DEPARTMENT OF ENERGY
FY 1993 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 responsibility 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 biological damage from radiation and chemical exposure. The initial laboratory research demonstrated that biological repair and recovery processes operate at low levels of X-ray or gamma exposure, thus providing assurance that radiation protection standards based on linear extrapolation of high dose findings are indeed conservative. 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 primarily oriented towards research at the relatively low doses and low dose rates normally encountered by human populations, e.g., radon exposures or environmental clean up operations. Radiobiological research is coordinated through the Office of Science and Technology Policy's (OSTP) Committee on Interagency Radiation Research and Policy Coordination. The DOE effort is also coordinated with European radiation research programs through a Memorandum of Understanding with the Commission of European Communities (CEC).

The limitations of population studies in estimating health risk from low-level exposure are well recognized. There is increasing agreement that an understanding of the molecular and cellular mechanisms underlying health impacts offers the best hope for reducing the uncertainties regarding health risks of low-level exposures. Recent scientific advances in our understanding of the molecular events associated with cancer causation, together with the development of promising new technologies in part stemming from the human genome program, promise to lead to vastly improved risk estimates for individuals and populations. The health effects program is being reoriented to take advantage of this new scientific understanding and technological potential in order to develop improved understanding of mechanisms and to provide powerful new tools for characterizing human risk from low level exposures. The CEC has also developed a plan for research approaches to understanding low dose radiation effects. Under the above-mentioned MOU, we are coordinating our research activities with those of the CEC.

The DOE human genome program represents a new effort which supports two of the BER program 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 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 and biotechnology communities with new resources and technologies. While the DOE program, which is planned and carried out in coordination with the National Institutes 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 the universities.

Structural biology brings the tools of modern science together (recombinant DNA technology, site-directed mutagenesis, rapid structure determination with sophisticated equipment, advances in theoretical analysis and molecular simulation and powerful computer and graphics technologies) to enable major advances in our understanding of the relationship between macromolecular structure and biological function. Such increased understanding and the concomitant ability to manipulate structure and biological function has enormous implications for the Department's ability to carry out its energy, environmental and technology transfer missions cost-effectively. This knowledge base will provide the intellectual foundation for the wide spectrum of applications of biotechnology and molecular biology. As pointed out by several DOE and National Academy committees, DOE has a special opportunity and responsibility (because of the capital-intensive user facilities currently located, and under development, at its laboratories, and computational and other resources located there) to play a major role in the advance of knowledge in structural biology. DOE's structural biology program is focused on providing the resources which are necessary for efficient utilization of current and developing facilities. These facilities will be increasingly utilized by structural biologists and would benefit from increased staff and modernization of equipment.

Increased funding is requested to support the effective utilization of current and developing structural biology user facilities located at DOE laboratories. The first priority is to upgrade facilities and technical support at existing large facilities (NSLS, HFBR, SSRL) which are widely used by the outside community. This will permit a substantial increase in the elucidation of biological macromolecular structures at these sites.

ENVIRONMENTAL SCIENCES

The environmental sciences research program of BER has evolved from the need to understand the pathways of radioactive materials from weapons testing through atmospheric and terrestrial media, to human exposure. The research has expanded to include the broader mission of the Department. The integrated environmental sciences program builds new scientific understanding on this foundation to support the objectives of the National Energy Strategy, the continuing Presidential initiative in global change, and the basic environmental research essential to underpin these activities, as well as the emergency response and waste disposal activities.

Enhanced research activities in environmental biotechnology will be carried out in several programs. The objective is to use the techniques of molecular biology to develop the methods for detecting and measuring significant changes in ecological systems. These include methods for detecting stressed states of organisms, understanding the genetic control mechanisms for environmental adaptation used by organisms, particularly terrestrial plants, microbial organisms and marine organisms.

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 major field studies of the processing of sulfur and nitrogen oxides by clouds and precipitation and the mechanisms of their deposition on sensitive ecosystems. 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 National Energy Strategy to focus on nitrogen oxides and aerosols. 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 research 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 and preparations to conduct experiments at Savannah River will be initiated.

The research has shown that the generation of fixed carbon on the continental shelf is about 70 times greater than in the open 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 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 Strategy. This environmental and ecological 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 reactions of ecological systems to global environmental changes and reactions of ecological systems to disturbances resulting from energy related activities. Specific research will be focused on understanding mechanisms that control the reactions, rates of environmental change and the understanding needed to enhance sustainability of natural and managed ecological systems, and the technology and understanding needed to separate biological adaptations to natural environmental changes from adaptation resulting from human-induced environmental changes.

A more recent environmental concern has been possible global warming from the increase of greenhouse gases and especially carbon dioxide (CO2) in the atmosphere from the burning of fossil fuels. For over ten 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 in the development of the National Energy Strategy. DOE has launched major research initiatives to accelerate progress in the scientific capability to predict global and regional climate change. To provide the essential data, the Atmospheric Radiation Measurement (ARM) program was initiated in 1989. The first ARM site will be providing the first year of data in April 1992 from the midwestern U.S. and the second site will initiate operation during FY 1993 in the Western Pacific region, a key climate area. 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 operate a prototype advanced climate model on a massively parallel computer to test emerging technology as well as emerging new understanding of the climate system. Funds to support development of Remotely Piloted Vehicles (RPVs) and small climate satellites to measure cloud-radiation interactions and augment surface base measurements are also requested. 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 program, the 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.

The terrestrial transport program includes DOE's only fundamental long-term research related to the geochemistry, hydrology, and microbiology of the subsurface biosphere with emphasis on the mobility and stability of natural chemicals and chemical contaminants in subsoils and groundwater, and insights into the hydrologic cycle. The BER program has developed a plan (5-20 year) for basic long-term research related to environmental restoration, in cooperation 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 a three year field experiment at DOE's Hanford site, coordinated by PNL's Environmental Sciences Research Center. Improved predictions about the transport of organic chemicals or 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 related to environmental restoration at DOE sites. New concepts and discoveries in such areas as organic-radionuclides contaminant transport and deep terrestrial 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 program is being initiated to determine the genesis 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 up to 14,000 years. Research is also being initiated to provide the basis for development of improved predictive models for chemical movement in the subsurface biosphere. 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, survival and metabolism.

MEDICAL APPLICATIONS

Under its mandate, originally expressed in the Atomic Energy Act of 1946, to promote the utilization of radioactive materials for medical and other purposes, the Atomic Energy Commission (AEC) undertook a vigorous program of producing and distributing radionuclides for medical applications and scientific research. Progressively sophisticated applications in diagnosis and therapy have led to the establishment of nuclear medicine as a recognized medical specialty, and radionuclide production as a flourishing industry. A major advantage of nuclear medicine procedures has been that dynamic functional information about various organs of the body can be obtained with non-invasive procedures. The concurrent development of instrumentation, particularly first the gamma camera and later single photon emission computed tomography (SPECT) and positron emission tomography (PET), which are imaging devices, greatly improved the physician's ability to detect small lesions and to quantify functional processes in the body.

Under the successors of the AEC, the Energy Research and Development Administration (ERDA) and the DOE, the medical applications program has been continued and expanded. The current program includes five major research areas: (1) research to develop new radioisotopes, (2) development and application of new radiopharmaceuticals, (3) instrumentation, (4) clinical feasibility and (5) exploration of new radiation therapy modalities. By exploiting advances that are being made in the genome and structural biology programs, potentially new approaches for early detection of tumors will be explored.

The isotope and radiopharmaceutical research programs are largely directed to improving methods for studying the functions and enhancing diagnosis of diseases of the brain and heart. The instrumentation program contributes to these efforts by improving the resolution and other qualities of the imaging process. The clinical feasibility program includes the use of synchrotron radiation for a safer method of angiography, the use of particle beams for therapy of vascular malformations and cancer, and the use of improved radiopharmaceutical for studying brain function.

The DOE program in medical applications differs from related programs of the NIH in that the latter are more strongly clinical and are disease-oriented, whereas the DOE program is oriented toward research and development of new technologies. Innovative procedures developed under the DOE programs become the province of the NIH when extensive clinical studies of feasibility are to be conducted.

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 cause of heart diseases, such as atherosclerosis; the diagnosis of 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 1993 Initiatives

FY 1993 emphasis will be placed on support of small science as called out in the NES. Such support will move the program in the direction of correcting the imbalance between large facility/group research support and support of individual university researchers.

-- Provides for development/deployment of remotely piloted vehicles and small climate satellites to provide near-term data on critical climate processes in support of global change research.

-- Supports global change economic research.

-- Enhances structural biology research activities to determine macromolecular structure; and construction of the Structural Biology addition at the National Synchrotron Light Source.

-- Expands environmental biotechnology efforts with objective to use techniques of molecular biology to develop methods for detecting and measuring significant changes in ecological systems. This includes methods for detecting stressed states of organisms and understanding the genetic control mechanisms for environmental adaptation used by organisms and for investigating basic mechanisms of carbon metabolism in the marine environment.

-- Supports expanded research on the boundaries between nuclear medicine and molecular biology by utilizing advances to achieve new approaches and technologies for the diagnosis and treatment of human disorders including synchrotron x-ray imaging and advanced PET technology.

-- Supports DOE basic research related to environmental restoration and waste management in the subsurface biosphere.

-- Provides support to significantly accelerate research that attempts to determine mechanisms of fundamental health effects of radiation and energy-related agents and provide direct linkage of animal tumors to human tumors and greatly facilitate bridging animal and human investigations.

-- Expands atmospheric chemistry research to strengthen regional, continental and global dispersion models and enhance studies on ocean-atmosphere exchange processes.

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(Dollars in Thousands)

LEAD TABLE

Biological and Environmental Research

Activity	FY 1991 Enacted		FY 1992 Enacted	FY 1993 Base	FY 1993 Request	Program Change Request vs Base Dollar	Program Change Request vs Base Percent
Biological and Environmental Research	$344,863		$326,878	$285,328	$344,700	$59,372	21%
Program Direction	5,766		6,100	6,600	6,600	0	0%
Capital Equipment	11,553		16,832	16,832	27,500	10,668	63%
Construction	3,465		3,500	3,500	5,900	2,400	69%
TOTAL	$365,647	a/b/	$353,310	$312,260	$384,700	$72,440	23%
Summary							
Operating Expenses	($350,629)		($332,978)	($291,928)	($351,300)	($59,372)	20%
Capital Equipment	(11,553)		(16,832)	(16,832)	(27,500)	(10,668)	63%
Construction	(3,465)		(3,500)	(3,500)	(5,900)	(2,400)	69%
Staffing Total FTEs							
Headquarters	59		60	60	60	0	0%
Field	89		90	90	90	0	0%
Total Program	148		150	150	150	0	0%

Authorization: Section 103, P.L. 93-438, Section 203, P.L. 95-91.

a/ Total has been reduced by $3,519,000, which has been transferred to the SBIR program, $5,010 for the FY 1991 sequester and $2,296,000 for General Reduction.

b/ Includes $1,972,000 for education programs funded in the Atomic Energy Defense Activities account and $226,000 for prior year deobligations.

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SUMMARY OF CHANGES

Biological and Environmental Research

FY 1992 Appropriation	$ 353,310
FY 1992 Base Adjustments	
- Increased personnel costs	+ 500
- Congressionally directed projects	- 41,550
FY 1993 Base	$ 312,260

The FY 1993 base provides funding for the core research, capital equipment, and construction at the FY 1992 level.

The following additions in research will support "small science" at both the DOE laboratories and universities.

FY 1993 Major Program Changes	
- Supports planned human genome program increase	+ 5,600
- Supports planned global change program increase	+ 7,600
- Supports development of remotely piloted vehicles and small satellites for use in carbon dioxide research	+20,000
- Supports global change economic research	+ 4,000
- Enhances research efforts in structural biology	+ 6,526
- Enhances research activities in environmental biotechnology	+ 2,971

- Expands research exploiting barriers between nuclear medicine and molecular biology.....	+ 5,545
- Supports basic research in environmental restoration and waste management.....	+ 3,977
- Significantly accelerates research in molecular radiation biology.....	+ 5,422
- Supports enhanced atmospheric chemistry research.....	+ 2,655
- Enhances fundamental molecular biology research	+ 923
- Provides additional capital needs in support of global change, structural biology, and genome	+ 4,668
- Provides a structural biology addition at the NSLS at BNL.....	+ 1,800
- Completes Biomedical Isotope Facility at LBL	+ 600
- Supports minor increases in analytical technology and cellular biology	+ 153
FY 1993 Congressional Budget Request.....	$ 384,700

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KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Analytical Technology

The Analytical Technology program provides the instrumentation and measurement science foundation that fosters advancement in all components of the BER program. Environmental research, health effects studies, structural biology, human genome research and nuclear medicine are vitally dependent on continued advancement in these instrumentation sciences to achieve new, exiting breakthroughs in areas of crucial importance for our national research enterprise, and in fulfillment of the Department's National Energy Strategy. Fundamental research on enhanced radiation and chemical dosimetry technology will provide an improved accuracy in assessing human exposure to energy agents, and to environmental radon, which will establish an improved scientific base for evaluating human risk to these agents, and will create a firmer technical foundation for adjudicating radiation and chemical health effects claims.

Basic instrumentation science research provides laser and other advanced measurement techniques crucial to achieving needed sensitive and specific measurement of radioisotopic and toxic chemical materials that result from energy technology development and operation, and so necessary to attain improved accuracy in assessing health and environmental risk from these energy related exposures.

This program also provides a foundation in instrumentation research for the Department's biotechnology enterprise which will bring a technological revolution in such crucial areas as environmental bioremediation, individual health risk assessment, and medical technology advancement. Basic research from this program activity feeds into other BER program elements, and through technological transfer into private sector industrial instrumentation development activities with major benefit to the U.S. economy and to U.S. international competitiveness.

II. A. Summary Table: Analytical Technology

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Dosimetry Research	$ 8,113	$ 7,690	$ 7,730	+ 1
Measurement Science	5,016	5,500	5,560	+ 1
Total, Analytical Technology	$ 13,129	$ 13,190	$ 13,290	+ 1

II. B. Major Laboratory and Facility Funding

	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Ames Laboratory	$ 436	$ 425	$ 425	0
Argonne National Laboratory (East)	$ 633	$ 690	$ 725	+ 5
Brookhaven National Laboratory	$ 110	$ 112	$ 112	0
Environmental Measurements Laboratory	$ 5,015	$ 4,815	$ 4,815	0
Idaho National Engineering Laboratory - EG&G	$ 113	$ 115	$ 115	0
Inhalation Toxicology Research Institute	$ 100	$ 100	$ 100	0
Lawrence Berkeley National Laboratory	$ 1,310	$ 1,060	$ 1,073	+ 1
Lawrence Livermore National Laboratory	$ 260	$ 140	$ 140	0
Oak Ridge National Laboratory	$ 2,075	$ 1,985	$ 1,985	0
Pacific Northwest Laboratory	$ 1,085	$ 1,005	$ 880	- 12

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

Program Activity	FY 1991	FY 1992	FY 1993
Analytical Technology			
Dosimetry Research	Maintained, updated and distributed a comprehensive Chernobyl data base with information on air samples, water samples, radioactive materials, etc.	Compilation of data on transport, deposition and distribution of radionuclides from the Chernobyl reactor accident will be updated and revised incorporating additional data from US/USSR collaboration.	No Activity.
	Maintained characterization studies of radiation sources and defined pathways from source to humans. Research continued on fundamental studies of the microdosimetry of high LET radiation. Dosimetry research on radon and radon daughters continued.	Fundamental studies of the physical and chemical effects of exposure to ionizing radiation will be applied in developing new concepts and methods for correctly defining the dose. Maintain research on developing dosimetric techniques for low LET and high LET radiations. Basic dosimetry research on radon and radon daughters will be 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.

III. Analytical Technology (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Dosimetry Research (Cont'd)	DNA adduct characterization and measurement program continued with emphasis on measuring chemical exposures.	Characterization and measurement of DNA adducts will continue 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.
	$ 8,113	$ 7,690	$ 7,730
Measurement Science	Maintained research program on advanced instrumentation and measurement concepts. Primary emphasis was on multiphoton ionization processes for ultra-sensitive detection of biological damage. Specific laser spectroscopic techniques were developed to measure DNA adducts at very low concentration levels.	Research on new instrumentation for detection and measurement of very low levels of biological damage due to radiation and chemical exposures will be continued. Advances in diode laser technology will be applied to development of simpler, less expensive systems for ultra-sensitive laser techniques will be explored to study very fast chemical processes caused by radiation exposure. New mass spectrometric instrumentation will be 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 proton 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 microprobes are under development which will be applied to direct imaging of target molecules on surfaces or directly within single biological cells.
	$ 5,016	$ 5,500	$ 5,560
Analytical Technology	$ 13,129	$ 13,190	$ 13,290

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KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Environmental Research

Discharges and disturbances from energy sources can be localized or distributed regionally or worldwide. This program addresses the transport of discharges and their behavior through the atmosphere, marine 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 resiliency of biological systems to disturbance from energy extraction, supply, and production is also an important aspect of the maintenance of the integrity of an ecosystem and mitigation techniques to control damage. The broadness of this charge requires focusing on a few selected but important areas of research that provide the information for developing unifying concepts that can be translated into solving current and future energy/environmental concerns. Recent advances in 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 in the area of atmospheric chemistry and addresses the processing of pollutants by clouds, precipitation, and air-surface exchange as well as the role of organics. The second explores transport and diffusion over complex terrain with a goal of providing research results which could 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.

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 terrestrial transport program concentrates on the mobility of organic and inorganic contaminants and radionuclides through the subsurface soils and ground water systems and on exploring microbial communities in deep sediments and aquifers. The program is directed at understanding 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 physiology of subsurface microbial communities.

Ecosystem functioning and response includes two components essential for operations of the DOE field sites. The first maintains long-term descriptive sampling and experimentation at the DOE Environmental Research Parks to provide data and data analyses that are useful for environmental compliance, land use questions at the sites, biological issues related to sustaining ecological systems, and detection of regional and global changes; the second focuses on ecosystem processes in arctic, arid, and forest ecosystems. These components are underpinned with theory and modeling to develop better predictive capability to anticipate problems before they become major issues.

This budget includes $1,100,000 in FY 1992 and $5,830,000 in FY 1993 in support of biotechnology activities.

II. A. Summary Table: Environmental Research

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Atmospheric Science	$ 10,370	$ 10,445	$ 13,100	+ 25
Marine Transport	4,567	5,558	8,487	+ 53
Terrestrial Transport	14,779	14,204	18,181	+ 28
Ecosystem Functioning and Response	6,710	6,490	6,532	+ 1
Total, Environmental Research	$ 36,426	$ 36,697	$ 46,300	+ 26

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory (East)	$ 1,490	$ 1,205	$ 1,353	+ 12
Brookhaven National Laboratory	$ 3,615	$ 3,532	$ 3,457	- 2
Environmental Measurements Laboratory	$ 1,634	$ 1,634	$ 1,634	0
Fermi National Accelerator Laboratory	$ 50	$ 50	$ 50	0
Idaho National Engineering Laboratory - EG&G	$ 1,178	$ 735	$ 1,014	+ 38
Lawrence Berkeley National Laboratory	$ 925	$ 1,015	$ 850	- 16
Lawrence Livermore National Laboratory	$ 1,810	$ 893	$ 1,045	+ 17
Los Alamos National Laboratory	$ 1,200	$ 1,240	$ 1,150	- 7
Oak Ridge Associated Universities	$ 113	$ 0	$ 0	0
Oak Ridge National Laboratory	$ 3,565	$ 3,022	$ 3,338	+ 10
Pacific Northwest Laboratory	$ 8,906	$ 8,648	$ 8,268	- 4
Savannah River Ecology Laboratory	$ 304	$ 100	$ 100	0
Savannah River Laboratory	$ 215	$ 200	$ 200	0

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

Program Activity	FY 1991	FY 1992	FY 1993
Environmental Research			
Atmospheric Science	A major field study was launched over the northeastern United States and the western North Atlantic to determine the fate of man-made emissions of sulfur and nitrogen oxides. Emphasis was placed on the aqueous phase transformations of these products into longer-lived aerosols which may have the potential to modify cloudiness and thus alter climate processes. Attention was focused initially on sulfate aerosols and cyclonic storms which may promote super-regional transport (>1000km). The contribution of naturally occurring sulfate aerosols from oceanic dimethylsulfide was explored. Activities were coordinated with the Interagency Global Tropospheric Chemistry Experiment. Limited numerical modeling of the governing atmospheric chemistry processes were pursued as well as benchmark laboratory studies of aqueous chemical reactions. A university grants program in atmospheric chemistry was launched.	The multi-laboratory consortium will launch a field study in conjunction with the Continental and Oceanic Fate of Energy Related Pollutants Program. The study is coupled with the Committee on Earth and Environmental Sciences (CEES) Global Tropospheric Chemistry Experiment. A university grants program in atmospheric chemistry will be 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 will continue. Development of the global tropospheric chemistry model will continue. The DOE program will join 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 expanded program will support field and modeling studies to improve our understanding of the important role of emissions of dimethylsulfide from oceanic biota in atmospheric chemistry and cloud radioactive properties. These natural emissions and processes must be better understood in order to determine the environmental effects of energy-related pollutants. The second phase of the field experiment conducted by the multi-laboratory consortium will be launched. The focus will remain the continental and oceanic fate of energy related pollutants with a tighter coupling to the CEES North American Regional Experiment (NARE) of IGAC. The university grants program in atmospheric chemistry will issue another solicitation. Laboratory studies will address transformation of more complex nitrogen based pollutants and organics. The global tropospheric chemistry model will be implemented on a massively parallel computer system and will be tested with IGAC field results.

III. Environmental Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Atmospheric Science (Cont'd)	A multi-laboratory team of scientists participated in the study of the environmental effects of the Kuwait oil fires plume. The G-1 aircraft of Battelle Pacific Northwest Laboratory (PNL) flew a series of research missions over Saudi Arabia and the Arabian Gulf in August 1991 and collected valuable atmospheric chemistry and atmospheric radiation data. The data will elucidate fundamental atmospheric chemistry processes and validate the developing global atmospheric chemistry models.	Analysis of data from the oil fires plume will be completed with resulting improvements in our understanding of fundamental atmospheric chemistry processes and in the global atmospheric chemistry models.	No activity.
	The first test for the Atmospheric Studies of Complex Terrain (ASCOT) models in the eastern mountainous terrain and in humid climates, and a new set of appropriate parameterizations were conducted. Pilot studies of uncertainty in emergency preparedness models were undertaken. At Savannah River Laboratory studies of atmospheric transport and diffusion under stable atmospheric conditions (e.g. during the night) addressed validation of model parameterizations; these studies are called the Stable Atmospheric Boundary Layer Experiment (STABLE).	Field studies and numerical modeling of transport and diffusion within the ASCOT Program will strengthen the scientific foundation of emergency preparedness and emergency response systems for critical DOE facilities. The focus remains on the Rocky Flats Plant in Colorado. The application of ground based remote sensing instrumentation will provide 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 and stagnation conditions.. The use of tracers and remote sensing instrumentation will validate models of dispersion on the mesoscale (within 100 km). The models will also be applied and tested against data acquired by STABLE at the Savannah River facilities.
	The study of the role of atmospheric organics in global atmospheric chemistry changes continued. Participated in Kuwait oil fire scientific and assessment studies.	Development and application of tracer technology will proceed to support the atmospheric dispersion studies. Improved instrumentation aboard the research aircraft will meet the scientific challenges of both the environmental processes and climate programs.	The research aircraft will greatly enhance field programs in environmental processes and climate research.
	$ 10,370	$ 10,445	$ 13,100

III. Environmental Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Marine Transport	The marine program has traditionally supported long term interdisciplinary studies on ocean margins as part of its concern for the dispersal, fate, and distribution of energy related materials in the oceans. In FY 1991, field analyses were completed for the 3 regional subprograms: in the Northeast Shelf Edge Exchange Program (SEEP), the Southeast South Atlantic Bight Program (SAB), and the West Coast California Basin Study (CABs). The results from each of these three programs will be synthesized to quantify the major physical, biological, and chemical processes that are specific to each region.	The three regional marine programs will be restructured to better quantify the role of the coastal ocean in the global flux of carbon and determine whether continental shelfs are quantitatively significant in removing carbon dioxide from the atmosphere and isolating it via burial in sediments or export to the interior ocean. The research will be formulated on the basis of a competitive solicitation for grants and contractors.	The following activities are part of the Biotechnology Research FCCSET crosscut. The ocean is home to a vast array of novel microorganisms, plants and animals whose poorly understood metabolic activity and ecology directly relate to problems of energy extraction and use. These novel organisms represent an as yet untapped genetic resource, and include species that convert solar energy to chemical energy, fix CO2 under a variety of conditions, produce and decompose methane and other greenhouse gases, decompose toxic chemicals, metabolize under conditions of extreme temperature and pressure, create biofilms that interfere with energy-related processes, and produce a variety of novel biopolymers. Because nutrients and other limiting factors are in a constant state of flux in the ocean, the organisms that mediate these processes have also evolved an ability to survive under conditions of stress and change. Molecular biology applied to marine systems promises to exploit these processes of relevance to energy extraction and use. Multi-agency planning meetings, field equipment development, and pilot studies will be conducted to accelerate research on ocean margins in tandem with the open ocean research of Joint Global Ocean Flux Studies (JGOFS) funded by other agencies and other countries. The restructuring of the Ocean Margins Program will be finalized with a strong coupling to the CO2 Ocean and Global Change Program and by coordination with the CEES ocean activities. Logistical preparations of the new field program for FY 1994 will commence. This program will analyze the role of continental shelves in the exchange of carbon

III. Environmental Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Marine Transport (Cont'd)			between continental shelves and ocean boundary currents.
	Through a series of interagency meetings and a BER-supported workshop in FY 1990 a program announcement has been made soliciting proposals from the scientific community for the next phase of ocean margins research beginning in FY 1992.	This effort will be integrated into the biogeochemical element of the CEES Global Change Research Program. The BER program will focus on key physical, chemical and biological processes that control carbon exchange and pollutant fate in ocean margins.	Ongoing process research in biogeochemistry will identify the key measurement parameters and the ideal sampling locations. Newly developed instruments and analytical techniques developed during FY 1992 will be assessed and incorporated into plans for the new field program. Together with previous DOE shelf programs, this activity will provide the best estimate of the role of continental shelves in the global carbon cycle.
	$ 4,567	$ 5,558	$ 8,487
Terrestrial Transport	Sixteen radon research projects 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. New research was initiated to define groundwater pathways for radon entry into homes using well water for their domestic water supply.	Research findings on radon transport through environmental systems will be summarized in a synthesis volume which will also contain a bibliography of more than 2,500 entries. Research emphasis will be on basic chemical reactions within soil and rock systems that affect the release of radon.	Conduct review of environmental radon research projects. 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 and indoor radon concentrations. These experimental structures have been placed in the California Coast Range (near Lawrence Berkeley Laboratory) and in the Colorado Front Range (near Colorado State University). Utilize research findings to identify areas with elevated risk potential and begin to test models that correlate environmental data with indoor monitoring data.

III. Environmental Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Terrestrial Transport (Cont'd)	Develop the first national comparative information database on microbial communities in deep sediments/aquifers to determine if diversity and abundance of microbial communities in groundwater can be predicted based on available physical-chemical monitoring data. Maintained research in the microbial degradation, abiotic degradation and sorptive-desorptive processes that mobilize organic-radionuclide chemical mixtures, and in the hydrologic, geochemical and microbiological properties that encourage their stabilization in subsoils and groundwater.	Accelerate transfer of DOE Deep Subsurface Microbiology Culture Collection to bioremediation industry and university researchers. Novel DOE/OER aseptic sampling methods will be refined to obtain uncompromised in situ microbial-sediment samples at depth. Such methods are needed nationally by everyone involved in microbiological research and analysis of chemical transport. Preliminary analysis of deep microbial-environmental interactions will be completed by a consortium of 20 national laboratory and university investigators using data from Savannah River, Hanford, and Idaho research sites. Molecular biologic methods for rapid identification of subsurface microbial communities will be expanded.	Complete preliminary analysis of comparative information base in deep microbiology at DOE Savannah River, Idaho, and Hanford sites, initiated in FY 1991. Maintain research to exploit new molecular biological techniques to evaluate deep microbiology culture collection. Define the fundamental ecological principles that control the distribution, abundance, and diversity of deep microbial communities, and test hypotheses at the laboratory and intermediate scale in advance of new field research. Conduct additional exploratory research on the survival of microbiota isolated from the surface in the vadose (unsaturated) zone of the subsurface, and area of special DOE remediation interest in the long term.
	Research will be continued in new generation expert systems related to chemical transport, and bacterial transport degradation that will provide basic underpinning for effective long term biochemical cleanup of contaminated subsurface systems.	Research on the hydrologic and geochemical properties of the unsaturated (vadose) zone and groundwater that control chemical transport will be continued and initial field injection experiments to determine the stability and transport of organic macromolecules (colloids) under aerobic and anaerobic conditions will be completed. Laboratory experiments using state-of-the-art molecular spectroscopic techniques will focus on quantifying organic chemical-radionuclide interactions and processes important to stabilization of contaminant mixtures.	Complete field injections experiments at colloids research sites and reduce research in organic colloids. Increase research in the genesis and deposition of inorganic colloids.

III. Environmental Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Terrestrial Transport (Cont'd)	Select the first field research site to test scientific concepts and speed transfer of new scientific methods, such as microbial degradation of organic chemical mixtures under pressure and water flux.	Research to develop new predictive models of how multiple (geochemical-hydrologic-microbial) processes control subsurface contaminant movement will be continued and prototype geochemical/hydrological modules of an expert system that allows prediction of mixed chemical stability and mobility will be completed.	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. Enhance basic research on microbiological - geochemical interactions, with emphasis on the subsurface environmental variables that control deep microbial populations in ground water. Accelerate research on the adaptability of microorganisms from extreme natural high Ph or high temperature hydrogeologic environments of long-term benefit to bioremediation at DOE sites, including their unique enzymes. Accelerate research in genesis of deep microbiota, including their adaptability and survival over tens of thousands of years or millennia, using integrated geochemical and molecular biology research methods.
	Upgrades of ESNET to conform to the National Research and Education Network Standards implemented; funding was shared among ER programs that benefit from ESNET. This subprogram's share was $62.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.
	$ 14,779	$ 14,204	$ 18,181

III. Environmental Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Ecosystem Functioning and Response	The evaluation of advanced field systems that measure evapotranspiration over a 1 to 2 km swath was completed and if appropriate will be deployed in arctic and arid sites for calibrations. Synthesis of the arctic program was completed and further research developed within a comprehensive multi-agency program, whose planning started in FY 1990 under the Arctic Research and Policy Act. Implementation of the arid research program started with use of data available at the DOE National Environmental Research Parks and the ecological theories necessary to conduct DOE goal oriented research. Focus of the program remained on changes in arid ecosystems that could cause a cascading effect to create decertification in dry ecosystems.	Research will be started that focuses 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 will be explored using a workshop format to define the research elements. Specific objectives of this exploratory research will focus 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 will establish 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 and physiological research will be started to detect biological responses to environmental changes, especially research that can be monitored at levels of precision sufficient to detect mechanistic responses. Research will begin that specifically focuses on physiological processes in plants and animals linked with biochemical pathways that are conceptually responsive to the low-rate changes in CO2 levels, water availability, and temperatures expected during global climate change; and growth and reproduction changes that result from energy development that are expected during species responses to episodic disturbance events and their reclamation. This work will establish the physiological processes that become the research focus for related mechanistic understanding of the cellular control mechanisms, and also the organismic functions that can provide the basis for scaling mechanistic understanding to higher levels of ecological organization.
	Research at the seven DOE National Environmental Research Parks was designed to provide validation opportunities for new and developing ecological theories and intra-continental transect analyses. ParkNet, the interactive DOE Research Parks data base network, continued to expand with links to the NSF Long-Term Ecological Reserves and the international Man and the Biosphere network started intercontinental and international transects that will be used to identify and understand critical gradients useful in forecasting global and regional change.	Activities of the DOE National Environmental Research Parks will begin developing definitions for DOE related environmental problems resulting from natural and anthropogenic disturbances that ecological research at the parks can provide solutions for. Cross-park experimental and descriptive research will be designed that links theoretical understanding and ecological knowledge with DOE Park related problems. Linkages with national and international programs by ParkNet will provide 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. The parks will provide the experimental and descriptive capability; whereas, ParkNet will provide the cross-site data synthesis needed to develop and validate theoretical understanding that

III. Environmental Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Ecosystem Functioning and Response (Cont'd)			is necessary to make correct strategic management decisions for energy development in disturbed ecological systems.
	The Theoretical Ecology program was peer reviewed to ensure it is of the highest scientific quality. This is the only ecology program in the Federal system with the specific goal of enhancing the theoretical base in ecosystem dynamics.	Results of the three years of research sponsored within the Theoretical Ecology program will be compiled and presented in an open forum for comments from the scientific community to explore new advances in theory development. An announcement in the Federal Register for theoretical ecology proposals to begin in FY 1993 will be published with a focus on mathematical, physical, and other disciplines to provide a framework to better understand and predict ecological processes.	Theoretical ecology research will be focused on understanding how mechanistic responses of plants and animals to environmental changes can be interpreted at the ecosystem to landscape levels.
	$ 6,710	$ 6,490	$ 6,532
Environmental Research	$ 36,426	$ 36,697	$ 46,300

DEPARTMENT OF ENERGY
FY 1993 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. This program is designed to provide information and technology relevant to understanding and mitigating the potential health effects of energy development, use and waste clean up. 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.

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.

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. Recent advances in molecular biology that allow us to study cancer at the level of individual genes 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. In order to take advantage of these opportunities, and also because of a significantly decreased budget, a notable consolidation and refocussing of the Health Effects program began in FY 1991.

Enhanced budget levels in FY 1993 are critical to the development of new tools for health surveillance and biological dosimetry as well as for understanding DNA repair and genetic susceptibility. Human cell culture models are needed to study cancer development in the laboratory. Such systems allow separation and analysis of the various stages of cancer development. This makes it easier to understand the complex interactions that are involved in the multi-step process required to turn a normal cell into a malignant cell. Sensitive assays are needed for the enzymes involved in metabolizing exogenous chemicals and repairing DNA. Transgenic animal systems are needed to investigate the effects of damage to specific genes (e.g., those coding for DNA repair enzymes, metabolic enzymes, cancer causing genes, tumor suppressors, etc.) and their role in cancer development following exposure to energy-related agents.

This budget includes $548,000 in FY 1992 and $583,000 in FY 1993 in support of education activities. Support for Hollaender fellowships are a part of the FCCSET Education crosscut.

II. A. Summary Table: Health Effects

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Biological Research	$ 33,379	$ 29,680	$ 34,366	+ 16
Radiological and Chemical Physics	5,914	5,996	6,732	+ 12
Total, Health Effects	$ 39,293	$ 35,676	$ 41,098	+ 15

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory (East)	$ 5,233	$ 4,875	$ 5,254	+ 8
Brookhaven National Laboratory	$ 732	$ 570	$ 500	- 12
Fermi National Accelerator Laboratory	$ 60	$ 0	$ 0	0
Inhalation Toxicology Research Institute	$ 7,338	$ 7,221	$ 7,645	+ 6
Laboratory of Radiobiology and Environmental Health	$ 902	$ 780	$ 932	+ 19
Lawrence Berkeley National Laboratory	$ 1,640	$ 1,235	$ 1,467	+ 19
Lawrence Livermore National Laboratory	$ 1,220	$ 820	$ 1,430	+ 74
Los Alamos National Laboratory	$ 855	$ 1,235	$ 1,239	0
Oak Ridge Associated Universities	$ 1,207	$ 1,048	$ 1,073	+ 2
Oak Ridge National Laboratory	$ 6,378	$ 5,609	$ 5,273	- 6
Pacific Northwest Laboratory	$ 5,418	$ 4,580	$ 4,922	+ 7
Sandia National Laboratories	$ 871	$ 0	$ 0	0

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

Program Activity	FY 1991	FY 1992	FY 1993
Health Effects			
Biological Research	Carcinogenesis research employs animal models to develop data on tumor formation caused by radiation and/or energy-related chemicals. Data from this research area provide important information regarding the relationship between dose and effects for tumorigenesis, dose-rate effects, the influence of host factors (age, sex, etc.). These studies contributed much toward our present understanding of the effects of radiation on mammals. As part of the refocussing and consolidation mentioned in the Preface,several animal studies that did not contribute significantly to understanding mechanisms were terminated or reduced in funding. Consolidation of life-span experiments with beagle dogs continued, with transfer of the few remaining dogs in one laboratory to another that still has a large colony. Other life-span experiments that focus on empirical observation are nearing completion. Recently initiated animal experiments designed to produce improved understanding of tumorigenic mechanisms were expanded. Support increased for operation of the Janus reactor for neutron radiobiology. Acquisition of data continued on the carcinogenic effect of inhaled radionuclides, such as plutonium compounds,beta-emitting radionuclides, and radon and radon progeny.	New animal experiments will be initiated with the aim of obtaining information regarding the underlying molecular mechanisms of radiation-induced cancer. Continue consolidation and orderly reduction of animal experiments which are 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 will enter the analysis phase upon the death of the last remaining dogs. Other experiments at BNL investigating the tumorigenic effects of neutrons will enter 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 will continue. Studies on the carcinogenic effects of other inhaled radionuclides,including radon and radon daughters, will also continue.	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. Initiate new carcinogenesis experiments, using mice as model systems. Complete experiments on neutron tumorigenesis and experiments to estimate the relative biological effectiveness of neutrons for producing cataracts. Research will be initiated to investigate (in transgenic animals) the effects of radiation damage in the absence of specific modifying factors such as DNA repair enzymes. Increased funds are required to develop a broad range of in vivo carcinogenesis studies that attempt to provide, through a knowledge of cancer-causing mechanisms, a direct link with known radiogenic human neoplasms. This research is likely to greatly facilitate bridging the gaps between animal and human investigations. Another high priority is characterization and quantification of pre-neoplastic events in animal tissues. Identification of markers that foretell the development of tumors may allow rapid and precise quantification of such early events. This capability is very important for better monitoring of the work force.

III. Health Effects (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Biological Research (Cont'd)	This activity provides information on the underlying mechanisms of potential long-term health effects, primarily cancer, that may be associated with low dose exposure to radiation or energy-related chemicals. In order to credibly extrapolate information from animal species to man, it must be shown that the mechanisms involved in producing health impacts are the same in both species. Likewise, the development of biological markers for early events in tumorigenesis, for use as biological dosimeters, or to measure individual susceptibility, depends on understanding these biological mechanisms. It has been recognized for some time that direct quantitative studies of human populations or of animals are, alone, unlikely to provide the information necessary for human risk assessment at low doses. Studies continued to define fundamental principles by which radiation and chemicals interact with living systems to cause cancer. Effects of energy-related agents on specific genes (oncogenes and tumor suppressor genes)that are associated with the development of human and animal tumors were examined. Studied changes in gene expression which are associated with low-level exposure. Continued studies of the cells in the airways that are most at risk for tumorigenesis following inhalation of toxic agents; and continued cell culture studies to define the nature of malignant transformations caused by energy-related agents. To expand the refocussing, new proposals were solicited and reviewed late in the year. A workshop was held to further coordinate research plans and activities with the Radiation Program	After solicitation for research proposals, initiate new research designed to provide information on comparative mechanisms of tumor formation in humans and potential model animal species. Begin research that couples cell culture to whole-animal experimentation to clarify the multi-step process by which normal cells become malignant. Expand efforts to develop biological markers for estimating biologically harmful doses of radiation and chemicals. Continue cellular level studies of the hematopoiesis (blood-forming) system in order to understand events associated with the development of radiogenic leukemia. Utilize new methods to identify and separate cells from the lung and bronchial pathway to determine the cell types most important in the development of lung tumors. Convene a workshop to explore the applicability of technologies from the Human Genome program to health effects research. Expand studies of the genes which are involved in metabolizing of energy-related chemicals that convert these chemicals to biologically active forms (that lead to cancer) or to forms which lead to their removal from the body.	Continue research initiated in FY 1991 and 1992 and expand research aimed at efficient, automated scoring of chromosome damage. New "chromosome painting" technology, stemming in part from the Human Genome program, can score chromosome aberrations so efficiently that they can be readily measured following irradiation both in vitro and in vivo. Aberrations are effective probes of variation of biological effect with dose, dose rate and radiation quality. Expand research aimed at elucidating specific chromosomal rearrangements which are associated with specific tumor types and developing specific diagnostic markers for such rearrangements. Markers for such specific translocations will find use in diagnosis and therapy. Develop markers to identify individuals who are particularly sensitive to effects of radiation and chemicals. In order to decrease reliance on animal models, develop new culture systems for human cells including organ culture systems which would allow all aspects of radiation induced transformation to be studied. Accelerate application of technologies from Human Genome program to development of new markers for diagnosis and quantitation of human exposure.

III. Health Effects (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Biological Research (Cont'd)	of the Commission of the European Communities. This activity provides information regarding the processing of radiation and/or chemically induced damage to DNA and information on the mutagenic properties of these agents, which are sometimes associated with tumor development. Mutation in germ line cells (eggs or sperm) can cause heritable effects which are seen in subsequent generations. DOE programs in this subarea have traditionally led the world, starting with the discovery of DNA repair and the later development of many short-term mutagenicity tests in use today. In this program research has been conducted on the mechanisms of DNA damage and its repair, and research to define the normal DNA repair capacity of humans and the extent to which this varies between individuals. This is one of the important questions which underlie evaluation of potential health effects associated with genotoxic agents such as radiation. Supported research to develop sensitive new measures of DNA damage, including development of monoclonal antibodies which bind to specific types of DNA damage. These studies included research to define the mutagenic properties of radon and radon daughters, development of mutagenesis assays which can be directly applied to humans, and studies to increase the sensitivity of tests for detecting human heritable mutations.	In order to study and predict the effects of low-dose and low dose rate exposures in humans, develop sensitive measures for isolating and characterizing DNA repair enzymes. Some of the genes responsible for DNA repair will be cloned this year. This will allow production of purified enzymes for use in assays and to prepare monoclonal antibodies for detecting these proteins. Continue efforts to clone and isolate additional genes involved in DNA repair. Initiate research to select and characterize of radiation-sensitive cell lines. A long-term goal of this program is to elucidate the molecular basis underlying spontaneous and induced events that lead to cancer, heritable mutations, and congenital malformations. In vitro studies are under way to define the frequencies and spectra of mutants induced by energy-related agents (ionizing radiation and chemicals). The results may provide a fingerprint that helps to identify the chemical or other agent responsible for the mutational event. Biological markers that detect exposure at very low levels will also be developed. Specifically, these markers will be molecular probes that detect proteins induced by radiation exposures or enzymes that are induced to metabolize and detoxify chemicals.	Increased funding is required to take advantage of exciting developments related to cloning of human DNA repair genes which may lead to assay systems for DNA repair. These same systems and reagents could be used for development of assays to identify and characterize variability of radiation-sensitive individuals. Direct in vivo/in vitro comparisons of radiation-induced mutations will be made between these mice and cell lines derived from transgenic embryos to gain information on response of individual organs and tissues. These animal and cell lines will also allow determination of the types and numbers of mutations observed in genes related to cancer. Additional assay systems are needed to detect mutations and measure human exposure to energy-related agents.

III. Health Effects (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Biological Research (Cont'd)	Inhaled radon is the major source of radiation exposure for the general population. Several studies have focused on elucidating the mechanisms by which inhaled aerosols are cleared from or retained in the respiratory tract. Included were studies related to estimating the health risks from radon exposures. Internally deposited cesium or plutonium from nuclear accidents and fallout usually finds its way into bone tissues. For dosimetric purposes, it is important to understand the relationships between bone metabolism and bone morphology. Methods using special microscopy to provide 3-D reconstructions of calcified bone are being developed. These techniques will allow comparison of radionuclide deposition in humans and animals; helping to use animal data to model radiation effects in humans.	Develop ultra sensitive techniques for analysis of DNA adducts in specific gene sequences (e.g.,cancer-related genes); this may have significance for human risk assessment. Study unique features of DNA damage processing in rodent cells in comparison with that in human cells. Initiate efforts to develop better biological dosimeters to monitor cells and or subcellular components to determine individual exposure to radiation or chemical agents. Systems are needed that can be used to determine either acute exposure or lifetime accumulated doses. The polymerase chain reaction technology promises insight into rare genomic events that result from radiation injury by studying biological markers of exposure that are preserved in subsequent generations of cells. In addition, these techniques could also be used to track exposed cells as they progress to tumors. Experimental approaches that examine differences between residential and mining exposures will be used to estimate health risk associated with exposure to radon and radon daughters. Studies to improve understanding of the basic physical and chemical characteristics of airborne materials would continue. Other factors that affect the behavior of airborne materials, influence their biological fate, and determine the health effects that follow inhalation would also be examined.	Efforts will be initiated to identify and clone proteins whose synthesis is induced by radiation exposure. Since these proteins are induced at very low levels of exposure they could serve as markers of acute radiation exposures. Research efforts on the development of biological dosimeters and development of ultra sensitive techniques for analysis of DNA damage in specific gene sequences will be expanded. Research would be initiated to evaluate the significance of interactions among radon, cigarette smoke, and other indoor pollutants on human health. Increased funding is critical to the development of improvements in individual dosimetry. Radiation exposure (both internal and external) leaves a permanent signal of the radiation dose in tooth enamel. Investigations are needed to develop methods for using this as a reliable dosimeter. Develop simple and widely applicable methods to monitor and characterize exposures to radon and other alpha-emitters in the work-place.

III. Health Effects (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Biological Research (Cont'd)	Studies were initiated to increase understanding of how results from animal studies can be used to better predict effects in humans. An interlaboratory computerized information system containing a summarized dose-and-effects data base with results for each of the life-span large animals studies has been implemented. This archive serves as a central library of information regarding the DOE life-span experiments for statistical analysis and modeling purposes. This will insure maximum utilization of the information derived from the various long-term animal studies. The usefulness of tissues from these long-term animal studies for developing insights into molecular events associated with tumor development is being evaluated. Funding and oversight of the radiation biology archive and data analysis of the dose-response life-span studies is jointly supported by the Office of Health and Environmental Research and the Office of Health and Environmental Safety.	The radiobiology data base will be further refined (including development of new statistical methods for cross-species extrapolation) to maximize the usefulness of the dose-response animal exposure data accumulated over the past 30 years. Information from the life-span rodent studies would be incorporated in this data base. The overall assessment of the experimental data from DOE life-span studies would be continued. Optimal methods of using these data for assessing human risks would be developed. Specifically, the data would be analyzed by modeling the hazard, or age-specific risk, as a function of dose, age, and other factors of interest. An understanding of the uncertainties of these models for predicting risks to humans would be developed. Funding and oversight of the radiation biology archive and data analysis of the dose-response life-span studies by the Office of Health and Environmental Safety is expected to continue.	Expand the radiobiological data base. Initiate new projects using improved statistical methods to analyze these data. Use the large animal data-base to attempt to develop models that have predictive value to describe radiation toxicity in humans. The small-animal dose response data would be used to examine the influence of different types (qualities) of radiation in causing biological effects. Research data indicate that, for a specific radiation dose risk decreases if that exposure occurs at lower dose rates. Animal data from the archive would be used to examine this effect in order to develop a dose-rate effectiveness factor. This factor has important implications for human safety relevant to environmental and occupational (low-level) exposures to radiation.
	No activity.	No activity.	In an effort to manage administrative costs more closely, the PSO/Office Director's share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year. ($590)
	$ 33,379	$ 29,680	$ 34,366

III. Health Effects (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Radiological and Chemical Physics	Radiation biophysics and fundamental studies on interaction of radiation with matter continued. Application of this research to the understanding of radiobiological effects at low doses and dose rates continued. Continued emphasis placed on obtaining data in condensed phase. Theoretical studies on understanding of conformational and structural changes in biomolecules caused by radiation and chemical agents continued.	Understanding of fundamental physical processes involved with interaction of ionizing radiation with matter will continue. Information obtained from this research will be used to enhance understanding of radiobiological effects at low doses and dose rates. Continued emphasis will be placed on the study of interaction processes in condensed phase, particularly those materials which may have biological significance. Theoretical and computational 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 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 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. Expanded 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.
	Basic studies on identifying and elucidating the mechanisms of energy transfer processes in biologically relevant model liquids will continue. Application of this knowledge in understanding the changes that are produced in physical and chemical properties of these liquids will be emphasized. Theoretical computational techniques will be emphasized to better define the structure-activity relationship of these liquids.	Basic mechanisms involved in energy transfer processes in biologically relevant macromolecules and model liquids will continue. Understanding of these mechanisms coupled with the physical mechanisms of interaction of radiation with matter will provide a sound scientific basis to relate initial damage to the production of ultimate health effects such as cancer. Theoretical research will continue to better understand and define the structure-activity relationship in model liquids. This information will be further extended to realistic biological systems.	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.

III. Health Effects (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Radiological and Chemical Physics (Cont'd)	$ 5,914	$ 5,996	$ 6,732
Health Effects	$ 39,293	$ 35,676	$ 41,098

DEPARTMENT OF ENERGY
FY 1993 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.

Increased funding is requested to support the effective utilization of current and developing structural biology user facilities located at DOE laboratories. These funds would upgrade facilities and technical support at existing large facilities (NSLS, HFBR, SSRL) which are widely used by the outside community. Increased structural biology funds would allow the development of new technology for x-ray imaging of biological structures at the new 1-2 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 $91,498,000 in FY 1992 and $104,600,000 in FY 1993 in support of biotechnology activities, and $325,000 in FY 1992 and $489,000 in FY 1993 in support of education activities.

II. A. Summary Table: General Life Sciences

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Structural Biology	$ 8,824	$ 11,974	$ 18,500	+ 55
Molecular Biology	13,492	13,787	14,710	+ 7
Cellular Biology	8,613	8,937	8,990	+ 1
Genome	45,486	56,800	62,400	+ 10
Total, General Life Sciences	$ 76,415	$ 91,498	$ 104,600	+ 14

II. B. Major Laboratory and Facility Funding

	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Ames Laboratory	$ 200	$ 200	$ 210	+ 5
Argonne National Laboratory (East)	$ 2,170	$ 2,610	$ 4,423	+ 69
Brookhaven National Laboratory	$ 6,882	$ 7,803	$ 9,333	+ 20
Laboratory of Radiobiology and Environmental Health	$ 2,036	$ 2,186	$ 2,300	+ 5
Lawrence Berkeley National Laboratory	$ 8,626	$ 10,510	$ 14,193	+ 35
Lawrence Livermore National Laboratory	$ 12,770	$ 12,178	$ 11,993	- 2
Los Alamos National Laboratory	$ 13,834	$ 14,807	$ 18,500	+ 25
Oak Ridge Associated Universities	$ 756	$ 875	$ 1,039	+ 19
Oak Ridge National Laboratory	$ 7,651	$ 7,641	$ 9,791	+ 28
Pacific Northwest Laboratory	$ 231	$ 120	$ 552	+360
Stanford Synchrotron Radiation Laboratory	$ 0	$ 250	$ 750	+200

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

Program Activity	FY 1991	FY 1992	FY 1993
General Life Sciences			
Structural Biology	This activity develops and supports national structural biology user facilities at DOE laboratories and conducts structural biology research in support of DOE research missions. Supported user facilities and operations at the Brookhaven National Laboratory (National Synchrotron Light Source, High Flux Beam Reactor and the Scanning Transmission Electron Microscopes), the Stanford Synchrotron Radiation Laboratory, and the Los Alamos National Laboratory (Los Alamos Neutron Scattering Center). New national facilities are under construction at the Lawrence Berkeley Laboratory (1-2 GeV) and the Argonne National Laboratory (6-7 GeV). Supported development of user facilities and programs at these oncoming synchrotrons. Developed new and improved detectors to take advantage of the intense beams	This activity provides for further development and increased technical support at current structural biology user facilities at the National Synchrotron Light Source and the High Flux Beam Reactor at the Brookhaven National Laboratory and to provide increased user support at the Stanford Synchrotron Radiation Laboratory. 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 will continue to be a high priority. Provides support to develop the 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 capabilities and user support 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 developing capability of user facilities, including microscope design and other technical support.

III. General Life Sciences (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Structural Biology (Cont'd)	available at current and developing synchrotrons.		
	Supported structural biology research on important biological molecules and structures important to various DOE missions. This research utilized both the national facilities and other, more routine instrumentation. Studied the structure of chromosomes and subcellular particles where proteins are synthesized (ribosomes) by means of small angle neutron scattering and transmission electron microscopy. At ANL, important progress has been made in understanding the structure of the photosynthetic reaction center, an enzyme activity of central importance to a variety of energy missions. Studied chemical modification of antibody molecules to create catalytic antibodies. This technology promises to make extremely important contributions to biotechnology. Determination of the structure of the active form of a cancer causing protein offers the possibility of designing drugs to inhibit its action.	Expanded research on the structure of the photosynthetic reaction center. Continue studies on the protein products of cancer causing genes have implications for tumor therapy. Expand 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 will be expanded somewhat.	Expand structural biology research on important macromolecules. Continue a focus on fine structure of chromatin; expand 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.
	$ 8,824	$ 11,974	$ 18,500
Molecular Biology	Much of this program is aimed at investigating the nature of DNA lesions produced by radiation and other environmental agents and elucidating the mechanisms by which these lesions are produced, modified and repaired. Developed new fluorescent techniques utilizing molecular probes for the detection and quantitation of genetic damage. A variety of model systems were exploited to understand the factors regulating the expression of particular genes. Efforts to isolate,	An important component is 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 will continue to be developed. Efforts to develop new molecular markers for monitoring human exposure and response continues. Expand	The techniques of molecular biology promise to provide new insight into the functioning of ecosystems. A new effort, based on a DOE-organized planning workshop, will focus on three areas of opportunity - (1) identify factors limiting and regulating biologically driven fluxes of geochemical compounds; (2) understand the processes that allow organisms to adapt to environmental changes; and (3) assess the impact of chronic environmental changes on the stability,

III. General Life Sciences (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Molecular Biology (Cont'd)	clone and characterize human DNA repair genes were expanded. This DOE program leads the world in the isolation and cloning of human DNA repair genes.	development of transgenic mice systems for study of important genes. Continue study of basic aspects of genetics which are important for understanding health impacts.	diversity, and function of biological communities. The new program will promote interdisciplinary research linking ecology and molecular biology, and will be achieved through competitive research grants and interdisciplinary training. A substantial effort is underway to clone and analyze DNA repair genes in several species, especially human DNA repair genes. Quantitative knowledge of repair gene activity will be useful in estimating the sensitivity of individuals and populations to various mutagenic and carcinogenic agents. Study the extent to which repair activity can be induced by exposures to low levels of DNA damaging agents. Supports protein engineering experiments focused on key proteins and enzymes such as the enzyme which fixes carbon dioxide. Studies of this enzyme may result in a capability to greatly modify plant growth and control the levels of atmospheric carbon dioxide.
	$ 13,492	$ 13,787	$ 14,710
Cellular Biology	Research in this program area serves to provide basic knowledge of cell function and structure necessary to understand cellular responses to radiation and chemical exposures and to develop better experimental models. Studies continued on the regulation of gene expression in particular cell types, on mammalian germ cell biology, on the metabolism, regulation and function of lipids in mammalian cells, and on the responses of cells to freezing and thawing. Particular emphasis is placed on improving flow cytometric analytical cytology methodology and the validation and	Selected cell types and specific cellular processes studied to identify the genetic and other factors that control cell transformation, cell division, and cell differentiation. Clarify cellular processes involved in radiation- or chemically-induced tumor formation. A significant component is aimed at improving cytogenetic techniques for the detection and quantification of damage to chromosomes. Develop new human cell systems for use in health effects studies.	A particular emphasis will be the further development of automated approaches for analysis of chromosome damage using chromosome specific DNA probes and to develop new DNA probes and technologies for characterization of the differences between humans in their response to exogenous agents. The new technologies will provide improved biological dosimetry and sensitive new measures of damage in human cells. As they are developed these new technologies need to be tested and validated. A new program in stem cell biology will be initiated in order to develop better understanding of cell

III. General Life Sciences (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Cellular Biology (Cont'd)	application of a flow cytometric procedure to detect and enumerate variant human red cells that are produced by mutational events that occur in the bone marrow and result in the loss of cell surface glycophorin A. New research applying analytical cytology to the study of hematopoiesis was initiated. These studies provide fundamental information for use in evaluating health effects.		repopulation of bone marrow leading to improved treatment following acute radiation exposure.
	$ 8,613	$ 8,937	$ 8,990
Genome	Continued development of biological resources and technologies and emphasized automation and robotization of advanced state-of-the-art capabilities for sequencing DNA. Started sequencing selected regions of DNA to facilitate physical mapping of chromosomes. Increased efforts to design and apply the software needed to manage and analyze data. Expanded the effort to construct physical maps of each human chromosome. Supported distribution of these resources from National Laboratories. Established human genome fellowships for training interdisciplinary specialists. These activities are part of the Education FCCSET crosscut. Facilitated transfer of technologies from labs to the private sector. Expanded ethical, legal, social issues activities.	Sustain the development of innovative biological and computational resources and instrumentation; design automated and robotized state-of-the-art technologies for mapping and sequencing DNA. Emphasize constructing physical maps of entire human chromosomes and sequencing selected regions. Encourage distribution of information and resources from National laboratories. Maintain special fellowship program and expand effort to support ethical, legal, and social issue activities. Facilitate transfer of technologies from laboratories to the United States private sector.	Accelerate mapping and sequencing genetically active (genes) 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.
	Upgrades of ESNET to conform to the National Research and Education Network Standards implemented; funding will be shared among ER programs that benefit from ESNET. This subprogram's share was $126.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.

III. General Life Sciences (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Genome (Cont'd)	$ 45,486	$ 56,800	$ 62,400
General Life Sciences	$ 76,415	$ 91,498	$ 104,600

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Medical Applications

Nuclear medicine is a world-wide medical specialty. The Atomic Energy Commission, the Energy Research and Development Administration, and the Department of Energy (DOE) over the past 40 years have provided the support which established this discipline as a vital component of clinical medicine in today's medical health care practice. The Society of Nuclear Medicine and the American College of Nuclear Physicians have singled out this program as being especially important to the continued development of new advances in diagnostic and therapeutic technology and of great benefit to the advancement of clinical medicine. The current program emphasis centers on research which will focus on brain metabolic function studies using positron emitting radioisotopic compounds. This program is also responsible for needed improvement in radionuclide instrumentation which will enable better spatial definition from nuclear medicine imaging procedures and improved quantitation of metabolic function so crucial to advancement in current diagnostic capability.

New and improved radiation therapy in collaboration with the National Cancer Institute (NCI) is also a key objective of this research activity. Heavy ion therapy clinical trials are underway at the Lawrence Berkeley Laboratory with NCI support, and basic heavy ion radiobiology is the responsibility of DOE. Other promising radiation therapy approaches are also being investigated such as photon activation therapy, in which a heavy element (e.g., iodine) tagged to a tumor localizing compound will deposit massive energy in the tumor after activation by specially selected external radiation; and boron neutron capture therapy in which a boron compound, after localization in a tumor, interacts with a thermal neutron beam to deposit a large amount of energy within the tumor.

To take advantage of new developments in molecular biology, and particularly, results from the human genome program, expanded research efforts will explore new directions in medical applications. New imaging techniques, and perhaps therapeutic methods, using engineered and tagged antibodies or molecules specific to cell-surface receptors will be investigated.

This budget includes $1,000,000 in FY 1992 and $1,300,000 in FY 1993 in support of biotechnology activities.

II. A. Summary Table: Medical Applications

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Stable Isotope Research	$ 450	$ 0	$ 0	0
Radioisotope Development	2,104	2,019	2,062	+ 2
Radiopharmaceuticals	15,765	15,411	15,245	- 1
Instrumentation	2,725	2,958	3,168	+ 7
Clinical Feasibility	5,071	6,016	6,269	+ 4
Boron Neutron Capture Therapy	16,621	7,363	7,568	+ 3
Molecular Medicine	0	0	5,000	>999
Congressionally Directed Projects	72,160	41,550	0	-100
Total, Medical Applications	$ 114,896	$ 75,317	$ 39,312	- 48

II. B. Major Laboratory and Facility Funding

	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Argonne National Laboratory (East)	$ 380	$ 458	$ 360	- 21
Brookhaven National Laboratory	$ 8,738	$ 9,199	$ 9,010	- 2
Hanford Production Facilities	$ 85	$ 0	$ 0	0
Idaho National Engineering Laboratory - EG&G	$ 12,876	$ 3,050	$ 3,550	+ 16
Lawrence Berkeley National Laboratory	$ 2,952	$ 2,689	$ 2,689	0
Lawrence Livermore National Laboratory	$ 494	$ 0	$ 0	0
Los Alamos National Laboratory	$ 1,597	$ 1,842	$ 1,692	- 8
Mound Facility	$ 250	$ 0	$ 0	0
Oak Ridge Associated Universities	$ 550	$ 260	$ 260	0
Oak Ridge National Laboratory	$ 1,673	$ 1,724	$ 1,724	0
Pacific Northwest Laboratory	$ 13	$ 0	$ 0	0

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

Program Activity	FY 1991	FY 1992	FY 1993
Medical Applications			
Stable Isotope Research	Complete the development of advanced nuclear magnetic resonance techniques for imaging the distribution of stable isotopes in humans and animals in real-time.	No activity planned.	No activity planned.
	$ 450	$ 0	$ 0
Radioisotope Development	Research efforts in this area are directed to improving the methods of producing radionuclides that are used in diagnosis and therapy and for study of physiological and biological processes. Progress has been made in the development of radionuclide generators, which make it possible to use short-lived radionuclides at locations distant from production sites by shipping a long-lived radionuclide that decays to the short-lived one of interest. Research includes preclinical studies of new radionuclides in animal models, with an aim to developing clinical applications of these substances. Progress has been	Develop 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.

III. Medical Applications (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Radioisotope Development (Cont'd)	made in the development of radionuclide generators for calcium-47, which is of use in diagnostic imaging of bones with positron emission tomography, gold-194 for use in arthritis treatment, and arsenic-72 for heart imaging.		
	$ 2,104	$ 2,019	$ 2,062
Radiopharmaceuticals	Radiopharmaceutical research spans the range from development of new labeled compounds and improvements in the labeling of established compounded, to clinical uses of these substances. Progress has involved the development of agents that provide more selective localization of radionuclides in specific organs or tissues. An example is a study to measure human biodistribution of a tin-117m labeled bone seeking agent, which has great promise for relieving bone pain in patients with breast and prostate cancer. Another study will prepare stable copper linked by porphyrins to antibodies for animal localization studies and will determine the biodistribution and tumor localization in nude mice bearing human colorectal carcinoma. These are among the most common types of cancer in humans. The studies have the potential for improving the therapy of these diseases.	Develop pharmacologic strategies to improve retention of radiolabeled antibodies in tumor cell targets following labeled antibody administration. Complete biokinetic assessment of tin-117m in 10 human subjects and refine organ dose estimates to develop a therapy protocol. Develop chemistry to enable the attachment of many porphyrins per antibody molecule, while only modifying one site on the antibody molecule, which will allow copper-67 porphyrin groups to be attached and still retain a high degree of immunoreactivity. This will increase 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 radiomedical Te-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 efficacy studies of human colorectal carcinoma.
	$ 15,765	$ 15,411	$ 15,245

III. Medical Applications (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Instrumentation	Research on high resolution PET and SPECT systems maintained with emphasis on true three-dimensional imaging capabilities. In-vivo computed tomography using a new beam line at the National Synchrotron Light Source equipped with a superconducting wiggler insertion device applied in multiphoton absorption studies to image brain tumors, especially pituitary adenomas and cerebral gliomas, and atherosclerotic plaques in major arteries. New biomedical generators for positron emitting isotopes explored for tumor imaging and for studying bone and brain metabolic processes. Development of a compact, portable instrument for monitoring the course of pulmonary edema at the hospital bedside or outpatient clinics completed. Development of magnetoencephalography instrument for non-invasive brain function studies continued.	Develop 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 will be evaluated. Research on three-dimensional PET imaging and magnetoencephalography will be continued.	Research on improved detector systems for PET and 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.
	$ 2,725	$ 2,958	$ 3,168
Clinical Feasibility	The clinical feasibility studies involve the application of the unique facilities of the DOE's National Laboratories to the study, diagnosis and treatment of human disease. These include the uses of proton and heavy particle accelerators and the National Synchrotron Light Source (NSLS). The program also includes clinical studies of newly developed radionuclides and radiopharmaceuticals. Progress has been made in the use of positron emission tomography (PET) in studies of brain function such as the identification of the sites of action of alcohol and cocaine. Studies of coronary angiography have been initiated, using the NSLS. A general objective of medical applications studies is the	Continue PET studies of brain function and heart blood flow and metabolism, including studies of the effects of alcohol and cocaine abuse. Develop methods to improve the specificity of labeled monoclonal antibodies for the treatment of cancer. Study 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.

III. Medical Applications (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Clinical Feasibility (Cont'd)	technology transfer from laboratory studies to more generally available clinical procedures.		
	$ 5,071	$ 6,016	$ 6,269
Boron Neutron Capture Therapy	In principle, the BNCT concept is simply to achieve localized irradiation of cancers by achieving relatively high concentration of boron in the cancer, then subjecting the affected area to an epithermal neutron beam. In practice, however, there are many difficulties in achieving the required conditions for safe and effective therapy. Research in this area is directed to the multiple problems of neutron beam composition, synthesis of more specific boron compounds, studies of the distribution kinetics of boron compounds and studies of the radiobiological effects of mixed field irradiation. Research to date has concentrated on efforts directed to treatment of brain tumors and metastatic melanoma. It has been proposed that the Power Burst Facility reactor at the Idaho National Engineering Laboratory be modified for use in BNCT. The reactor has been kept in a standby condition pending a decision whether to proceed with the modification or to prepare for transferring the reactor to the Decontamination and Decommissioning program.	Continue 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.
	$ 16,621	$ 7,363	$ 7,568

III. Medical Applications (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
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 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	$ 0	$ 5,000
Congressionally Directed Projects	Congressionally directed university projects conducted.	Congressionally directed university projects conducted.	No activity.
	$ 72,160	$ 41,550	$ 0
Medical Applications	$ 114,896	$ 75,317	$ 39,312

DEPARTMENT OF ENERGY
FY 1993 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 the greenhouse effect or global warming has become a national and international issue with possible serious impacts on energy policy, economic development and national security. Although the science base for the greenhouse effect issue is insufficient for policy action (i.e, there is no firm evidence of a measurable quantifiable link between temperature change and increased CO2), there is considerable pressure for a quick legislative fix and for international treaties to limit worldwide emissions of greenhouse gases. Additional funds are requested in FY 1993 to accelerate global warming research as part of the Presidential initiative on Global Change, particularly in the area of improving the capability to predict 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 development of Remotely Piloted Vehicles (RPVs) and small climate satellites will greatly enhance the measurement of cloud-radiation interactions and will augment the on-going surface-based measurements.

This budget includes $74,500,000 in FY 1992 and $100,100,000 in FY 1993 in support of global change activities, which includes $2,404,000 in FY 1992 and $3,050,000 in FY 1993 in support of education activities.

II. A. Summary Table: Carbon Dioxide Research

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Core Program	$ 19,764	$ 19,982	$ 20,850	+ 4
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	7,188	10,465	12,100	+ 16
Quantitative Links and Atmospheric Radiation Measurement (ARM)	22,462	25,513	30,100	+ 18
Oceans Research	4,050	5,136	7,000	+ 36
National Institute for Global Environmental Change (NIGEC)	8,836	11,000	9,000	- 18
Remote Sensing with Unmanned Aircraft and Satellites	0	0	14,000	>999
Global Change Economics Research	0	0	4,000	>999
Education	2,404	2,404	3,050	+ 27
Total, Carbon Dioxide Research	$ 64,704	$ 74,500	$ 100,100	+ 34

II. B. Major Laboratory and Facility Funding

	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Ames Laboratory	$ 122	$ 0	$ 0	0
Environmental Measurements Laboratory	$ 415	$ 415	$ 415	0
National Renewable Energy Laboratroy	$ 49	$ 50	$ 50	0
Argonne National Laboratory (East)	$ 729	$ 720	$ 760	+ 6
Brookhaven National Laboratory	$ 2,536	$ 2,302	$ 2,820	+ 23
Lawrence Berkeley National Laboratory	$ 316	$ 342	$ 342	0
Lawrence Livermore National Laboratory	$ 9,442	$ 8,731	$ 9,308	+ 7
Los Alamos National Laboratory	$ 1,677	$ 2,231	$ 2,451	+ 10
Oak Ridge Associated Universities	$ 2,253	$ 1,154	$ 3,350	+190
Oak Ridge National Laboratory	$ 5,930	$ 5,470	$ 6,217	+ 14
Pacific Northwest Laboratory	$ 11,666	$ 17,570	$ 18,143	+ 3
Sandia National Laboratories	$ 889	$ 566	$ 450	- 20

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

Program Activity	FY 1991	FY 1992	FY 1993
Carbon Dioxide Research			
Core Program	Continued acquisition of emissions and atmospheric CO2 data; pursued the development of ocean-atmosphere CO2 models and initiated the parameterizations of terrestrial-atmospheric CO2 exchange. Explored how natural processes (e.g., forestation) and other biotechnology can alter fluxes of CO2 and methane and slow the rate of atmospheric increases.	Explore natural processes that sequester carbon; support acquisition of emissions and atmospheric CO2 and methane data; implement operational carbon cycle model to explore relationships between energy emissions and changing properties of the global carbon cycle.	Initiate studies of terrestrial fluxes of carbon to determine sources and sinks; 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.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Core Program (Cont'd)	Completed implementation of the climate modeling diagnostic program at LLNL. Completed diagnostic experiments with fixed ocean surface temperatures and started experiments to test model validity on select cases of regional interannual variability; continued comparisons of model output to observations. Expanded development of required data bases over long time periods and multiple climate events (e.g., extreme events).	Operate model diagnostic center at LLNL concentrating on improving regional predictions through advanced modeling concepts such as nested fine model grids. Continue to explore model and observed natural variability of climate. Apply advanced statistical techniques to climate data. Continue 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.
	Continued experimental research and modeling to determine the influence of CO2 and climate change on vegetation, with emphasis on photosynthesis and growth in relation to variable CO2 and temperature. Explored approaches for enhancing plant productivity to accelerate CO2 removal from the atmosphere.	Continue 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.
	Continued operation of the Carbon Dioxide Information Analysis Center; Continued quality audits on global and regional data sets.	The Carbon Dioxide Information Analysis Center will continue 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.
	No activity.	Develop a program to identify the critical data needed for the first detection of global climate change. The program will explore tapping as yet undiscovered data sets and develop the statistical techniques needed for first detection determination.	Implement the high priority components of the program to detect global climate change.
	$ 19,764	$ 19,982	$ 20,850

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP)	Expanded research activities associated with the CHAMMP initiative. Applications of innovative hardware systems such as massively-parallel processing or "thinking machine" concepts have been made to the set of differential equations simulating the climate system. Corresponding advances are expected in the associated software algorithms.	Fully implement plans of the CHAMMP Program; experiment with the application of a conventional climate model on different massively parallel computing architectures to determine optimum arrangements; complete implementation of the first ocean circulation model on a massively parallel computing system; develop the comprehensive visualization system for climate modeling data; determine the predictability of climate change and the limits of regional resolution; initiate 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.
	A significant fraction of DOE's Cray-3 supercomputer was used for extended climate predictions.	Continue support for access to the Cray 2&3 by the broad climate modeling community with continued emphasis on predictability of climate change.	Provide access to the CRAY 2&3 and emerging advanced computational systems for climate research.
	$ 7,188	$ 10,465	$ 12,100
Quantitative Links and Atmospheric Radiation Measurement (ARM)	Supported experimental studies to quantify the link between the rise of atmospheric greenhouses gases and climate change. Examples include a sound propagation field program to identify and ocean warming signal and studies of stratospheric temperature measurements.	Experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases will continue.	Experimental studies to detect and quantitatively link increasing atmospheric concentrations of radiatively active trace gases will continue.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Quantitative Links and Atmospheric Radiation Measurement (ARM) (Cont'd)	Principal activity is ARM Program. The objective is to improve the fundamental understanding of the cloud-climate feedback mechanism and to incorporate this improved understanding in the relevant parameterizations of the climate models. Specific tasks included the development of ground based remote sensing instrumentation, site selection and preparation of the first fixed ARM site.	The first fixed ARM site will be established based on the resolved scientific priorities; the first suite of ARM instruments will be deployed at this central site and on the surrounding network; initial experiments will be conducted and data management systems will be tested. Preparations for the second fixed site, possibly at an ocean location, will commence. The ARM mobile system will participate in the field campaign of the International Satellite Cloud Climatology Program. 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 include 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.	Continue ARM operation through planned program growth; mobile system developed for ARM will participate in selected national/international field experiments to assess cloud radiative interactions and cross-grid variability studies for climate model parameterization development. First site fully operational; initiate partial operation at second site. Operations at the second site will support activities of the international Tropical Ocean Global Atmosphere (TOGA) Program.
	$ 22,462	$ 25,513	$ 30,100
Oceans Research	Continued to support the ocean carbon measurements in cooperation with the international World Ocean Circulation Experiment (WOCE) and the Global Ocean Flux Study (GOFS). Expanded the research to include the ocean's ability to store and transport carbon. Initiated experiments and ocean modeling with high resolution grids to explore processes such as those controlling the formation of deep water.	Continue to support the global survey of CO2 in the oceans; expand process modeling including deep convection and the surface mixed layer to understand the exchange of heat and carbon with the atmosphere. Establish the standards for the ocean carbon chemistry survey in cooperation with NSF. Initiate a field program for deep convection in cooperation with existing WOCE and polar programs.	Continue ocean measurements as part of the global survey of CO2 in the oceans; expand process modeling including deep convection and the surface mixed layer to understand the exchange of heat and carbon with the atmosphere.
	$ 4,050	$ 5,136	$ 7,000

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
National Institute for Global Environmental Change (NIGEC)	NIGEC will continue the study of regional impacts of global change.	NIGEC will continue 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.
	$ 8,836	$ 11,000	$ 9,000
Remote Sensing with Unmanned Aircraft and Satellites	No activity.	No activity.	Pursue the application of Remotely Piloted Vehicles (RPVs) to support DOE Atmospheric Radiation Measurement (ARM) program and other components of the U.S. Global Change Research Program (USGCRP). RPVs will provide the necessary near-term data on critical climate processes that will significantly improve the capability to detect and predict global and regional climate change, e.g. the role of cloud feedbacks in the Earth's radiation balance. Possible instrumentation for RPVs include advanced radiometers to measure outgoing radiation from the earth-atmosphere system, multispectral imagers for cloud albedo measurements and laser-based instruments for the measurement of cloud composition and atmospheric aerosols. Recent advances in miniaturization of sensors and data processing technology make the application of RPVs to global climate change research feasible. ($7,000) Existing DOD and DOE small satellite technology will be adapted and further developed in support of the use of small satellites in support of USGCRP objectives, with emphasis on instruments and mission profiles for extending the ARM data on the role of cloud feedbacks in the Earth's radiation balance to regional scales, and focusing on other important global change process studies. Instrument designs suitable for effective deployment on either RPVs or small satellites will be developed. This

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Remote Sensing with Unmanned Aircraft and Satellites (Cont'd)			effort will be coordinated with FY 1992 SERDP small satellite activities. ($7,000)
	$ 0	$ 0	$ 14,000
Global Change Economics Research	No activity.	No activity.	DOE will conduct economics research to help build the economics knowledge base necessary for sound policy analysis of global change issues. The five areas of focus for the economics research effort in FY 1993 are: (1) improving understanding of the economic forces affecting or affected by global environmental change and representing this understanding in economic models, (2) improving approaches and methods for economic impact analysis that include consideration of adaptive measures that can be taken and technical and management innovation that may be expected to occur that might affect the vulnerability of economic sectors/systems to global environment changes, (3) developing approaches to assess the present and future economic values of environmental characteristics and framing approaches to decisionmaking under uncertainty, (4) improving the understanding of the spread of, for example, energy technologies and practices and how the diffusion of such technologies in economics is affected by various factors, and (5) development and refinement of tools (e.g., macroeconomic models) for policy analysis and the strengths and weaknesses of types of generic policy instruments that are potentially applicable in the global change context.

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Global Change Economics Research (Cont'd)	$ 0	$ 0	$ 4,000
Education	The DOE educational program on global change will emphasize interdisciplinary research at the graduate and postgraduate level and will promote operational experience in team research at national laboratories and other science and technology centers.	Continue the energy related global change educational program including undergraduate, graduate, and postdoctoral fellowships; primary and secondary science teacher training programs and curriculum development.	Provide for the next generation of scientists through energy related global change educational program initiated in FY 1991 including undergraduate, graduate, and post doctoral fellowships; primary and secondary science teacher training programs and curriculum development. ($3,050)
	Upgrades of ESNET to conform to the National Research and Education Network standards implemented; funding was shared among ER programs that benefit from ESNET. This subprogram's share was $305.	ESNET will be supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.	ESNET will be supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.
	$ 2,404	$ 2,404	$ 3,050
Carbon Dioxide Research	$ 64,704	$ 74,500	$ 100,100

DEPARTMENT OF ENERGY
FY 1993 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 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Salaries and Expenses	$ 5,496	$ 5,800	$ 6,077	+ 5
Other	270	300	523	+ 74
Total, Biological and Environmental Research Program Direction	$ 5,766	$ 6,100	$ 6,600	+ 8

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

Program Activity	FY 1991	FY 1992	FY 1993
Biological and Environmental Research Program Direction			
Salaries and Expenses	Provide funds for salaries, benefits, and travel for 59 full-time equivalents (FTEs) in the Office of Health and Environmental Research, Office of Assessment and Support, and related program and management support.	Provide funds for salaries, benefits, and travel for 60 FTEs included in the FY 1992 budget.	Provide funds for salaries, benefits, and travel for 60 FTEs, including for normal increased personnel costs resulting, for example, from a general pay raise and within-grade and merit increases.
	The Office of Health and Environmental Research provided guidance and support for over 875 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. Strengthened management oversight of research projects at numerous laboratories and universities. Provided enhanced 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, and biotechnology. The global climate change program involves critical atmospheric experiments, advanced computer networks, and understanding the process of climate change and the carbon cycle. The genome program initiated new efforts on the ethical, legal and societal issues, while intensifying efforts on mapping additional chromosomes, developing new sequencing technologies, and improving computational resources for data management, analysis and distribution. Continued to closely coordinate activities with other programs and agencies, nationally and	Continue management support for the BER program as in FY 1991. Support planned growth of the joint DOE/NIH human genome effort and expanded global climate change and ocean research. Continue increased emphasis on ES&H responsibilities at program facilities. Manage ongoing efforts in structural biology, health and environmental effects of radiation and toxic chemicals, subsurface research, and medical applications. Continue liaison 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 continues to support other DOE programs and development of sound energy policy, and has significant human health benefits.	Continue program management as in FY 1992. Continue emphasis on ES&H responsibilities at program facilities and management of the joint DOE/NIH human genome effort and expanded global climate change research. Manage planned growth in structural biology, 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. Strengthen program management capability and oversight and accountability of contractor operations. Continue liaison with other DOE programs, Federal agencies, and international bodies. The research managed by this staff continues to support other DOE programs and development of sound energy policy, and continues to have significant human health benefits.

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

Program Activity	FY 1991	FY 1992	FY 1993
Salaries and Expenses (Cont'd)	internationally, to meet needs and avoid duplication.		
	Provided a portion of the total staffing requirement for the Office of Assessment and Support to implement ES&H oversight and support activities to ensure compliance with applicable ES&H regulations and directives.	No activity. Transferred to the Advisory and Oversight Program Direction account within the Energy Supply, R&D appropriation.	No activity.
	Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, policy review and coordination, and utilities management.	Continue to provide program and management support with particular emphasis on the Departmental priority to strengthen line management control and accountability.	Continue to provide program and management support as in FY 1992.
	$ 5,496	$ 5,800	$ 6,077
Other	Provided for a variety of program support such as printing and editing and contractual services, for example, to assist with ES&H workload required by current regulations and directives and time-sharing on various information systems and communication networks. ($270)	Continue the variety of program support required in FY 1991 and provide additional administrative and professional services. ($300)	Continue the variety of program support required in FY 1992 and provide support for additional administrative and professional services and AOSS workstations. ($523)
	$ 270	$ 300	$ 523
Biological and Environmental Research Program Direction	$ 5,766	$ 6,100	$ 6,600

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

Program Activity	FY 1991	FY 1992	FY 1993
Facilities Operations			
Capital Equipment	Maintained capital equipment budget at approximately FY 1990 level, while supporting increased emphasis to needs of the human genome and carbon dioxide research. ($11,553)	Expand capital equipment budget. In the Carbon Dioxide Research program, the Atmospheric Radiation Measurement program (ARM) is a field experiment requiring LIDARS (Light Radars), radars, and other advanced remote sensing systems. The equipment is essential to begin the experiments at the first permanent site and for participation in the National/ International FIRE experiment. The equipment schedule has been designed so that the data will be available over the next 10 years to advance climate model development directed at global warming and support the National Energy Strategy. In addition, the human genome and structural biology programs have substantial capital equipment requirements. ($16,832)	Maintain capital equipment budget at the FY 1992 level and provide for additional equipment for current and developing structural biology facilities ($1,300). Maintains capital equipment budget for the core program ($6,300) and the allocations for the Carbon Dioxide program ($6,900) and for the genome program.($2,300)
	No activity.	No activity.	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 undulatory beamline, an x-ray scanning microscope capable of investigating subcellular structures with the unique low emittance soft x-ray beams. ($4,700)

III. Facilities Operations (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Capital Equipment (Cont'd)	No activity.	No activity.	Acquire the appropriate Remotely Piloted Vehicle (RPV) platform to fulfill the ARM needs following the review of all RPV candidates. Funds are also requested for sensors and data collection and processing equipment for the RPVs including radiometers and lidars. ($6,000)
	$ 11,553	$ 16,832	$ 27,500
Construction	Maintained general plant project budget at the FY 1990 level. ($3,465)	Maintain general plant projects at the FY 1991 level. ($3,500)	Maintain general plant projects at the FY 1992 level. ($3,500)
	No activity.	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).
	No activity.	No activity.	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. The majority of this project has been funded in prior years. Prior year funds totaling $1.7M are identified in a proposed FY 1992 reprogramming that proposes to consolidate these funds into this line item construction project. ($600)
	$ 3,465	$ 3,500	$ 5,900

III. Facilities Operations (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Facilities Operations	$ 15,018	$ 20,332	$ 33,400

DEPARTMENT OF ENER
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY
CONSTRUCTION PROJECTS

Biological Environmental Research

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1992 Appropriated	FY 1993 Request	Unappropriated Balance	TEC
GPE-120	General Plant Projects	$ XXX	$3,500	$ 3,500	$ 0	$ XXX
93-E-337	Structural biology addition at NSLS	XXX	0	1,800	0	1,800
91-E-310	Biomedical Isotope Facility	XXX	XXX	600	0	2,300
Total, Biological and Environmental Research Construction		$ 0	$3,500	$ 5,900	$ 0	$4,100

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Biological and Environmental Research

IV. B. Plant Funded Construction Project

1. Project title and location: GPE-120 General Plant Projects

Project TEC: $ 3,500
Start Date: FY 1993
Completion Date: FY 1994

2. Financial schedule:

		Costs			
Fiscal Year	Obligations	FY 1991	FY 1992	FY 1993	After FY 1993
Prior Year Projects	XXXXXXX	$ 2,544	$ 990	$ 1,386	$ 280
FY 1991 Projects	$ 3,465	700	882	364	1,519
FY 1992 Projects	3,500	0	600	875	2,025
FY 1993 Projects	3,500	0	0	700	2,800

3. Narrative:

(a) 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.

(b) 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 (BA):	Prior Years	FY 1991	FY 1992	FY 1993 Request	To Complete
Construction.....	XXX	$ 3,465	$ 3,500	$ 3,500	XXX

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Biological and Environmental Research

IV. B. Plant Funded Construction Project

1. Project title and location: 93-E-337 Structural biology addition at NSLS
Brookhaven National Laboratory, Upton, New York

Project TEC: $ 1,800
Start Date: FY 1993
Completion Date: FY 1994

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
FY 1993	1,800	1,800	625
FY 1994	0	0	1,175

3. Narrative:

(a) The proposed addition to the NSLS building will provide approximately 6,300 sq. ft. of laboratory and support space and promote increased utilization of the NSLS facility.

(b) The synchrotron light source facilities in place at BNL offer forefront structural biology research capabilities. Effective utilization of the facility by numerous biomedical research teams is limited by lack of adequate laboratory space adjacent to the beam lines. The request will provide space urgently needed to exploit the BNL facility for pioneering research in structural biology.

4. Total Project Funding (BA):

	Prior Years	FY 1991	FY 1992	FY 1993 Request	To Complete
Construction.....	XXX	XXX	XXX	$ 1,800	XXX

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Biological and Environmental Research

IV. B. Plant Funded Construction Project

1. Project title and location: 91-E-310 Biomedical Isotope Facility
Lawrence Berkeley Laboratory
Berkeley, California

Project TEC: $ 2,300
Start Date: FY 1992
Completion Date: FY 1993

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1990	$ 400*	$ 400	$ 92*
1991	600*	600	0
1992	700*	700	1,608
1993	600	600	600

3. Narrative:

(a) The proposed Biomedical Isotope Facility will include the remodeling of Building 56 and the construction of an addition.

(b) The proposed Biomedical Isotope Facility will involve the acquisition of a small, 11 MeV negative ion cyclotron and renovation of Building 56. The cyclotron will produce short-lived radionuclides in various cyclotron targets. The radionuclides and radiopharmaceuticals produced by this facility will be used in animal and human imaging research studies.

4. Total Project Funding (BA):

	Prior Years	FY 1991	FY 1992	FY 1993 Request	To Complete
Construction.....	$ 400**	$ 600**	$ 700**	$ 600	$ 0

* Cost of $92,000 included in FY 1990 under non-capital modifications with funding received as BER operating funds.

** These funds are identified in a proposed reprogramming request to be reprogrammed from operating expenses to this construction project.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
PROJECT DATA SHEETS
ENERGY SUPPLY, RESEARCH & DEVELOPMENT - PLANT & CAPITAL EQUIPMENT
BIOLOGICAL AND ENVIRONMENTAL RESEARCH
(tabular dollars in thousands. narrative material in whole dollars.)

1. Title and Location of Project: Structural Biology Addition at NSLS
Brookhaven National Laboratory (BNL)
Upton, New York

2. Project Number: 93-E-337

3a. Date A-E work initiated: 1st Qtr. FY 1993

3b. A-E work (Title I & II) duration: 5 months

4a. Date physical construction starts: 3rd Qtr. FY 1993

4b. Date construction ends: 3rd Qtr. FY 1994

5. Previous construction cost estimate: None

6. Current construction cost estimate: $1,800
TECC: $1,800

Date: January 1992

7. Financial Schedule:

Fiscal Year	Appropriations	Obligations	Costs
1993	$ 1,800	$ 1,800	$ 625
1994	0	0	1,175

PROJECT DATA SHEETS

1. Title and Location of Project:	Structural Biology Addition at NSLS Brookhaven National Laboratory (BNL) Upton, New York	2. Project Number:	93-E-337

8. Brief Physical Description of Project

The proposed addition to the NSLS building will provide approximately 6,300 sq. ft. of laboratory and support space and promote increased utilization of the NSLS facility.

The proposed expansion will be at the west side of the building. It will be a one-story structure. Provision will be made in the design to accommodate a future second floor. The composite concrete/insulated metal roof deck will be supported on steel framing, carried through steel columns, to reinforced concrete walls and footings.

Prefinished insulated metal panels will be used on the exterior to match the existing facility. Windows will be provided, as necessary, for operational and functional requirements, but will be minimized for energy conservation. Matching windows will be installed where necessary.

The plan layout is devoted principally to laboratory space but with some space for a computer room, clean room, small shop, user's room and kitchen/copy equipment room. A mechanical equipment room, with direct access to the outside, will be provided. An existing janitor's closet will also be relocated to this area.

The addition will be designed to at least the same energy conservation standards as the existing building and contain a similar fire protection sprinkler system.

1. Title and Location of Project:	Structural Biology Addition at NSLS Brookhaven National Laboratory (BNL) Upton, New York	2. Project Number:	93-E-337

9. Purpose, Justification of Need and Scope of Project

The NSLS is operated as a national facility. This means that researchers from other national laboratories, universities and industries are able to carry out x-ray scattering and diffraction experiments as required by their research programs. The gradual increase in BNL's programmatic and external users requirements surpassed the present resources, particularly the ancillary biochemical and computational lab space close to the beam lines used for structural biology.

The NSLS is the major synchrotron facility used for structural research on biological systems in the USA and 7 stations have been developed for use by scientists from BNL, universities and industry. There are, however, few support facilities to efficiently use these beam lines. For protein crystallography, biochemical laboratory space is needed for crystal preparation, diffusion of substrates measurement of optical properties, setting up of fast mixing systems, etc. A clean room is needed for crystal mounding and alignment of optical components like a laser set up for flash photolysis in time slicing experiments. A computing and scanning facility is needed for the on-line processing of data from two dimensional detectors and image plates. These facilities have to be close to the beam lines for easy access and data transmission. General biochemical technique facilities are required for the characterization and assay of biochemical complexes scattering data. Some of these procedures require fume hoods. Some of these procedures will have to be carried out in the cold requiring a standard walk-in cold room. Many of the experiments require special sample environments and sample holders as well as applied electronic stimuli. A small mechanical and electronic laboratory is planned where such devices can be assembled and modified.

On average, it is expected that about 30 scientists and technicians will be using the structural biology facilities -- 1/3 being BNL personnel and the remainder visitors from other labs. An area with several desks is needed to provide working space for record keeping, etc. This space will be used around the clock since the synchrotron is often run continuously; in most cases two to three shifts are operating these devices. This requires some kitchen facilities, particularly for off hours operation. The major structural biology beam lines are located adjacent to the planned laboratory facilities.

PROJECT DATA SHEETS

1. Title and Location of Project: Structural Biology Addition at NSLS
Brookhaven National Laboratory (BNL)
Upton, New York

2. Project Number: 93-E-337

10. Details of Cost Estimate a/

	Item Cost	Total Cost
a. Engineering Management Costs		
1. Engineering, design and inspection at approximately 14% of construction costs		$ 192
2. Construction management at approximately 2% of of construction costs		27
Sub-total		219
b. Construction Costs		1,373
1. Site work	$ 53	
2. Architectural/Structural	740	
3. Mechanical services	415	
4. Electrical services	165	
Sub-total		$ 1,592
c. Contingency at approximately 13% of the above cost		208
Total estimated construction cost		$ 1,800 b/

a/ This estimate is based on Conceptual Design Report dated March 1990.
b/ Escalation rates used were taken from DOE Departmental Price Change Index - FY 92 Guidance, August 1990 Update; 3.6% for FY 1991, 4.5% for FY 1992; 5.1% for FY 1993 and 5.6% for FY 1994.

1. Title and Location of Project:	Structural Biology Addition at NSLS Brookhaven National Laboratory (BNL) Upton, New York	2. Project Number:	93-E-337

11. Method of Performance

Design and inspection will be on the basis of a negotiated architect-engineer contract. Construction and procurement will be accomplished by a competitively obtained lump sum contract.

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

Not applicable.

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

Not applicable.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
PROJECT DATA SHEETS
ENERGY SUPPLY, RESEARCH & DEVELOPMENT - PLANT & CAPITAL EQUIPMENT
BIOLOGICAL AND ENVIRONMENTAL RESEARCH
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and Location of Project: Biomedical Isotope Facility
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

2. Project Number: 91-E-310

3a. Date A-E work initiated: 1st Qtr. FY 1992

3b. A-E work (Title I & II) duration: 8 months

4a. Date physical construction starts: June FY 1992

4b. Date construction ends: June FY 1993

5. Previous construction cost estimate: None

6. Current construction cost estimate: $2,300
TECC: $2,300
TPC: $2,300
Date: January 1992

7. Financial Schedule:

Fiscal Year	Appropriations	Obligations	Costs
1990	$ 400	$ 400	$ 92
1991	600	600	0
1992	700	700	1,608
1993	600	600	600

1. Title and Location of Project: Biomedical Isotope Facility
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

2. Project Number: 91-E-310

8. Brief Physical Description of Project

The proposed Biomedical Isotope Facility will include the remodeling of an existing structure (Building 56), and the construction of an addition (Building 56A). As part of the rehabilitation of Building 56, the building would be expanded by about 800 square feet, from its present size of 1,200 square feet to 2,000 square feet. This line item construction project is contained in a proposed FY 1992 reprogramming request. The reprogramming request identifies the prior year funds proposed to be reprogrammed into this line item construction project.

The proposed expansion will be at the west side of the building and will house the mini-cyclotron. The resulting building will be a combination of a two-story steel frame structure and a one-story reinforced concrete structure. The first floor will total approximately 1,600 square feet, and the second floor mezzanine approximately 400 square feet. The lower floor will contain four separate areas: the cyclotron vault, the heat exchanger room, an electrical closet, and a radiopharmaceutical preparation laboratory. The upper floor will be used for storage space.

The building will be built with cast-in-place concrete and metal frame and siding construction. The first floor of the existing structure will be raised by pouring a 4-in. thick slab throughout the existing building. The first-floor walls will be supported by the present concrete pavement and rest on top of the new 4-in. slab. The first floor of the addition will be composed of 14-in.-thick reinforced concrete that will rest on engineered fill and extend 4 in. above grade. The first-floor walls will be supported by a steel-reinforced footing, the base of which will be roughly 2 ft below grade and be approximately 2 ft wide and 1 ft thick.

The walls of the remodeled portion of the building will be made up of metal studs, over which 5/8-in. thick 1-hr fire resistant gypsum will be applied. Metal siding will be applied on top of the gypsum. The first-floor walls of the addition will consist of 12-in. wide cast-in-place reinforced concrete walls. These walls will resist lateral loads as well as vertical loads and will provide additional radiation shielding for the "self-shielded" mini-cyclotron. The heat-exchanger room and electrical closet will be composed of steel framing with metal studs similar to the remodeled portion of the building.

1. Title and Location of Project: Biomedical Isotope Facility
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

2. Project Number: 91-E-310

8. Brief Physical Description of Project (continued)

The planned layout is devoted to two main functional areas: a cyclotron vault and a radiopharmaceutical preparation area. The renovation of the existing building and the addition will be designed for maximum energy conservation (and the mini-cyclotron is the lowest power consuming model available in the world). The facility is designed with separate ventilation systems for three functional areas (the mini-cyclotron, the lead shielded radiopharmaceutical boxes, and the radiopharmaceutical preparation area) with radiation safety of primary concern. Numerous safety interlocks, radiation monitoring systems, automatic fire sprinklers, and ventilation monitors will be in place to assure safe operation of the facility.

9. Purpose, Justification of Need and Scope of Project

The proposed Biomedical Isotope Facility 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 various cyclotron targets. The radionuclides will be used either directly as they emerge from the targets or be incorporated into other radiopharmaceuticals in remotely operated hot synthesis caves at the facility. The positron-emitting radionuclides and radiopharmaceuticals produced by this facility will be used in imaging research studies involving either animals or humans. These imaging studies (termed positron emission tomography or PET) utilize the detection of the gamma rays produced by positron disintegration to provide high resolution images of physiological processes such as metabolism, blood flow, tissue viability, and receptor function. This imaging technique is unique in that actual in vivo physiological processes can be imaged and quantitated. These studies differ dramatically from CAT, magnetic resonance (MRI) or ultrasound imaging in that the latter indicate structure or anatomy of tissues while PET indicates the functional, living status of tissues. The study of functional states in normal and abnormal subjects provides unique and valuable medical information in numerous conditions such as stroke, Alzheimer's and Parkinson's disease, depression, schizophrenia, cancer, and myocardial ischemia. For the past 15 years, the research group at Lawrence Berkeley Laboratory have been world leaders in the development of high resolution cameras to non-invasively image and quantitate physiological processes using PET. They require a reliable, steady source of radionuclides to maintain and further expand their work in collaboration with basic scientists and physicians in the Bay Area.

1. Title and Location of Project: Biomedical Isotope Facility
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

2. Project Number: 91-E-310

9. Purpose, Justification of Need and Scope of Project - Continued

The cyclotron at the Biomedical Isotope Facility will produce the short-lived positron-emitting radionuclides O-15, N-13, C-11, and F-18 for PET studies to be performed at LBL utilizing the two existing PET cameras in Building 55. The Biomedical Isotope Facility will be operated by the LBL Nuclear Medicine group, which is part of the LBL Research Medicine and Radiation Biophysics Division, one of 9 research divisions of LBL.

The four radionuclides proposed to be produced at this facility have all previously been produced at the LBL 88-inch cyclotron, although they have been produced infrequently. The Biomedical Isotope Facility will allow these radionuclides to be produced regularly.

The regular production of the radionuclides will increase the frequency of PET studies currently conducted at LBL. At present, PET studies are conducted two days per week on average. Two patients are involved in the PET studies per day. The construction of the Biomedical Isotope Facility will allow the capability to double the number of PET studies.

1. Title and Location of Project: Biomedical Isotope Facility, Lawrence Berkeley Laboratory (LBL), Berkeley, California

2. Project Number: 91-E-310

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design and inspection (at approximately 19% of construction costs) items C.1-4	$ 154	
Contingency at approximately 20%	30	
Subtotal Engineering Costs		$ 184
b. Standard Equipment Costs a/		
1. Basic cyclotron with primary support equipment and shielding	$ 780	
2. One shielded target pod with 8 target positions	180	
Subtotal Standard Equipment Costs		$ 960
c. Construction Costs b/		
1. Demolition & Removals	$ 127	
2. Improvements to Land	32	
3. Building Modifications	608	
4. Special Facilities	23	
5. Utilities	142	
6. Project Management	47	
7. Contingency at approximately 20%	177	
Subtotal Construction Costs		$ 1,156
Total Estimated Construction Cost (TECC)		$ 2,300

a/ Based on a quote from CTI Cyclotron Systems
b/ Based on revised Conventional Facilities Description and Class D Cost Estimate performed by LBL

1. Title and Location of Project: Biomedical Isotope Facility
Lawrence Berkeley Laboratory (LBL)
Berkeley, California

2. Project Number: 91-E-310

11. Method of Performance

Design and inspection will be on the basis of a negotiated architect-engineer contract. Acquisition of the cyclotron and construction will be accomplished by a competitively obtained lump sum contract.

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

Not applicable.

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

Not applicable.

DEPARTMENT OF ENERGY
FY 1993 OMB BUDGET
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
FUSION ENERGY
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)*

2. Project No.: 92-E-340

3a. Date A-E work initiated: 1st Qtr. FY 1992

3b. A-E work (Titles I & II) duration: 12 months

4a. Date physical construction starts: 2nd Qtr. FY 1992

4b. Date construction ends: 1st Qtr. FY 1994

5. Previous:--Construction cost estimate: $4,800
--Total project cost: $4,800

6. Current construction cost estimate: $ 4,800
TECC -- $4,800
TPC -- $4,800

7. Financial Schedule:

Fiscal Year	Appropriations	Obligations	Costs
1992	$ 2,600	$ 2,600	$ 1,000
1993	2,200	2,200	2,200
1994	0	0	1,600
Total	$ 4,800	$ 4,800	$ 4,800

8. Brief Physical Description of Project

This project makes improvements to life safety and fire protection at the Princeton Plasma Physics Laboratory. It is divided into three main segments: Fire alarm system improvements, improvements for compliance with the Life Safety Code (LSC) and sprinklers and fire walls.

The alarm system segment itself consists of three parts: Part one provides for additional building alarm panels; part two provides a new fire alarm reporting and recording system for the entire complex and part three provides a 100 screen, full color graphics package that will automatically provide the Security Officer with all the necessary emergency information whenever an alarm is received.

* This project will be located on non-Government owned land. The U.S. Government has leased this land from Princeton University for a 40 year period ending September 30, 2026.

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 92-E-340

8. Brief Physical Description of Project (Continued)

The LSC segment of the project makes a variety of improvements for compliance with the LSC including three new external stairs and second exits from four areas.

The sprinkler/firewall portion of the project provides new sprinkler systems in seventeen buildings or areas, improvements to three additional sprinkler systems and improvements to the fire resistent capacity of certain walls and ceilings.

9. Purpose, Justification of Need and Scope of Project

The purpose of this project is to improve life safety and fire protection at the Princeton Plasma Physics Laboratory by providing increased protection against personnel injury during a fire or other emergency and improved protection against property loss by fire.

Life Safety Code Compliance Improvements

During the May 1988 Industrial Safety and Fire Protection Appraisal of PPPL conducted by the Chicago DOE, a recommendation was made to review the laboratory for compliance with the current (1988) Life Safety Code, NFPA 101. In the past, facilities had been required to comply with the codes in existence at the time of construction; however, as a result of DOE Technical Safety Appraisals, a policy change was effected to apply current safety codes to all DOE facilities.

Since the May 1988 appraisal, PPPL has been engaged in a thorough and detailed review of the laboratory facilities for compliance with the 1988 edition of the Life Safety Code, NFPA 101. The original C-Site portion of the Princeton Plasma Physics Laboratory was built largely in the 1950s. Since that time, there have been many changes in LSC requirements, fire alarm systems and DOE philosophy on fire protection. A program of corrective action and facilities review was immediately instituted. As the review of each building was completed, a plan of corrective action was prepared and many of the deficiencies were corrected. The overall review was recently completed and the final report plus plan of corrective action was submitted to the DOE/PAO. The total number of original deficiencies was 69. In general, the laboratory's plan for correction of these problems is to do as much as possible with operating funds and to seek line item and/or GPP funding for those projects that are too large to do within the constraints of operating funds.

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 92-E-340

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

Fire Alarm System Replacement

During the same 1988 appraisal, another recommendation was made to review the laboratory fire alarm system for compliance with NFPA 72D. As a result of that review, it was discovered that the existing system was not properly supervised -- that is, it would not provide the required trouble and alarm signals in the event of system wiring malfunctions. It is not considered feasible to upgrade the existing system to comply with NFPA 72D because of the large expense and unacceptable system down-time that would be involved. Upgrading would also not result in a system that is listed and/or approved for fire alarm system use. For those reasons, it is proposed to replace the existing system with a new system as part of this project.

To ameliorate the risk with the current system, (1) PPPL has installed an interim redundant alarm system for D-Site, which houses the major experimental device and (2) frequent preventative maintenance and testing of the system is performed.

Fire detection throughout much of C-Site is currently accomplished with a dated ADT Aerotube system. This system is difficult to maintain because parts are not readily available. The system's reliability needs improvements because of its age and lack of supervision. This project replaces the Aerotube system with automatic sprinkler systems which will not only provide detection via the flow alarms but will also automatically take action to suppress the fire.

In some buildings at C-Site there are no local alarms. Consequently, there could be a fire with a fire alarm generated to the Security Office without the occupants of the area being aware that there was a problem. The Security officer would have to alert the area of the fire via local public address system. In these areas the project will provide individual building alarm panels which will be used to gather all the fire alarm signals from that building (pull boxes, sprinkler flow alarms and detection) transmit them to Security via the new alarm reporting and recording system and also sound a local alarm in the building where the alarm signal originated.

This project would provide a new state-of-the-art alarm reporting and recording system in full compliance with NFPA 72D.

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 92-E-340

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

Sprinkler Systems and Fire Walls

DOE fire protection policy as contained in DOE Order 5480.7 dated 11-16-87 requires automatic fire suppression whenever the potential fire loss exceeds $1 million. In an effort to achieve compliance with this policy, the laboratory has added sprinkler systems to several parts of the facility; however, this piecemeal approach is costly, inefficient and slow. This project would provide sprinkler protection throughout the remaining important unsprinklered portions of the laboratory in order to assure compliance with DOE Order 5480.7. Sprinkler protection is also used to achieve Life Safety Code exit distance compliance in one building.

DOE Order 5480.7 also requires the limitation of fire spread by physical means (e.g. geographic isolation, fire walls, firedoors, draft barriers). This part of the project will provide the work necessary to assure that effective fire walls exist in appropriate locations throughout the laboratory.

The effect of disapproval will be a higher risk of fire loss or personnel injury during a fire or other emergency at the laboratory.

10. Details of Cost Estimate a/

	Item Costs	Total Cost b/
a. (1) Engineering, design, construction management and inspection at about 11.0% of construction cost, Item b.....		$ 400
(2) Construction Management at 6% of construction costs, Item c...		200
b. Land and Land Rights.....		0
c. Construction costs.....		3,600
(1) Improvements to Land.....	$ 0	
(2) Buildings		
(a) Fire Alarm System Replacement.....	1,000	
(b) Life Safety Code Compliance Improvements.....	900	
(c) Sprinkler Systems and Fire Walls.....	1,700	
(3) Other Structures.....	0	
(4) Utilities.....	0	
(5) Special Facilities.....	0	

a/ The above estimates are based on conceptual design and feasibility studies which are 100% complete.
b/ All costs are stated in current year dollars consistent with the inflation factors promulgated by DOE (7.3% for FY 1992 and 11.5% for FY 1993) as of May 1991.

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 92-E-340

10. Details of Cost Estimate (Continued)

d.	Standard Equipment	0
e.	Major Computer Items	0
f.	Removal less Salvage	0
	Subtotal	4,200
g.	Contingency at approximately 15% of above cost	600
	Total Estimated Construction Cost (TECC)	$4,800

11. Method of Performance

The engineering, design and inspection shall be performed under a single, or series of, negotiated architect or engineer subcontracts.

Construction and equipment procurement for the project shall be accomplished by fixed price contracts awarded on the basis of competitive bidding.

Management of all contracts for engineering, design inspection, materials testing and construction shall be performed by PPPL to maximize the effective integrated performance of all participants involved in project development.

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

Not required.

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

Not required.

14. Incorporation of Fallout Shelters

This project does not include the construction of new buildings or building additions. Therefore, the provision for fallout shelters is not applicable.

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 92-E-340

15. Federal Compliance with Pollution Control Standards

As presently conceived, operation of this project will not generate any environmental pollutants; therefore, the requirements of Executive Order 12088 are not applicable.

16. Evaluation of Flood Hazards

This project will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

17. Environmental Impact

The project will comply with the National Environmental Policy Act, related DOE orders and guidelines. This project is not located in a flood plain/wetland.

18. Accessibility for the Handicapped

While this project is not intended to address existing deficiencies with respect to handicapped access it does not generate any additional noncompliance. Existing deficiencies are being addressed through other projects.

19. Facility Utilization

No new space or capacity is being provided by this project.

20. Safe and Healthful Workplace

The portions of this project providing a new alarm system and Life Safety Code compliance improvements are for the purpose of providing a safe and healthful workplace. These parts of the project account for $2,500K.