effects	$ 35,822	$ 38,400	$ 38,852

DEPARTMENT OF ENERGY
FY 1994 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 information and technologies which 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 the advance of 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. One emphasis of molecular and cellular research is on clarification of the role of DNA repair in determining the response of human cells to environmental toxins.

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. 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. The program carries out 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 user facilities located at DOE laboratories. These funds would upgrade operating staff and technical support at existing large facilities i.e., National Synchrotron Light Source (NSLS), High Flux Beam Reactor (HFBR), and Stanford Synchrotron Radiation Laboratory (SSRL), which are widely used by the outside community. An increased level of funding would also augment research into new concepts for x-ray imaging of biological structures at the new 1-2 GeV light source and the development of user support at the 6-7 GeV light source. Funds are also requested for new fundamental research in which the techniques of molecular biology are utilized to increase understanding of ecosystem functioning.

This budget includes $100,780,000 in FY 1993 and $109,100,000 in FY 1994 for the Biotechnology FCCSET initiative. This budget also includes $568,000 in FY 1993 and $500,000 in FY 1994 for the Education FCCSET initiative which is also included in the amounts for Biotechnology.

II. A. Summary Table: General Life Sciences

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Structural Biology	$ 11,420	$ 16,300	$ 18,500	+ 13
Molecular Biology	13,631	13,900	14,500	+ 4
Cellular Biology	8,068	8,400	8,600	+ 2
Genome	56,677	62,180	68,000	+ 9
Total, General Life Sciences	$ 89,796	$ 100,780	$ 109,600	+ 9

II. B. Major Laboratory and Facility Funding

AMES LABORATORY	$ 200	$ 270	$ 210	- 22
ARGONNE NATIONAL LABORATORY (EAST)	$ 3,604	$ 5,280	$ 5,550	+ 5
BROOKHAVEN NATIONAL LABORATORY	$ 8,128	$ 8,179	$ 8,473	+ 4
LAB OF RADIOBIOLOGY AND ENVIRONMENTAL HEALTH	$ 2,186	$ 2,186	$ 1,620	- 26
LAWRENCE BERKELEY LABORATORY	$ 12,311	$ 12,584	$ 12,983	+ 3
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 12,308	$ 12,083	$ 11,865	- 2
LOS ALAMOS NATIONAL LABORATORY	$ 15,432	$ 15,309	$ 14,097	- 8
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 1,097	$ 983	$ 1,350	+ 37
OAK RIDGE NATIONAL LABORATORY	$ 8,875	$ 9,593	$ 8,591	- 10
PACIFIC NORTHWEST LABORATORY	$ 394	$ 727	$ 1,115	+ 53
STANFORD SYNCHROTRON RADIATION LABORATORY	$ 250	$ 1,250	$ 950	- 24

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

Program Activity	FY 1992	FY 1993	FY 1994
General Life Sciences			
Structural Biology	This activity provided for increased technical support at current structural biology user facilities at the NSLS and the HFBR at the Brookhaven National Laboratory and provided increased user support at the SSRL. Research on fast large area detectors capable of exploiting the increased intensity of advanced light sources for dynamic studies of macromolecular catalysis and molecular interactions continued to be a high priority. Provided support to develop the research capabilities for biological structure studies at the advanced synchrotron light sources coming on line at LBL (1-2 GeV) and ANL (6-7 GeV). Additional support is projected for structural studies at the Los Alamos Neutron Scattering Center.	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 will be 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.
	Expanded research on the structure of the photosynthetic reaction center. Continued studies on the protein products of cancer causing genes have implications for tumor therapy. Expanded research to develop catalytic antibodies with predesigned capabilities. A major focus of research in this program has been to elucidate the structure of protein-nucleic acid complexes including ribosomes and chromatin. This work was expanded somewhat.	Expand structural biology research on important macromolecules. Continue 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 will become 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

III. General Life Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Structural Biology (Cont'd)			coordinates of biological macromolecules.
	$ 11,420	$ 16,300	$ 18,500
Molecular Biology	An important component was aimed at characterization and cloning of human DNA repair genes in order to provide a better basis for evaluation of low level exposures. This and related work will lead to the ability to characterize individual susceptibility to DNA damaging agents. New and improved technology to detect and quantitate genetic damage continued to be developed. Efforts to develop new molecular markers for monitoring human exposure and response continues. Expanded development of transgenic mice systems for study of important genes. Continued study of basic aspects of genetics which are important for understanding health impacts.	Continue 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. Examine 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 will be made between these mice and cell lines containing repair defects to compare the response of specific tissues to radiation exposure. Begin to determine the types and numbers of mutations observed in genes related to cancer. Validate 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 and genetics of industrially important microorganisms.

III. General Life Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Molecular Biology (Cont'd)	$ 13,631	$ 13,900	$ 14,500
Cellular Biology	Selected cell types and specific cellular processes studied to identify the genetic and other factors that control cell transformation, cell division, and cell differentiation. Clarified cellular processes involved in radiation- or chemically-induced tumor formation. A significant component was aimed at improving cytogenetic techniques for the detection and quantification of damage to chromosomes. Developed new human cell systems for use in health effects studies.	Continue research aimed at developing efficient, automated scoring of chromosome aberrations (cell changes resulting from damage by radiation or chemicals). Sustain 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). Begin to develop molecular markers to identify individuals who are particularly sensitive to effects of radiation or chemicals to better protect them from occupational exposure. Initiate 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 would provide an important tool for understanding development and progression of cancer in humans. Accelerate 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 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). Study 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.
	$ 8,068	$ 8,400	$ 8,600

III. General Life Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Genome	Sustained the development of innovative biological and computational resources and instrumentation; designed automated and robotized state-of-the-art technologies for mapping and sequencing DNA. Emphasized constructing physical maps of entire human chromosomes and sequencing selected regions. Encouraged distribution of information and resources from National laboratories. Maintained special fellowship program and expanded effort to support ethical, legal, and social issue activities. Facilitated transfer of technologies from laboratories to the United States private sector.	Accelerate mapping and sequencing genetically active and other selected regions of the human genome. Finish constructing physical maps of chromosomally aligned DNA clones for several human chromosomes. Initiate physical maps of additional chromosomes. Improve data analysis algorithms and data retrieval software for mapping and sequencing data and support development of a large public database for chromosome mapping information. Improve automated and robotized manipulations required to greatly increase the efficiency and reduce the cost of DNA cloning, mapping and sequencing. Encourage national laboratory-private sector interactions and technology transfer. Expand 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.
	Funding in the amount of $1,130,000 has been transferred to the SBIR program.	Funding in the amount of $1,509,000 has been budgeted for the SBIR program.	Funding in the amount of $1,644,000 has been budgeted for the SBIR program.
	$ 56,677	$ 62,180	$ 68,000
General Life Sciences	$ 89,796	$ 100,780	$ 109,600

DEPARTMENT OF ENERGY
FY 1994 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. Current programs will continue research on developing improved radiopharmaceuticals for use in radioimmunotherapy. Fundamental metabolic and physiological processes in both normal and disease states will be studied using radiolabeled monoclonal antibodies. Research on chemical synthesis procedures will focus on labeling monoclonal antibodies with positron emitting radioisotopes for early detection of tumors. Technology developed under this program provides a non-invasive capability for detection and treatment of small lesions in human tissue.

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 National Biomedical Tracer Facility Project Definition Phase will be initiated.

The Department of Energy's program in medical applications 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.

This budget includes $4,300,000 in FY 1993 and $5,000,000 in FY 1994 for the Biotechnology FCCSET initiative and $500,000 in FY 1994 for the Education FCCSET initiative.

II. A. Summary Table: Medical Applications

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Radioisotope Development	$ 1,892	$ 1,825	$ 3,825	+110
Radiopharmaceuticals	14,167	13,838	13,763	- 1
Instrumentation	5,815	5,368	5,368	0
Clinical Feasibility	3,339	3,240	3,240	0
Boron Neutron Capture Therapy	7,335	8,744	8,744	0
Molecular Medicine	0	3,000	4,900	+ 63
Congressionally Directed Projects	41,560	0	0	0
Total, Medical Applications	$ 74,108	$ 36,015	$ 39,840	+ 11

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LABORATORY (EAST)	$ 484	$ 250	$ 0	-100
BROOKHAVEN NATIONAL LABORATORY	$ 9,589	$ 8,411	$ 8,480	+ 1
IDAHO NATIONAL ENGINEERING LABORATORY - EG&G	$ 3,050	$ 4,000	$ 1,500	- 63
LAWRENCE BERKELEY LABORATORY	$ 2,189	$ 2,530	$ 2,405	- 5
LOS ALAMOS NATIONAL LABORATORY	$ 1,842	$ 1,530	$ 860	- 44
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 324	$ 280	$ 320	+ 14
OAK RIDGE NATIONAL LABORATORY	$ 1,724	$ 1,195	$ 1,195	0

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

Program Activity	FY 1992	FY 1993	FY 1994
Medical Applications			
Radioisotope Development	Developed specific chelators for purification of desired medical radionuclides providing greatly simplified separation of desired radionuclides from an overwhelming excess of target material and other products.	Continue development of chelators, using automation and other methods to improve the efficiency with which radionuclides of medical interest are separated from other material. Initiate 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.
	$ 1,892	$ 1,825	$ 3,825
Radiopharmaceuticals	Developed pharmacologic strategies to improve retention of radiolabeled antibodies in tumor cell targets following labeled antibody administration. Completed biokinetic assessment of tin-117m in 10 human subjects and refined organ dose estimates to develop a therapy protocol. Developed chemistry to enable the attachment of many porphyrins per antibody molecule, while only modifying one site on the antibody molecule, which allows copper-67 porphyrin groups to be attached and still retain a high degree of immunoreactivity. This increased the concentration of radioactivity that can be achieved in a tumor and improve the therapeutic effectiveness. Similar efforts will be conducted to find attachment agents to develop stable complexes of the radiometal Tc-99m and antibodies for diagnostic imaging procedures.	Develop 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 will be labeled with various radiometals and evaluated in vitro and in mice bearing implanted human tumors. Begin 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 will be developed to detect cancer cells in sputum samples from patients with early stage lung cancer. These

III. Medical Applications (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Radiopharmaceuticals (Cont'd)			compounds will also be evaluated for therapy.
	$ 14,167	$ 13,838	$ 13,763
Instrumentation	Developed a totally automated radiochemistry system which will utilize an integrated approach of radiochemistry modular stations and robotics for the production of radiotracers for use in PET. New and improved detector systems for PET imaging were evaluated. Research on three-dimensional PET imaging and magnetoencephalography continued.	Research on improved detector systems for Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) imaging will be 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 will be 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.
	$ 5,815	$ 5,368	$ 5,368

III. Medical Applications (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Clinical Feasibility	Continued PET studies of brain function and heart blood flow and metabolism, including studies of the effects of alcohol and cocaine abuse. Developed methods to improve the specificity of labeled monoclonal antibodies for the treatment of cancer. Studied the radiobiological aspects of irradiation of the brain with accelerated heavy particles.	Continue 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 DTPA for palliative treatment of bone pain in breast and prostate cancer patients.
	$ 3,339	$ 3,240	$ 3,240
Boron Neutron Capture Therapy	Continued physical, radiobiological and preclinical studies of BNCT with emphasis on new boron compounds and possible expansion to cancers other than brain and melanoma.	Continue preclinical studies. Develop 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.
	$ 7,335	$ 8,744	$ 8,744
Molecular Medicine		An expanded research effort will exploit 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	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.

III. Medical Applications (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Molecular Medicine (Cont'd)		for diagnostic and therapeutic applications. The possible use of molecules targeted to specific cell-surface receptors will also be explored. Use of synchrotron light source facilities for medical research, such as x-ray angiography, will be expanded.	
	$ 0	$ 3,000	$ 4,900
Congressionally Directed Projects	Congressionally directed university projects conducted.	No activity.	No activity.
	Funding in the amount of $420,000 has been transferred to the SBIR program.	Funding in the amount of $540,000 has been budgeted for the SBIR program.	Funding in the amount of $598,000 has been budgeted for the SBIR program.
	$ 41,560	$ 0	$ 0
Medical Applications	$ 74,108	$ 36,015	$ 39,840

DEPARTMENT OF ENERGY
FY 1994 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 potential impacts on energy policy, economic development, and international affairs. Additional funds are requested in FY 1994 to accelerate global warming research as part of the National Research Program on Global Change. Of particular interest is improved prediction of global and regional climate change. Emphasis is placed on experimental studies of the cloud-climate feedback and on innovative hardware-software applications to the advanced climate models. The small climate satellites will be delayed.

In the Core Program, the carbon cycle research will emphasize the measurement of CO2 fluxes 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.

The Core Climate Research develops and tests models that predict the global and regional climate change induced by increasing atmospheric concentrations of CO2 and other greenhouse gases. This includes modeling climate change, with emphasis on coupled climate system of the atmosphere, ocean, and cryosphere. A key element is support of the Program for Climate Model Diagnosis and Intercomparison.

Also included in the Core Program is DOE's unique research on plant response to changing CO2 concentrations. This will focus increased attention on plant carbon metabolism, specifically to address basic biological mechanisms that affect direction, rate and magnitude of CO2 fluxes and biotic responses to CO2 enrichment.

The Information and Integration Program operates the ORNL Carbon Dioxide Information Analysis Center, including its operation as a World Data Center under UN auspices. The Center conducts quality audits on global and regional data sets and make the data sets available to global change researchers.

The Quantitative Links Program includes a broad range of research to link the predicted global and regional climate changes with observed changes in measurable Earth system properties. Field studies are emphasized.

In the Atmospheric Radiation Measurement (ARM) Program, determine the radiation balance from the surface to the top of the atmosphere and the atmospheric characteristics responsible for this balance, to improve the parameterization of the formation and evolution of clouds in climate models, to create an experimental testbed for testing process models used in GCMs and for the support of 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. In addition, the research examines atmospheric cycling and transformation of radiatively and chemically important trace species.

Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP) Program accelerates and improves prediction of the response of global and regional climates to the increasing atmospheric concentrations of carbon dioxide and other greenhouse gases. Developing advanced climate models will require computers capable of increasing throughput by a factor of at least 10,000 over 1990; mathematical formulations and software that use parallel processing; and improved algorithms.

The Oceans Research Program conducts a global survey of carbon dioxide 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

I. Carbon Dioxide Research (Cont'd)

cycling in the ocean, and the exchange of heat and carbon between the ocean and the atmosphere. The DOE ocean research program is focused on central questions of uncertainties about the rates of carbon and heat transport in the ocean and changes in the oceanic CO2 reservoir.

The National Institute of Global Environmental Change (NIGEC) provides support for research through six Regional Centers on the highest priority areas in DOE's Carbon Dioxide Research, including regional and global climate modeling, greenhouse gas sources and sinks, and impacts on regional ecosystems of climatic and atmospheric changes.

Unmanned Aerospace Vehicles (UAVs) are used in support of the ARM Program and other process-oriented studies of climate change phenomena. These are needed to extend the ARM energy balance and cloud data to regional scales and to investigate other processes not accessible to existing or planned ground facilities.

The Economics Research provides support for an integrated framework in which to compare the costs and benefits of different policy options and their potential impacts of climate change. This research includes investigation into the underlying economic forces that drive global change, including technology and innovation, and the tradeoffs that can be evaluated in an integrated framework, such as the comparative impact from the emission of various greenhouse gases.

Global Change Education will maintain fellowships and scholarships previously awarded. Special emphasis will also be given to involving students in ongoing research at the National Laboratories to achieve practical experience in the multi-disciplinary sciences of global change.

This budget includes $82,376,000 in FY 1993 and $90,300,000 in FY 1994 for the Global Change FCCSET initiative. This budget also includes $2,800,000 in FY 1993 and $2,000,000 in FY 1994 for the High performance Computing and Communications FCCSET initiative, and $2,800,000 in FY 1993 and $2,930,000 in FY 1994 for the Education FCCSET initiative which is also included in the amounts for Global Change.

II. A. Summary Table: Carbon Dioxide Research

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Core Program	$ 17,604	$ 17,376	$ 17,638	+ 2
Information & Integration	2,100	2,100	2,250	+ 7
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	10,507	11,700	11,926	+ 2
Quantitative Links	4,900	5,100	5,336	+ 5
Atmospheric Radiation Measurement (ARM)	20,400	24,700	32,465	+ 31
Oceans Research	4,700	5,600	5,383	- 4
National Institute for Global Environmental Change (NIGEC)	10,862	11,000	9,600	- 13
Unmanned Aerospace Vehicles	0	0	1,046	>999
Global Change Economics Research	0	2,000	1,726	- 14
Education	2,504	2,800	2,930	+ 5
Total, Carbon Dioxide Research	$ 73,577	$ 82,376	$ 90,300	+ 10

II. B. Major Laboratory and Facility Funding

	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
ENVIRONMENTAL MEASUREMENTS LABORATORY	$ 415	$ 415	$ 415	0
NATIONAL RENEWABLE ENERGY LABORATORY	$ 50	$ 0	$ 0	0
ARGONNE NATIONAL LABORATORY (EAST)	$ 826	$ 870	$ 870	0
BROOKHAVEN NATIONAL LABORATORY	$ 2,518	$ 2,879	$ 2,870	0
LAWRENCE BERKELEY LABORATORY	$ 342	$ 342	$ 342	0
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 9,137	$ 7,332	$ 6,282	- 14
LOS ALAMOS NATIONAL LABORATORY	$ 3,593	$ 3,702	$ 3,747	+ 1
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 2,638	$ 3,100	$ 3,100	0
OAK RIDGE NATIONAL LABORATORY	$ 6,188	$ 5,982	$ 6,082	+ 2
PACIFIC NORTHWEST LABORATORY	$ 17,614	$ 17,429	$ 24,921	+ 43
SANDIA NATIONAL LABORATORIES	$ 817	$ 415	$ 165	- 60

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

Program Activity	FY 1992	FY 1993	FY 1994
Carbon Dioxide Research			
Core Program	Explored natural processes that sequester carbon; supported acquisition of emissions and atmospheric CO2 and methane data; implemented operational carbon cycle model to explore relationships between energy emissions and changing properties of the global carbon cycle.	Explore natural processes that sequester carbon; acquire emissions data on atmospheric carbon dioxide (CO2) and methane data; implement operational carbon cycle model to explore relationships between energy emissions and changing properties of the global carbon cycle. Model simulations will provide 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.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Core Program (Cont'd)	Operated climate model diagnostic center at LLNL concentrating on improving regional predictions through advanced modeling concepts such as nested fine model grids. Continued to explore model and observed natural variability of climate. Applied advanced statistical techniques to climate data. Continued expanded access to supercomputers to assess multi-variate climate change.	Initiate second phase of international comparison of model 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; analysis of traditional climate data will use 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.
	Continued experimental projects and modeling research to understand the simultaneous effects of increased CO2 and climate change on selected plants with focus on photosynthesis and growth.	Obtain 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" 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.
	$ 17,604	$ 17,376	$ 17,638
Information & Integration	The Carbon Dioxide Information Analysis Center continued to compile, evaluate and distribute CO2-related information.	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.	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.
	$ 2,100	$ 2,100	$ 2,250

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	Fully implemented plans of the CHAMMP Program; experimented with the application of a conventional climate model on different massively parallel computing architectures to determine optimum arrangements; completed implementation of the first ocean circulation model on a massively parallel computing system; developed the comprehensive visualization system for climate modeling data; determined the predictability of climate change and the limits of regional resolution; initiated development of an Advanced Climate Model (ACM). Hardware and software improvements are expected to pave the way to the next generation physical parameterizations of key processes in the climate system.	Pursue development of the Advanced Climate Model CHAMMP to expand use of advanced computer architecture and software applications in concert with advanced model algorithms; fully implement 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.
	$ 10,507	$ 11,700	$ 11,926
Quantitative Links	Experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases continued.	Experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases will continue.	Complete experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases.
	$ 4,900	$ 5,100	$ 5,336
Atmospheric Radiation Measurement (ARM)	The first ARM ground site was established in the U.S. southern Great Plains, near Oklahoma-Kansas border. ARM instruments deployed at a central facility near Lamont, Oklahoma, and at approximately 38 secondary locations within 100 miles of Lamont, taking full advantage of existing facilities in this area by deploying supplementary instruments and an integrated data system. Preparations for the second and third ARM ground sites began, with scientific, environmental, and	Continue ARM operation through planned program growth. First ARM site fully operational. ARM scientists will participate 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 will also serve as a catalyst for participation by other national and international programs in a range of atmospheric and multidisciplinary	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

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Atmospheric Radiation Measurement (ARM) (Cont'd)	logistics studies of the tropical western pacific ocean and the north slope of Alaska. The focus of ARM is on the acquisition of high quality radiation measurements in the atmospheric column as well as on the atmospheric characteristics responsible for the radiative balance; emphasis is on the cloud-climate feedbacks. Goals included the improvement of cloud feedback parameterizations in climate models and tie-ins to current and planned satellite observations to achieve quantitative measures of changes in the radiative balance on a global scale.	global change disciplines. An experiment will be 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 will continue.	logistics studies.
	$ 20,400	$ 24,700	$ 32,465
Oceans Research	Continued to support the global survey of CO2 in the oceans; expanded process modeling including deep convection and the surface mixed layer to understand the exchange of heat and carbon with the atmosphere. Established the standards for the ocean carbon chemistry survey in cooperation with NSF. Initiated a field program for deep convection in cooperation with existing World Ocean Circulation Experiment (WOCE) and polar programs.	Continue and expand participation in ocean measurements as part of the global survey of CO2 in the oceans; expand 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.
	$ 4,700	$ 5,600	$ 5,383

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
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 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.
	$ 10,862	$ 11,000	$ 9,600
Unmanned Aerospace Vehicles	No activity.	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.
	$ 0	$ 0	$ 1,046

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Global Change Economics Research	No activity.	DOE will conduct 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 are: (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 consequences, and (4) understanding the international flow of economic goods and policy instruments for influencing change in other countries.	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 forecasts, population growth, international trade, impacts of climate change, and economic tradeoffs between generations.
	$ 0	$ 2,000	$ 1,726
Education	Awarded graduate and postdoctoral-level fellowships to provide the DOE and other members of the Committee on Earth and Environmental Sciences (CEES) with highly trained and educated individuals for advancing the science of global change. Sixteen new graduate fellowships and eleven new postdoctoral fellowships awarded, bringing the total number of BER-supported fellowships in energy-related global change research to 65 for graduate student education and 25 for postdoctoral research.	Continue 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. Organize and conduct a special DOE Global-change Fellowship Program Symposium which will allow the fellowship recipients to present their research results and	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.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Education (Cont'd)		professionally interact, and to showcase the program. The total number of fellowships awarded will no longer increase.	
	Funding in the amount of $889,000 has been transferred to the SBIR program.	Funding in the amount of $1,229,000 has been budgeted for the SBIR program.	Funding in the amount of $1,354,000 has been budgeted for the SBIR program.
	$ 2,504	$ 2,800	$ 2,930
Carbon Dioxide Research	$ 73,577	$ 82,376	$ 90,300

DEPARTMENT OF ENERGY
FY 1994 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 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Salaries and Expenses	$ 4,566	$ 5,839	$ 6,010	+ 3
Other	1,534	761	1,090	+ 43
Total, Biological and Environmental Research Program Direction	$ 6,100	$ 6,600	$ 7,100	+ 8

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

Program Activity	FY 1992	FY 1993	FY 1994
Biological and Environmental Research Program Direction			
Salaries and Expenses	Provided funds for salaries, benefits, and travel for 58 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 to continue 58 FTEs.	Provide funds for salaries, benefits, and travel for 59 FTEs.
	The Office of Health and Environmental Research provided management oversight, guidance and support for over 850 active research projects (reviewing and evaluating many hundreds more throughout the proposal selection process) and conducted major reviews of the numerous BER-sponsored programs at laboratories and universities. Provided ES&H line management capability as well as program management capability for increased R&D and liaison activities in areas such as the human genome, global climate change, biotechnology and ocean research. Managed ongoing efforts in structural biology, health and environmental effects of radiation and toxic chemicals, subsurface research, and medical applications. Closely coordinated activities with other DOE programs, Federal agencies, and international bodies to avoid duplication and meet needs to advance the program in a timely way. The research managed by this staff supports other DOE programs and development of sound energy policy, and has significant human health benefits.	Continue program management as in FY 1992. Support planned growth in the areas of structural biology, environmental sciences, and health effects research. Continue to oversee the safe operation of program facilities. Continue management of the joint DOE/NIH human genome effort and expanded global climate change research. Manage 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. Provide program management, oversight and accountability of contractor operations. Continue liaison with other DOE programs, Federal agencies, and international bodies.	Support planned growth 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. Manage efforts in analytical technology, health and environmental effects of radiation and toxic chemicals, and molecular nuclear medicine. Provide program management, oversight and accountability of contractor operations, including new construction activities for Structural Biology Centers at Argonne National Laboratory (ANL) and Lawrence Berkeley Laboratory (LBL), the LBL Human Genome Laboratory, the Environmental Molecular Sciences Laboratory (EMSL) at the Pacific Northwest Laboratory, and the upgrade of the Brookhaven Linac Isotope Producer at Brookhaven National Laboratory. Continue liaison with other DOE programs to facilitate technology and information transfer, and with other Federal agencies and international bodies.

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

Program Activity	FY 1992	FY 1993	FY 1994
Salaries and Expenses (Cont'd)	Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, policy review and coordination, information resources management, and utilities management.	Continue to provide program and management support as in FY 1992.	Continue to provide program and management support as in FY 1993.
	$ 4,566	$ 5,839	$ 6,010
Other	Provided for a variety of program support such as printing and editing and contractual services, including timesharing on various information systems and communication networks and Automated Office Support Systems (AOSS) workstations.	Continue the variety of program support required in FY 1992 and provide support for additional administrative and professional services, including permanent changes of station.	Continue the variety of program support required in FY 1993. Provide additional contractual support to ensure compliance with environmental, safety and health regulations.
	$ 1,534	$ 761	$ 1,090
Biological and Environmental Research Program Direction	$ 6,100	$ 6,600	$ 7,100

DEPARTMENT OF ENERGY
FY 1994 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.

This budget includes $6,900,000 in FY 1993 and $8,000,000 in FY 1994 for the Global Change FCCSET initiative and $10,100,000 in FY 1993 and $15,100,000 in FY 1994 for the Biotechnology FCCSET initiative.

II. A. Summary Table: Facilities Operations

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Capital Equipment	$ 16,832	$ 20,500	$ 21,600	+ 5
Construction	7,234	5,900	49,300	+736
Total, Facilities Operations	$ 24,066	$ 26,400	$ 70,900	+169

II. B. Major Laboratory and Facility Funding

AMES LABORATORY	$ 35	$ 0	$ 30	>999
ARGONNE NATIONAL LABORATORY (EAST)	$ 848	$ 912	$ 4,645	+409
BROOKHAVEN NATIONAL LABORATORY	$ 2,541	$ 3,325	$ 7,200	+117
ENVIRONMENTAL MEASUREMENTS LABORATORY	$ 525	$ 225	$ 200	- 11
INHALATION TOXICOLOGY RESEARCH INSTITUTE	$ 1,080	$ 598	$ 500	- 16
LAB OF RADIOBIOLOGY AND ENVIRONMENTAL HEALTH	$ 150	$ 110	$ 100	- 9
LAWRENCE BERKELEY LABORATORY	$ 3,827	$ 1,840	$ 5,800	+215
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 4,084	$ 1,178	$ 1,000	- 15
LOS ALAMOS NATIONAL LABORATORY	$ 2,015	$ 1,384	$ 1,200	- 13
OAK RIDGE INSTITUTE FOR SCIENCE & EDUCATION	$ 111	$ 50	$ 0	-100
OAK RIDGE NATIONAL LABORATORY	$ 1,965	$ 805	$ 1,000	+ 24
PACIFIC NORTHWEST LABORATORY	$ 6,790	$ 10,375	$ 43,100	+315
SAVANNAH RIVER ECOLOGY LABORATORY	$ 25	$ 0	$ 20	>999
SAVANNAH RIVER LABORATORY	$ 20	$ 0	$ 20	>999
STANFORD SYNCHROTRON RADIATION LABORATORY	$ 0	$ 2,901	$ 2,100	- 28

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

Program Activity	FY 1992	FY 1993	FY 1994
Facilities Operations			
Capital Equipment	Supported core program capital equipment needs. ($8,973)	Supports capital equipment budget for the core program. ($5,300)	Maintains capital equipment budget for the core program to provide state-of-the-art instrumentation. ($5,300)
	Supported structural biology capital equipment needs. ($2,390)	Supports capital equipment for structural biology. New funds are requested for: (1) computer and detector upgrades of the crystallography station on beamline X-12C at the 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 (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. ($6,000)	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)
	Supported genome capital equipment needs. ($2,658)	Supports genome capital equipment needs. ($2,300)	Supports genome needs for replacement of capital equipment to maintain existing capability. ($2,300)
	Supported equipment needs related to global climate research. ($2,811)	Enhances 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 are also requested for sensors and data collection and processing equipment for the UAVs including radiometers and lidars. Funds are 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 surface radiometers, cloud imagers and

III. Facilities Operations (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Capital Equipment (Cont'd)			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)
	$ 16,832	$ 20,500	$ 21,600
Construction	Maintained general plant projects at the FY 1991 level. ($3,500)	Maintain general plant projects at the FY 1992 level. ($3,500)	Maintains general plant projects at the FY 1993 level. ($3,500)
	No activity.	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 is limited by lack of adequate laboratory space adjacent to the beam lines. New laboratory space is urgently needed if the capabilities of NSLS to support user programs for structural biology research are to be realized ($1,800).	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)

III. Facilities Operations (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Construction (Cont'd)	Continued construction of the Biomedical Isotope Facility at LBL. ($1,700)	The Biomedical Isotope Facility at LBL will involve 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 will be completed in FY 1993. ($600)	No activity.
	Completed the Biomedical Modular Laboratory at LLNL. ($2,034)	No activity.	No activity.
	No activity.	No activity.	Continue support, provided previously by the Environmental Restoration and Waste Management program, for construction of the Environmental and Molecular Sciences Laboratory (EMSL) to provide a focused laboratory capability for developing technology solutions to Hanford site-specific environmental restoration and waste management problems for the full duration of site clean-up. The EMSL will focus on a wide variety of experimental and theoretical capabilities in an interdisciplinary culture that will: (1) develop the scientific basis to predict contaminant transport and transformation; (2) advance materials technologies for measurement, containment, and separation of wastes; (3) increase use of biosystems for remediation and knowledge of health effects due to toxic substances; (4) facilitate training, education, and technology transfer initiatives; and (5) achieve transfer of technology through industry involvement. The facility size is approximately 200,000 square feet, housing 209 permanent scientific and support staff, and 60 visiting scientists. Key facility elements include laboratories, offices, conference rooms, computer rooms, library, kitchen, support shops, and a

III. Facilities Operations (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Construction (Cont'd)			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. ($33,000)
	No activity.	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 (Buildings 74 and 83) that are used for related research on gene expressions and physiology.

III. Facilities Operations (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Construction (Cont'd)			This and other light laboratory space at LNL 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. 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)
	$ 7,234	$ 5,900	$ 49,300
Facilities Operations	$ 24,066	$ 26,400	$ 70,900

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

IV. A. Construction Funded Project Summary

Project No.	Project Title	Previous Obligations	FY 1993 Appropriated	FY 1994 Request	Unappropriated Balance	TEC
Biological and Environmental Research						
GPE-120	General Plant Projects	$0	$0	$3,500	$0	$3,500
94-E-339	Human Genome Laboratory, LBL	0	0	2,200	22,700	24,900
94-E-338	Structural Biology Center, ANL	0	0	4,000	11,193	15,193
94-E-337	ALS Structural Biology Support Facilities, LBL	0	0	600	7,300	7,900
94-E-335	Brookhaven Linac Isotope Producer, BNL	0	0	6,000	0	6,000
91-EM-100	Environmental & Molecular Science Lab., PNL	22,270 a/	28,500 a/	33,000	112,530	196,300
Total Biological and Environmental Research		$22,270	$28,500	$49,300	$153,723	$253,793

a/ Funds provided by Environmental Restoration and Waste Management program.

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 1994 Completion Date: 4th Qtr. FY 1995

2. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1992	FY 1993	FY 1994	After FY 1994
Prior Year Project	XXXXXXXX	$ 2,151	$ 1,886	$ 1,248	$ 56
FY 1992 Projects	3,500	401	1,026	986	1,087
FY 1993 Projects	3,500	0	413	691	2,396
FY 1994 Projects	3,500	0	0	400	3,100

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 1992	FY 1993	FY 1994 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: $ 26,900
TPC: $ 25,200

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	5,900	5,900	9,850
FY 1997	1,000	1,000	8,800

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 1992	FY 1993	FY 1994 Request	To Complete
Construction.....	$ 0	$ 0	$ 0	$ 2,200	$22,700
Capital Equipment.....	0	0	0	0	0
Operating Expenses.....	170	0	0	130	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: $ 15,193
TPC: $ 21,561

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	4,493	4,493	3,733
FY 1997	0	0	760

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 1992	FY 1993	FY 1994 Request	To Complete
Construction.....	$ 0	$ 0	$ 0	$ 4,000	$11,193
Capital Equipment.....	0	0	0	0	800
Operating Expenses.....	8	410	740	470	3,940

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 1992	FY 1993	FY 1994 Request	To Complete
Construction.....	$ 0	$ 0	$ 0	$ 600	$7,300
Capital Equipment.....	0	0	0	0	0
Operating Expenses.....	100	0	0	0	0

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-335, Brookhaven Linac Isotope Producer
Brookhaven National Laboratory (BNL)
Upton, New York

TEC: $ 6,000
TPC: $ 6,550

Start Date: 1st Qtr. FY 1995 Completion Date: 3rd Qtr. FY 1996

2. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
FY 1994	$ 6,000	$ 6,000	$ 2,000
FY 1995	0	0	3,000
FY 1996	0	0	1,000

3. Narrative: This project will expand existing DOE-supported efforts through some new construction and an upgrade of existing resources (Linac, BLIP, Hot Lab). This is the most efficient and cost effective way to improve the national isotope supply and allow a better assessment of national isotope needs.

This project is part of a comprehensive effort to upgrade production of radionuclides and radiopharmaceuticals for supply to the pharmaceutical/medical community, upgrade major research programs leading to new and more effective diagnostic and therapeutic agents, and comply with Federal, state and local government laws and regulatory requirements.

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993	FY 1994 Request	To Complete
Construction.....	$ 0	$ 0	$ 0	$ 6,000	$ 0
Capital Equipment	0	0	0	0	0
Operating Expenses	50	0	0	0	500

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: $196,300
TPC: $217,800

Start Date: 1st Qtr. FY 1994 Completion Date: 1st Qtr. FY 1996

2. Financial Schedule:

Fiscal Year	Appropriation a/	Obligations a/	Costs
1991	$ 5,170	$ 5,170	$ 1,460
1992	17,100 b/	17,100 b/	4,140
1993	28,500	28,500	21,800
1994	33,000	33,000	46,400
1995	75,000	75,000	71,300
1996	37,530	37,530	48,900
1997	0	0	2,300

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 1992	FY 1993	FY 1994 Request	To Complete
Construction.....	$5,170	$17,100	$28,500	$33,000	$ 112,530
Capital Equipment	0	1,580	3,510	50	0
Operating Expenses	1,500	3,940	1,750	1,150	8,020

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 1994 CONGRESSIONAL BUDGET REQUEST

ENERGY SUPPLY, RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
(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 Schedule): 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 1994

4b. Date Construction Ends: 4th Qtr. FY 1995

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

7. Financial Schedule:

		Costs			
Fiscal Year	Obligations	FY 1992	FY 1993	FY 1994	After FY 1994
Prior Year Projects	XXXXXXXX	$ 2,151	$ 1,886	$ 1,248	$ 56
FY 1992 Projects	$ 3,500	401	1,026	986	1,087
FY 1993 Projects	3,500	0	413	691	2,396
FY 1994 Projects	3,500	0	0	400	3,100

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 1994 support. The estimated costs for each of the subprojects are preliminary in nature, with a project limitation of $1,200,000, 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 fire protection upgrades, water distribution systems improvements involving improved water system controls and metering, additional fire protection

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)

sprinkler piping, replacement of underground hot water heating lines, replacement and upgrade of exhaust fan duct connectors, and modifications to the central plant heating and cooling system.

Los Alamos National Laboratory 600

Modify biosciences laboratory/office building to provide needed space for the structural biology programs, as well as free up space for human genome research.

Richland Field Office
Pacific Northwest Laboratory 2,000

Miscellaneous capital work orders, e.g., laboratory additions, improvements, and modifications.

San Francisco Field Office
Lawrence Livermore National Laboratory 400

Capital improvements, modification and upgrading facilities for various programmatic objectives.

Washington Headquarters 150

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.

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST

ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT & CAPITAL EQUIPMENT
(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) -- None
Total Project Cost (TPC) -- None

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

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

6. Current Cost Estimate:
TEC -- $24,900
TPC -- $25,200

7. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 2,200	$ 2,200	$1,280
1995	15,800	15,800	4,970
1996	5,900	5,900	9,850
1997	1,000	1,000	8,800

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

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. Engineering design and inspection at 16 percent of construction costs..		$ 2,350
b. Construction Costs.....		15,800
1. Improvements to Land.....	$ 1,710	
2. Buildings (41,000 GSF at approximately $259/sq. ft.).....	11,290	
3. Special Facilities.....	1,540	
4. Utilities.....	230	
5. Project Management.....	1,030	
c. Standard Equipment.....		3,090
d. Relocations.....		300
Subtotal.....		$21,540
e. Contingencies at approximately 16 percent of above costs.....		3,360
Total line item cost.....		$24,900

a/ Construction costs have been escalated at 2.5% for FY 1992; 3.9% for FY 1993; 4.7% for FY 1994; 4.8% for FY 1995 and 4.9% 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

	Prior Yrs.	FY 1994	FY 1995	FY 1996	FY 1997	Total
a. Total project funding						
1. Total facility costs						
(a) Line item	$ 0	$ 1,280	$ 4,970	$ 9,850	$ 8,800	$24,900
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	$ 8,800	$25,200

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 1994 CONGRESSIONAL BUDGET REQUEST

ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT & CAPITAL EQUIPMENT
(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) -- None
Total Project Cost (TPC) -- None

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

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

6. Current Cost Estimate:
TEC -- $15,193
TPC -- $21,561

7. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 4,000	$ 4,000	$4,000
1995	6,700	6,700	6,700
1996	4,493	4,493	3,733
1997	0	0	760

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

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.

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)

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 microammeters, 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 fitout 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. Engineering design and inspection at approximately 16 percent of construction costs..		$ 1,919
b. Project costs.....		10,664
1. Special Facilities	$8,786	
2. Project Management	1,878	
Subtotal		12,583
c. Contingencies at approximately 24 percent of above costs		2,610
Total line item cost.....		$15,193

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

	Prior Yrs.	FY 92	FY 93	FY 94	FY 95	FY 96	FY 97	Total
a. Total project funding								
1. Total facility costs								
(a) Line item	$ 0	$ 0	$ 0	$4,000	$6,700	$3,733	$ 760	$15,193
(b) Operating expenses funded equipment	0	0	0	0	200	200	400	800
(c) Inventories	0	0	0	0	200	100	100	400
Total direct costs	0	0	0	4,000	7,100	4,033	1,260	16,393
2. Other project costs								
(a) R&D necessary to complete construction	0	385	740	470	510	535	0	2,640
(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	$ 740	$ 470	$ 510	$ 535	2,495	$ 5,168
Total project costs (TPC)	$ 8	$ 410	$ 740	$4,470	$ 7,610	$ 4,568	$3,755	$21,561

b. Related annual funding in FY 1996 dollars (estimated by 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 1994 CONGRESSIONAL BUDGET REQUEST

ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT & CAPITAL EQUIPMENT
(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 Schedule): 2nd Qtr. FY 1994

3b. A-E Work (Title I & II) Duration: 10 Months

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

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

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

6. Current Cost Estimated:
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 1-2GeV 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 1-2 GeV 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 1-2 GeV offers unique opportunities for research in the life sciences. In addition, though, the 1-2 GeV 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 1-2 GeV 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 1-2 GeV 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 1-2 GeV 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 1-2 GeV 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 1-2 GeV 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 1-2 GeV 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 1-2 GeV -- 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 facitlies, (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. Engineering design and inspection at approximately 15 percent of construction costs		$ 560
b. Project 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 funding					
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 requirements in FY 1996 dollars

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

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. Other related funding requirements

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 1994 CONGRESSIONAL BUDGET REQUEST

ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT & CAPITAL EQUIPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

Biological and Environmental Research

1. Title and Location of Project: Brookhaven Linac Isotope Producer
Brookhaven National Laboratory (BNL)
Upton, New York

2a. Project No. 94-E-335
2b. Construction Funded

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

3b. A-E Work (Title I & II) Duration: 10 Months

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

4a. Date Physical Construction Starts: 1st Qtr. FY 1995

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

6. Current Cost Estimate:
TEC -- $ 6,000
TPC -- $ 6,550

7. Financial Schedule:

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 6,000	$ 6,000	$2,000
1995	0	0	3,000
1996	0	0	1,000

8. Brief Physical Description of Project

This project in the west side of Building 801 (the Hot Lab), is part of a comprehensive effort to accomplish the following: upgrade the production of radionuclides and radiopharmaceuticals for supply to the pharmaceutical/ medical community outside the Laboratory; upgrade major research program leading to new and more effective diagnostic and therapeutic agents; comply with DOE Order 5802.2A, which requires that the generation of low-level radioactive waste be reduced; support a continuing effort to bring Brookhaven National Laboratory (BNL) into conformance with Federal, state, and local environmental laws and regulatory requirements. The unique location of BNL over an EPA designated "sole-source" aquifer has heightened regulatory concern over potential ground water contamination from BNL facilities.

1. Title and Location of Project:	Brookhaven Linac Isotope Producer Brookhaven National Laboratory (BNL) Upton, New York	2a. Project No. 94-E-335 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

Work to renovate the Facility consists of the following:

1. A radiological cleaning of the building interior.

2. Removing asbestos and lead.

3. Upgrading the Hot Cell by installing a new polymer solidification system for removing radioactive waste and improving ventilation. The upgrade involves decontaminating, removing, replacing old tanks, including piping, valves and controls and new ventilation blower and ducting.

4. Installing security and fire alarm systems and connecting telephone lines to Laboratory security and fire detection main systems.

5. Removing and replacing the existing fume hoods and equipment with new fume hoods and equipment in accordance with OSHA 1910.1450.

6. Upgrading the electrical power and removing and replacing the entire electrical and lighting system to meet new codes and the most recent energy conservation requirements.

7. Removing and replacing the plumbing system, including piping, valves, fixtures, tanks, and controls with new equipment that will meet all codes and regulations.

8. Packaging and shipping all radioactive, chemical, and asbestos waste to appropriate disposal sites for burial in compliance with all applicable codes and regulations.

b. Modifications are required at Brookhaven Linac Isotope Producer (BLIP) (Buildings 931A, 931B) to support the higher beam currents proposed, and resulting higher radioactivity levels produced. This work consists of the following:

1. Replace the BLIP target cooling manifold and target assembly with a new design to increase the rate of heat removal.

2. The BLIP hot cell radiation shielding must be improved at several known weak spots.

1. Title and Location of Project:	Brookhaven Linac Isotope Producer Brookhaven National Laboratory (BNL) Upton, New York	2a. Project No. 94-E-335 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

3. Build additional new hot cells to handle the increased processing load. An internal conveyor system to transfer targets between the existing hot cells and new ones is required.

4. An addition is required to connect buildings 931A and 931B and provide a shed for the target transport forklift.

c. For the proposed Biomedical Isotope Resource Center (BIRC) at BNL the Brookhaven 200 MeV Linac is required to deliver 30 milliamps of proton beam over 650 microseconds pulse width at 7.5 Hertz (Hz) repetition rate. Studies have shown that such a performance level can be achieved by upgrading the existing operating Linac. The Linac presently operates for approximately 20 weeks per year at a peak output of 25 milliamps, a pulse width of 450 microseconds, and a repetition rate of 5 Hertz. The present limitations of the various Linac subsystems have been reviewed, and it is concluded that the best way to increase the average current is to make smaller improvements in several of the operating parameters, rather than try to make a large increase in a single parameter. The proposed parameter changes are shown in the following table.

TABLE

	Present	Upgrade
Beam Current	25.0 milliamps	30.0 milliamps
Repetition Rate	5.0 Hertz	7.5 Hertz
Beam Width	450.0 microseconds	650.0 microseconds
RF Width	650.0 microseconds	850.0 microseconds
Average Current	56.0 microamps	146.0 microamps
Operating Weeks	20.0 weeks	46.0 weeks

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

The Biological and Environmental Research supported program on Radionuclide and Radiopharmaceutical Research at BNL has continued to fulfill the following functions: (1) carry out nuclear and radiochemical research on new accelerator (BLIP) produced isotopes; (2) develop, characterize, and evaluate new radiopharmaceuticals for diagnosis and therapy, based on the above; and (3) transfer technology of commercial potential to industry. With partial support from NE (IDP Office) also, on a limited basis, BNL has engaged in the production and distribution of certain radioisotopes not available commercially, but needed by the nuclear medicine community and industry for patients health care.

1. Title and Location of Project:	Brookhaven Linac Isotope Producer Brookhaven National Laboratory (BNL) Upton, New York	2a. Project No. 94-E-335 2b. Construction Funded

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

a. As a result of discussions with DOE over the past 3 years, and based on the recommendations of advisory committee(s), BNL has come to the conclusion that in order to respond to the ever mounting national need for a continuous and reliable source of isotopes, BNL should undertake a program to increase the supply of accelerator-provided isotopes. Such a project (Biomedical Isotopes Resource Center) at BNL will require the expansion of the existing DOE-supported efforts through some new construction and mostly an upgrade of our existing resources (Linac, BLIP, Hot Labs). This is considered to be the most efficient and cost-effective way to provide an immediate interim solution to improve national isotope supply which has already reached a crisis level. The BIRC at BNL would also allow a better assessment of the national isotope needs for a future more ambitious facility to eliminate the national isotope shortage.

1. Building 801: Most of the group is housed in Building 801, which contains offices, chemistry laboratories for non-radioactive work, chemistry laboratories for low-medium level radioactivity work hot cells, a counting room and hot waste storage. The building is 41 years old. The facilities and laboratories are inadequate for current uses and do not comply with environmental, safety, and health standards. The specific justifications of the major items requested in this renovation are described below.

2. Improve Hot Cell Ventilation System: The hot cell in the (BLIP) processing area of Building 801 requires air handling improvements. The ventilation system in this hot cell also is used to exhaust air from four other attached shielded hot boxes. Access to the hot cell and hot boxes is frequently required for setting up equipment and disposing of waste. Port holes and movable lead panels are used for access. The air flow through these openings is insufficient for personnel safety and has been responsible for several minor incidents of laboratory contamination. This situation has been exacerbated by increased processing of long-lived radionuclides (e.g., strontium (^{82}SR), t1/2= 25 days). Also, the exhaust flows serially from unit 5 to unit 1, which results in very poor ventilation for unit 5 and spreads air contaminated by radioactivities and acid through all the units. Modifications will use parallel ducts and provide equal supply and exhaust for all processing areas in accordance with OSHA 1910.1450.

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

3. Renovate Semi-Hot Labs: These obsolete laboratories need to be completely refurbished, particularly the hoods, which no longer meet code, have poor lighting, and unsafe wooden sashes. In addition, the mechanisms for raising or lowering the sashes are broken and wood blocks or cotter pins are used to hold up the sashes. The Lab furniture also is broken; many desk drawers do not work. The floor tile is so worn that spilled radioactive solutions tend to make decontamination more difficult.

4. Install a Fume Hood at the Port Hole in Hot Box 3: A new fume hood at the port hole in hot box 3 is necessary for controlling contamination during such operations as aliquoting from radioactive solutions in the hot box.

5. Install a Shield Door to Hot Cell 1: Radiation levels as high as 5000 milliroentgen per hour have been measured at the unshielded entrance door to hot cell 1. This level is the limit for a high radiation area (ES&H Manual 3.4.0). The access control levels are adequate for this level; however, we anticipate handling higher levels of radioactivity in the future, and a shield door will be required to permit maintenance work just outside the door.

6. Renovate Laboratories: Laboratories contain obsolete lead caves with old rectilinear manipulators, used mostly for processing reactor targets. They are poorly laid out, contain no port holes, and have inadequate ventilation. The manipulators, built in-house at least 30 years ago, offer only restricted motion, are difficult to use, and are unreliable. These caves should be replaced with modern hot boxes.

7. Upgrade the Liquid Radioactive Waste System: The "B" systems for storing higher level B,2 liquid radioactivity was taken off line years ago due to corrosion. The present level of operations (and future enhanced levels) produce liquid radioactive waste that is too hot for the existing "D" system. Removing this waste is a major problem; therefore, a "B" system is required. It is proposed to solidify this high level waste by a polymerization process in a shielded area.

8. Build Additional Office Space: The BLIP/Linac upgrade project will require additional staff in the group. Thus, four more offices are needed.

b. The high beam intensity proposed herein will deposit significantly more heat in the target and create significantly more radioactivity. Also, more frequent target transfers and processing will occur. Modifications are required to safely accomplish this mission. Specifically,

1. Title and Location of Project:	Brookhaven Linac Isotope Producer Brookhaven National Laboratory (BNL) Upton, New York	2a. Project No. 94-E-335 2b. Construction Funded

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

1. Replace BLIP target cooling manifold and target assembly: Increased water flow and more efficient water distribution across target faces is required to prevent target overheating. This will be accomplished with a larger circulation pump, more efficient design of the manifold to reduce pressure losses, and a new low differential pressure filter. The target design will be modified to allow quicker removal of heat from target sent to the surface.

2. BLIP hot cell shielding: Because of high radiation levels expected to be produced in this project increased shielding is required at the BLIP target handling hot cell. Extra lead will be installed at known weak spots and one lead glass window will be replaced with a thicker piece.

3. Additional hot cells: More hot cell space is required to handle the increased isotope processing load. BNL proposes to locate this in building 931A rather than the Hot Laboratory (building 801) to reduce transit time for short lived isotopes, and eliminate the need to carry the most intensely radioactive targets across site. An interconnection through an adjoining wall of building 931A and 931B will be built to accommodate a target conveyor system to transfer irradiated targets between the BLIP targeting handling hot cell and the new processing hot cells.

4. Addition to Building 931A and 931B: An addition to the existing structure is needed to provide an interior walkway between buildings 931A and 931B. This is required because the spaces will now frequently be used simultaneously. Also, because of the frequent target processing expected, the fork lift used for target transfers must be kept available at BLIP. An enclosed shed is required to protect it from the weather.

c. In order to meet the requirements for production of isotopes for biomedical application, the Brookhaven 200 MeV Linac has to be upgraded to provide 30 milliamps of proton beam with a 650 microseconds width at 7.5 Hertz. To achieve such a performance level, the following programs have to be implemented.

1. 7835 Power Amplifier Cavity/Capacitor Bank/Modulator: For the longer pulse width and high power, it is necessary to increase the capacitor bank, upgrade the crowbar system, improve the modulator grid deck supply, and add dry air flow for 7835 amplifier cavities.

2. 4616 Driver Capacitor Bank/Modulator: For the longer pulse width and high power, it is necessary to increase the driver capacitor bank, improve the power supplies, 4616 driver modulator, and the Silicon Controlled Rectifier (SCR) controller for the anode power supply.

1. Title and Location of Project:	Brookhaven Linac Isotope Producer Brookhaven National Laboratory (BNL) Upton, New York	2a. Project No. 94-E-335 2b. Construction Funded

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

3. High Power Transmission Line: To eliminate arcing and other possible failure at the high repetition rate, it is necessary to replace the existing (BNL-designed) transmission line with an "industry-standard" design, including a nitrogen gas flow through system for the line. Procurement would be from an outside vendor, including installation by the vendor.

4. 60 kV Power Supplies and High Voltage Cabling: Replace the power supply transformers, eliminate the diode stack, replace all HV cables, and replace the circuit breakers.

5. Low Level RF Improvements: For higher current and the faster repetition rate, new radio frequency (RF) phase and amplitude servo systems are needed, to reduce energy fluctuations created by beam loading.

6. Check and Repair all Tanks RF Joints: After more than twenty-five years of operation, it is necessary to open tanks and inspect all rf joints to ensure reliable operation of BLIP.

7. Ion Source Low Energy Beam Transport (LEBT): To achieve higher operating current, a second ion source before the Radio Frequency Quadrupole (RFQ) (possibly delivering positively charged hydrogen ion (H+)) has to be added, and reduce the beam losses between the RFQ and the Linac by modifying the transport line. Upgrade of the 750 keV chopper is also required to handle higher current and the faster repetition rate.

8. 200 MeV Transport to BLIP: Improve vacuum pumping, gauging, add valve, all new flanging and seals. Improve beam optics in the collimator chamber. Add instrumentation to the line (transformers, position monitors).

1. Title and Location of Project: Brookhaven Linac Isotope Producer
Brookhaven National Laboratory (BNL)
Upton, New York

2a. Project No. 94-E-335
2b. Construction Funded

10. Details of Cost Estimate [a/]	Item Cost	Total Cost
a. Engineering design and inspection (ED&I) at approximately 18 percent of construction costs,		$ 895
1. Conventional construction at approximately 14 percent of Item b.1	$ 140	
2. Technical components at approximately 20 percent of item b.2	605	
3. Construction management at approximately 3 percent of costs of item a.1., a.2. and b	150	
b. Construction costs		4,050
1. Conventional construction	$ 1,000	
(a) Experimental and support facilities $1,000		
2. Technical components 3,050		
(a) BLIP modifications 300		
(b) 801 modifications 450		
(c) Linac upgrade 2,300		
c. Standard equipment includes auxiliary equipment and office furniture		70
d. Removal less salvage		0
Subtotal		$ 5,015
e. Contingencies at approximately 20 percent of above costs		985
Total line item cost		$ 6,000 [b/]

a/ Estimate is based on feasibility study. Conceptual Design Report to be completed March 1993.
b/ Escalation rates used were taken from DOE Departmental Price Change Index - FY 95 Guidance, August 1992 Update.

11. Method of Performance

Conventional design and inspection will be on the basis of a negotiated architect-engineer contract. Conventional construction and procurement will be accomplished by a competitively obtained lump sum contract. Technical engineering, design and inspection will be performed by the operating contractor. Technical construction and procurement will be accomplished by a competitively obtained lump sum contract where practical. Operating contractor forces will perform balance of work.

1. Title and Location of Project: Brookhaven Linac Isotope Producer
Brookhaven National Laboratory (BNL)
Upton, New York

2a. Project No. 94-E-335
2b. Construction Funded

12. Schedule of Project Funding and Other Related Funding Requirements

	Prior Years	FY 1994	FY 1995	FY 1996	Total
a. Total project funding					
1. Total facility costs					
(a) Line item	$ 0	$ 2,000	$ 3,000	$ 1,000	$6,000
(b) Inventories	0	0	0	0	0
Total direct costs	$ 0	$ 2,000	$ 3,000	$ 1,000	$ 6,000
2. Other project costs					
(a) R&D Necessary to complete construction	$ 0	$ 0	$ 0	$ 0	$ 0
(b) Conceptual design costs	50	0	0	0	50
(c) Other project related costs (start up)	0	0	0	500	500
Total project costs (TPC)	$ 50	$ 2,000	$ 3,000	$ 1,500	$ 6,550

b. Related annual funding (FY 1996 dollars x 1000)

1. Annual BIRC operating costs	$ 3,100
2. Annual Injector operating costs	1,500
Total operating costs	4,600
3. Annual plant and capital equipment costs	1,100
4. Other funding sources for operations	-1,870
5. Sales of Isotopes	-3,300
Total related annual funding	$ 530

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

a. 1. Total project funding
Total facility costs -- Explained in items 8, 9, and 10.

1. Title and Location of Project:	Brookhaven Linac Isotope Producer Brookhaven National Laboratory (BNL) Upton, New York	2a. Project No. 94-E-335 2b. Construction Funded

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

2. Other project costs
   (a) R&D necessary to complete construction -- Narrative not required.
   (b) Conceptual design -- Conceptual design report to be completed at a cost of $50,000.
   (c) Start-up costs -- These funds are needed for operation training of crew, early testing and checkout of various systems, as well as to establish a special process spares inventory as their construction is completed. It is anticipated that portions of the beam injection system will be in an operational status in FY 1996.

b. Related annual funding requirements (Estimated life of the facility: 20 years)
   1. BIRC facility operating costs assume 46 weeks of operation with appropriate manpower, material, and support services associated with the research program.
   2. Injector operating costs assume that the AGS Linac complex is being used for other functions in addition to BIRC for the 46 weeks.
   3. This item includes plant and capital equipment needed to maintain the research capability of the facility to evolving research requirements as well as funds for minor improvement projects.
   4. Other funds are provided by Biological and Environmental Research (R&D) for the same staff to be shared.
   5. Revenue is generated by the production of isotopes for Nuclear Energy and the sale of excess isotopes.

DEPARTMENT OF ENERGY
FY 1994 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 Schedule): 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: 1st Qtr. FY 1994

4b. Date Construction Ends: 1st Qtr. FY 1996

6. Current Cost Estimate:
TEC -- $196,300
TPC -- $217,800

7. Financial Schedule:

Fiscal Year	Appropriation a/	Obligations a/	Costs
1991	$ 5,170	$ 5,170	$ 1,460
1992	17,100 b/	17,100 b/	4,140
1993	28,500	28,500	21,800
1994	33,000	33,000	46,400
1995	75,000	75,000	71,300
1996	37,530	37,530	48,900
1997	0	0	2,300

a/ Funds provided by the 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.

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

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, 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 1994 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. 1. Facility engineering, design, and inspection at approximately 16 percent of construction costs		$ 6,280
2. Research & Computer Eqpt. engineering, design and inspection		36,520
3. Construction Management at approximately 8 percent of items c & d		3,610
b. Land and land rights		0
c. Construction costs		42,820
1. Improvements to land	1,840	
2. Buildings ($178.36/sq ft based on 201,000 gross sq ft)	35,850	
3. Utilities (including water electrical power and sewers)	610	
4. Special facilities	4,520	

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
d.	Standard equipment (furnishing and standard lab and shop equipment).		2,220
e.	Computer equipment (see next page for details).....		20,930
f.	Research equipment.....		42,890
g.	Project management.....		16,330
	Subtotal b/.....		171,600
h.	Contingency at approximately 14.4 percent of all above costs.....		24,700
	Total Estimated Cost (TEC).....		$196,300

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. Rates are based on the DOE Material and Labor Escalation Study, February 1991, Kaiser Engineers Hanford Company, Richland, Washington. Research equipment escalation included at the rates of 2.0% (FY 1992), 2.5% (FY 1993), 2.8% FY 1994), 3.3% (FY 1995), 3.9% (FY 1996) and 4.3% (FY 1997). Research equipment rates based on the composite of three indices for similar equipment (9/20/91). Includes escalation applied to PNL effort at the rate of 5.5% for labor and 4.5% for non-labor per fiscal year. Composite PNL rate based on DRI US cost information service "cost and preview" short range focus, 3rd quarter 1991.

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	-	-	3,410
Operating Software	-	-	210
Installation Cost for Above Hardware	-	-	90
Total			$ 20,930

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

a. Total project funding

	Prior Years	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	TOTAL
1. Total facility costs									
(a) Construction Line Item..	$ 0	$ 1,460	$ 4,140	$21,800	$46,400	$71,300	$48,900	$ 2,300	$196,300
(b) PE&D.....	0	0	0	0	0	0	0	0	0
(c) Inventories.....	0	0	0	0	0	0	0	0	0
(d) Non-Federal Contribution.....	0	0	0	0	0	0	0	0	0
Total Estimated Cost.....	$ 0	$ 1,460	$ 4,140	$21,800	$46,400	$71,300	$48,900	$ 2,300	$196,300
2. Other Project Costs									
(a) R&D Required for Construction.....	$ 0	$ 0	$ 3,720	$ 1,320	$ 680	$ 1,130	$ 1,240	$ 120	$ 8,210
(b) Conceptual design costs.	1,500	0	0	0	0	0	0	0	1,500
(c) Other project related costs.....	0	0	220	430	470	920	3,950	660	6,650
(d) Capital Equipment.....	0	0	1,580	3,510	50	0	0	0	5,140
Total other project cost....	$1,500	$ 0	$ 5,520	$ 5,260	$ 1,200	$ 2,050	$ 5,190	$ 780	$ 21,500
Total Project Costs (TPC)...	$1,500	$ 1,460	$ 9,660	$27,060	$47,600	$73,350	$54,090	$ 3,080	$217,800

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 (Continued)

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/ All estimated costs are for FY 1997 and are escalated to FY 1997 dollars.

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

a. Total project cost (TPC)

1. Total project costs

(a) Construction line item -- Includes estimated cost for conventional facility design and construction, initial complement of research equipment and computers, and project management -- $196,300,000
(b) Operating Expense Funded Equipment -- None
(c) Inventories -- Inventories necessary to put the facility into use are included in operating cost.
(d) Non-Federal Contribution -- None.

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)

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 -- $8,210,000
(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 -- $1,500,000
(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 --$6,650,000
(d) Non-Federal Contribution -- None
(e) Programmatic capital equipment includes research and computer equipment necessary for R&D required for construction -- $5,140,000

b. Other related funding requirements

Annual related funding requirements will vary as research and operations are implemented, the new facility is occupied in FY 1996, and steady-state operation is attained in FY 1997. 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:

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

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. Other related funding requirements

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.

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.

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.