DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT

OVERVIEW

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

HEALTH, ENVIRONMENT AND ENERGY TECHNOLOGY

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. Another objective of the program is to use the Department's unique scientific and technological capabilities to solve major scientific problems in medicine and biology.

The Department's Health and Environmental Research responsibility began with the formation of the AEC 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 that might be received by worker populations or the general public. This concern dictated additional epidemiology studies on selected populations, such as contractor employees, and a more comprehensive research program involving experimental animal, cellular, and molecular studies. The epidemiologic studies showed some excess mortality from multiple myeloma in an early radiation worker population that received relatively large exposures compared with today's worker population. However, the 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 extensive human exposure data base within the Departmental contractor worker population has, as previously stated, been used by DOE scientists to study health effects. These studies have been and continue to be published in the scientific literature. However, outside groups have also expressed interest

in access to this information and we are responding to this interest. An expanded effort to develop a Comprehensive Epidemiologic Data Resource (CEDR) is included in this budget request. With guidance from the National Academy of Sciences, a central facility containing validated data on worker exposure will be maintained. Care will be taken to assure individual privacy. This effort will be coordinated at the international level. Through active participation, with the International Agency for Research on Cancer, we will strive to achieve a coordinated research effort to assure intercomparability of research findings and valid combining of exposure data. Under the protocol signed May 26, 1989, following the Eighth Meeting of the US-USSR Joint Committee on Cooperation in the Peaceful Uses of Atomic Energy, the Joint Committee agreed to full and complete sharing of information on environmental and health effects of radiation. At a follow-on joint US-USSR task group meeting this coming September, we shall work to include Soviet epidemiologic studies on the exposed Chernobyl population into the international research effort.

The DOE program continues to be the lead Federal program in Radiobiology, constituting about two-thirds of the national effort. The program is primarily oriented towards research at the relatively low doses received by worker populations. Most of the rest of U.S. radiobiological research is supported by the National Cancer Institute and is oriented towards high-dose radiation therapy of tumors and evaluating the late effects of such doses to the surviving patient. Radiobiological research in this country is coordinated through the OSTP's 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; with Japan through the Binational Agreement; and with the USSR through the Joint Coordinating Committee for Civilian Nuclear Reactor Safety which includes formal cooperation on research and data exchange on the health and environmental effects of the Chernobyl reactor accident.

The late effects of chronic low level radiation exposure will be difficult if not impossible to confirm in epidemiologic studies, yet improved insight is needed to understand such concerns as indoor radon and general population exposure to contaminants that may result from Departmental activities. There is a particular need for a firm scientific basis to guide decisions regarding any changes in the occupational exposure standards to neutrons.

The DOE human genome program represents a new approach, 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. The Department is exploiting the multidisciplinary capabilities of its national laboratories to develop the biological resources and the technologies needed to characterize at the molecular level the entire human genome in the next fifteen years. Results of this work will provide the basis for more definitive risk estimates, and the assessment of individual sensitivities at low levels of exposure to physical and chemical agents. It will open completely new levels of understanding of radiation and chemical action at the most fundamental level of life, the DNA molecule, and will significantly impact the biomedical and biotechnology communities. 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, the NIH effort is oriented towards characterizing disease-oriented genes, by exploiting both human and non-human model systems.

Structural biology brings the tools of modern science (recombinant DNA technology, site-directed mutagenesis, rapid structure determination with sophisticated equipment, theoretical advances, powerful computers and graphics) together to permit 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 cost-effectively carry out its energy, environmental and technology transfer missions. This knowledge base will provide the intellectual foundation for the enormous gamut of applications of biotechnology and molecular sciences. As pointed out by several DOE and National Academy committees, DOE has a special opportunity and responsibility (because of the capital-intensive user facilities located and under development at its laboratories, and computational and other resources located there) to play a major role in the advance of this knowledge base. DOE's structural biology program is focused on providing the resources which are necessary for efficient utilization of current and developing facilities.

The environmental research program, in a similar manner, evolved from an initial need to understand the pathways of radioactive materials from weapons testing through atmospheric, marine and terrestrial media, to human exposure. This research has produced quantitative models describing atmospheric, oceanographic and terrestrial movement of materials which were employed to describe and predict the distribution, uptake and human exposure from the Chernobyl nuclear reactor accident.

The research base established within the DOE environmental research program has enabled the Department to respond effectively to recent national concerns. The DOE research in atmospheric chemistry has been a key component of the National Acid Precipitation Assessment Program (NAPAP). The National Laboratories have mounted 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. The work will contribute to a more informed approach to contemplated emission control strategies addressing the acid rain problem. The DOE research in atmospheric transport and diffusion has greatly enhanced the emergency preparedness and emergency response systems at the sensitive DOE facilities. Other environmental research programs cover the marine and terrestrial ecosystems. These programs are directed at regional or large scale systems addressing water and land use that include the exchange of materials from marine ocean margins with the deep open ocean system such as fate of carbon production from the shelf, as well as human derived contaminants. The terrestrial ecosystem program has established a Federal lead in landscape research and modeling and from research in the past provided definitive information on the buffering capacity of soils to acid rain and carbon cycling in forested ecosystems.

A more recent environmental concern has been possible global warming from the increase of greenhouse gases and especially carbon dioxide (CO_2) in the atmosphere from the burning of fossil fuels. For over ten years the Carbon Dioxide Research Program has studied the carbon dioxide interactions with the atmosphere, the biosphere, the oceans and the cryosphere 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 organized by the Committee on Earth Sciences of the Office of Science and Technology Policy (OSTP). The Secretary of Energy has identified global warming as an important environmental consideration in the development of the National Energy Strategy. Consequently, DOE has launched a major research initiative to accelerate progress in the scientific capability to predict global and regional climate change. A principal component of this initiative is an experimental program to accurately quantify the cloud-climate feedback system and to improve the corresponding parameterizations in the climate change prediction models. A second 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 terrestrial transport program is DOE's only basic long term research directly related to subsurface contamination and ground water. It evolved in the 1980's from research that addressed primarily surface deposition of radionuclides into one directed at mixed wastes. It provides the underpinning for environmentally safe and cost effective restoration and remediation. In FY 1991 research will be directed at characterization, assessment, and environmental restoration, including: improved environmental measurement technology; physical, chemical, and biological interactions that control the transport of mixed contaminants; and chemical and microbial techniques for waste remediation. The program is completing a research program plan for long-term research in environmental restoration for the Office of Energy Research. Close coordination is maintained with the near-term five year planning effort for environmental restoration and waste management to assure effective coupling of our longer term research with the more immediate five year task force that has been mobilized within the Department.

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. As progressively sophisticated applications in diagnosis and therapy developed, this 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 Department of Energy (DOE), the programs of medical applications have been continued and expanded. The current program includes six major research areas: (1) research with stable isotopes, (2) research to develop new radioisotopes, (3) development and application of new radiopharmaceuticals, (4) instrumentation, (5) clinical feasibility and (6) boron neutron capture therapy (BNCT).

The isotope and radiopharmaceutical research programs are largely directed to improving methods for studying the functions and improving 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 radiopharmaceuticals for studying brain function.

The DOE program in medical applications differs from related programs of the National Institutes of Health (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.

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(Dollars in Thousands)

LEAD TABLE

Biological and Environmental Research

Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Base	FY 1991 Request	Program Change Request vs Base	
					Dollar	Percent
Biological and Environmental Research	$214,303 a/b/	$270,736	$270,736	$317,888	$+47,152	+ 17%
Program Direction	4,000	4,536	5,800	5,800	0	--
Capital Equipment	8,965	11,272	11,272	11,621	+ 349	+ 3%
Construction	23,500	22,149	22,149	3,485	- 18,664	- 84%
Total	$250,768 a/b/c/	$308,693 c/d/	$309,957 c/	$338,794 c/	$+28,837	+ 9%
Operating Expenses	($218,303)	($275,272)	($276,536)	($323,688)	$+47,152	+ 17%
Capital Equipment	(8,965)	(11,272)	(11,272)	(11,621)	+ 349	+ 3%
Construction	(23,500)	(22,149)	(22,149)	(3,485)	- 18,664	- 84%
Staffing Total FTE's						
Headquarters	54	65	65	65	--	--
Field	89	87	87	87	--	--
Total	143	152	152	152	--	--

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

a/ Total has been reduced by $2,650,000 which has been transferred to SBIR.
b/ Reflects comparability adjustment of $890,000 for transfer of isotopes to Nuclear Energy.
c/ Reflects comparability adjustment for new Environmental Restoration and Waste Management program as follows: FY 1989 - $4,084,000; FY 1990 - $5,294,000; FY 1991 - $3,401,000.
d/ FY 1990 reflects final Gramm-Rudman-Hollings sequester adjustments.

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ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

SUMMARY OF CHANGES

Biological and Environmental Research

FY 1990 Appropriation	$ 308,693
Adjustments - Increased personnel costs	+ 1,264
FY 1991 Base	309,957
- Continue radiation and chemical dosimetry, sustain measurement technology and instrumentation	+ 1,851
- Increase field and laboratory studies on transport and transformation of chemicals through atmospheric, terrestrial and marine systems	+ 4,160
- Maintain epidemiologic, biological markers studies, and long-term experimental animal research on radiation and complex chemical mixtures	+ 1,661
- Continue research in structural biology, molecular genetics, cell biology	+ 4,001
- Maintain efforts on medical applications feasibility studies and related instrumentation	- 292
- Expand carbon dioxide research program to develop atmospheric measurement systems for first detection of the global warming signal and to quantify linkages between the rise of greenhouse gases and climate change	+15,854

- Continue to enhance efforts on mapping the entire human genome.....	+19,917
- Maintain base capital equipment and general plant projects program needs.....	+ 1,405
- No provision for funding of Congressionally initiated university construction projects in FY 1991.....	-19,720
FY 1991 Congressional Budget Request.....	$338,794

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Analytical Technology

Population exposure underlies both the development of risk coefficients and an assessment of projected health impacts. This exposure may be estimated by characterization of the radiation or chemical source combined with the application of suitable mathematical models which compute the exposure of the receptor population. Alternatively, exposure may be determined by direct measurement using appropriate personnel or area monitoring instrumentation. The analytical technology program develops and evaluates the instrumentation and computational technology required to address this responsibility for safe operation of Departmental facilities.

II. A. Summary Table: Analytical Technology

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Dosimetry Research	$ 9,305	$ 9,252	$ 10,360	+ 12
Measurement Science	4,927	5,907	6,650	+ 13
Total, Analytical Technology	$ 14,232	$ 15,159	$ 17,010	+ 12

II. B. Major Laboratory and Facility Funding

Ames Laboratory	$ 514	$ 401	$ 436	+ 9
Argonne National Laboratory	$ 707	$ 687	$ 653	- 5
Brookhaven National Laboratory	$ 86	$ 102	$ 110	+ 8
Environmental Measurements Laboratory	$ 4,315	$ 4,496	$ 4,790	+ 7
Idaho National Engineering Laboratory - EG&G	$ 85	$ 105	$ 113	+ 8
Inhalation Toxicology Research Institute	$ 170	$ 166	$ 181	+ 9
Lawrence Berkeley National Laboratory	$ 1,651	$ 1,650	$ 1,722	+ 4
Lawrence Livermore National Laboratory	$ 839	$ 627	$ 491	- 22
Los Alamos National Scientific Laboratory	$ 125	$ 0	$ 0	0
Oak Ridge National Laboratory	$ 2,501	$ 2,363	$ 2,689	+ 14
Pacific Northwest Laboratory	$ 1,385	$ 1,263	$ 1,340	+ 6

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

Program Activity	FY 1989	FY 1990	FY 1991
Analytical Technology			
Dosimetry Research	Maintained radiological characterization and Chernobyl data base activities.	Complete compilation of a comprehensive Chernobyl data base. Maintain characterization studies of radiation sources and defining pathways from source to humans.	Maintain, update and distribute a comprehensive Chernobyl data base. Maintain characterization studies of radiation sources and defining pathways from source to humans.
	Maintained radiation and chemical dosimetry research with emphasis on mixed field radiation dosimetry techniques and methodology for DNA adduct measurement. Continued extension of advanced external dosimetry computational techniques to occupational health applications. Sustained radon research for development of better dosimetric concepts; improved exposure-dose relationships; enhanced definition of radon availability, distribution and migration in the indoor environment; and a more refined understanding of high LET interactions with biomolecules. ($9,305)	Maintain radiation dosimetry research with particular emphasis on radon and radon daughters, and on fundamental studies of the microdosimetry of high LET radiation. Continue research on characterizing DNA damage resulting from energy-related chemical toxicants. ($9,252)	Research will continue on fundamental studies of the microdosimetry of high LET radiation. Dosimetry research on radon and radon daughters will be continued. DNA adduct characterization and measurement program will continue with emphasis on measuring chemical exposures. ($10,360)
	$ 9,305	$ 9,252	$ 10,360
Measurement Science	Sustained measurement technology and instrumentation development research. Continued development of advanced laser techniques for sensitive and selective chemical measurements. Maintained a focus on biologically active materials and detection of damage to biological systems. Completed development of instrumentation to measure primary biomass production in the oceans. ($4,927)	Maintain development of advanced instrumentation and new measurement technology concepts. Emphasis on laser based techniques for ultrasensitive detection of biological damage will continue. Development of new techniques to chemically separate toxic compounds will be completed. ($5,907)	Maintain research program on advanced instrumentation and measurement concepts. Primary emphasis will be on multiphoton ionization processes for ultrasensitive detection of biological damage. Specific laser spectroscopic techniques will be developed to measure DNA adducts at very low concentration levels. ($6,650)

III. Analytical Technology (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Measurement Science (Cont'd)	$ 4,927	$ 5,907	$ 6,650
Analytical Technology	$ 14,232	$ 15,159	$ 17,010

DEPARTMENT OF ENERGY
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ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Environmental Research

Discharges and disturbance from energy sources can be localized or distributed regionally and 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 and the resiliency of biological systems to disturbance. 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.

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 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 Federal agencies working in the open ocean and space 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.

The terrestrial transport program concentrates on the transport of materials through the subsurface soils and ground water systems and on exploring microbial communities in deep sediments for remediation potential. The program concentrates on mid- to long-term needs of DOE waste related problems and is being closely coordinated with the near-term applied research in other parts of DOE.

Ecosystem functioning and response is designed to develop the fundamental theoretical basis needed to understand complex ecological systems and to apply these to experimental DOE field sites designated as National Environmental Research Parks and in Arctic Alaska for optimum management of environmental problems at DOE weapons and energy sites and for understanding global and regional systems.

II. A. Summary Table: Environmental Research

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Atmospheric Science	$ 11,448	$ 12,281	$ 13,292	+ 8
Marine Transport	5,779	6,040	6,901	+ 14
Terrestrial Transport	10,492	14,356	15,688	+ 9
Ecosystem Functioning and Response	8,573	7,844	8,800	+ 12
Total, Environmental Research	$ 36,292	$ 40,521	$ 44,681	+ 10

II. B. Major Laboratory and Facility Funding

	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Argonne National Laboratory	$ 1,501	$ 1,532	$ 1,525	0
Brookhaven National Laboratory	$ 4,556	$ 4,072	$ 4,260	+ 5
Environmental Measurements Laboratory	$ 2,190	$ 2,208	$ 2,059	- 7
Fermi National Accelerator Laboratory	$ 50	$ 49	$ 50	+ 2
Idaho National Engineering Laboratory - EG&G	$ 145	$ 368	$ 330	- 10
Lawrence Berkeley National Laboratory	$ 833	$ 1,041	$ 863	- 17
Lawrence Livermore National Laboratory	$ 1,603	$ 1,710	$ 1,694	- 1
Los Alamos National Scientific Laboratory	$ 1,466	$ 1,280	$ 1,235	- 4
Oak Ridge Associated Universities	$ 84	$ 0	$ 0	0
Oak Ridge National Laboratory	$ 3,033	$ 3,282	$ 3,599	+ 10
Pacific Northwest Laboratory	$ 6,365	$ 8,197	$ 9,064	+ 11
Savannah River Ecology Laboratory	$ 409	$ 295	$ 350	+ 19
Savannah River Laboratory	$ 442	$ 408	$ 515	+ 26

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

Program Activity	FY 1989	FY 1990	FY 1991
Environmental Research			
Atmospheric Science	The final field study of cloud and precipitation processing of pollutants took place with emphasis on frontal and primarily nonconvective large scale systems. This experimental effort was also coordinated with the EPA sponsored field measurements for the verification of the acid deposition models. Development of the wet scavenging module for the acid deposition models was completed and delivered to the modeling task group. Laboratory simulations of the dominant chemical mechanisms continued for further improvement of the chemical kinetics parameterizations. The task of synthesis of the major PRECP accomplishments coupled with a concise deposition climatology commenced. The upgraded MAP3S research network continued operations. Analytical studies exploring source/receptor	Research activities for the National Acid Precipitation Program will concentrate primarily on the preparation of key parts of the 1990 state-of-the-science reports on precipitation scavenging, cloud chemistry processes and dry deposition. Data from the seven PRECP experiments and the dry deposition investigations will be evaluated for their relevance to the integrated assessment needs and will be used for model verifications and for improvement of parameterizations of atmospheric processes in these models. Limited field and laboratory investigations will be undertaken for quality assurance purposes and for incidental model verification needs. The experimental upgrade of the MAP3S precipitation chemistry network will commence. A pilot study of climatic	A major field study will be launched over the northeastern United States and the western North Alantic to determine the fate of man-made emissions of sulfur and nitrogen oxides. Emphasis will be 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 will be 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 will be explored. Activities will be coordinated with the Interagency Global Tropospheric Chemistry Experiment. Limited numerical modeling of the governing atmospheric chemistry processes will be pursued as well as

III. Environmental Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Atmospheric Science (Cont'd)	relationships with the use of the MAP3S data was initiated. Dry deposition research activity remained level. ($5,429)	effects of aerosols on a super-regional scale will be initiated. ($4,040)	benchmark laboratory studies of aqueous chemical reactions. The MAP3S Precipitation Chemistry Network will continue monitoring and will expand to include parameters related to Global Change. ($6,142)
	Transport and dispersion research by the Atmospheric Studies in Complex Terrain (ASCOT) moved to a larger mountain-valley system to explore the tie-ins of local circulations to more regional weather systems. Experimental limitations due to enhanced spatial scales was compensated by more elaborate modeling parametric studies. Emergency response research activities concentrated on the incorporation of a forecasting dimension to the Atmospheric Release Advisory Capability (ARAC) system, supported by the Office of Environment, Safety and Health. ($2,890)	The ASCOT program will concentrate on specific problems of transport and diffusion relevant to emergency preparedness. Emphasis will be placed on modeling and experimental investigations providing the scientific tools to serve the DOE facilities with emergency preparedness needs. An upgrade in the forecasting capability of emergency response models for the local and the regional scale will be initiated. Modeling systems addressing reactive fluids will receive increased attention. ($4,520)	The ASCOT program will continue its emphasis on research which can be used by DOE to improve the emergency preparedness and emergency response atmospheric dispersion systems at key DOE sites. Field programs will be conducted around the DOE sites in Oak Ridge, Tennessee. This will also be the first test for the ASCOT models in the eastern mountainous terrain and in humid climates, and a new set of appropriate parameterizations are expected. Pilot studies of uncertainty in emergency preparedness models will be undertaken. ($5,500)
	The study of organic compounds in the atmosphere continued with field measurements taken in conjunction with the PRECP field efforts. Laboratory studies of fundamental chemical processes along with applications of tracer technology was pursued. ($3,129)	The study of the role of organics in regional oxidant and acid production will continue with field and laboratory studies. The impact of sulfate aerosols on cloudiness and radiative balance will be studied in the context of global change. Technology transfer activities with tracers will continue for a variety of industrial applications. ($3,721)	The study of the role of atmospheric organics in global atmospheric chemistry changes will continue. ($1,650)
	$ 11,448	$ 12,281	$ 13,292

III. Environmental Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Marine Transport	The marine transport program, has for more than a decade, been focused in the coastal ocean margins for several reasons. Aquatic and atmospheric effluents and discharges from many energy and weapons facilities end up in the coastal zone; the coastal zone is the most productive oceanic renewable resource for commerical and sport fisheries, and 70% of the population lives within close proximity of the ocean. The research conducted in the Northeast, Southeast and Southwest coastal margins is determining the flushing rate and the fate of energy and weapons materials in these regions to address concern of deleterious concentrations of these discharges in the coastal zone. This research is also important in contributing to the knowledge of carbon and nitrogen flux of the coastal margins in the global cycle; since coastal margins are estimated to be providing 80% of the productivity in the entire ocean system and are considered the "missing carbon" in the global CO2 budget. In FY 1989, the Shelf Edge Exchange Program (SEEP) in the Northeast is in the midst of an 18 month field year to determine particle flux from the New York Bight and Delmarva peninsula off the shelf. The Southeast program has shown that the major flushing from the shelf is driven by surface winds, resulting in discharges off the shelf at Cape Hatteras and at Cape Canaveral. The California Basins study (CaBS) in the southwest discovered that 80% of the productivity in the water column is	Because of its expertise in coastal margins research DOE/BER became the lead agency in FY 1989 of a multiagency organization in coastal research. In FY 1990 BER will build closely collaborative programs with other Federal agencies to form a coherent, effective costal margins component of the Global Ocean Flux Study (GOFS) which is a major global change multiagency program. In FY 1990 the Northeast SEEP program will complete its 18 month field year to determine level of discharge of particles from the shelf and begin analyzing samples and synthesizing data. The SAB and CaBS programs will complete synthesis of their field years and prepare advanced planning for the enhanced collaboration with GOFS in FY 1991 and FY 1992. ($6,040)	Formal multiagency planning meetings, field equipment development and buildup and pilot studies will be conducted on the ocean margins as this region begins to accelerate its programs in tandem with the open ocean research of GOFS funded by other agencies. It is closely integrated into the biogeochemical element of the Global change research plan issued by the Committee on Earth Sciences (CES) and will address the role of the ocean margins in exchanges with land and open ocean systems. The BER ocean program will be directed at assessing the quantitative contribution of carbon and other associated chemicals removed from the eastern U.S. continental shelf and advected into the Western North Alantic ocean boundary current system which includes the Gulf Stream. This research will begin to put into perspective the significance of boundary exchanges in biogeochemical cycling of ocean systems, the amount of greenhouse gases absorbed from the atmosphere and the disposition of the carbon in the oceans. This same research will also continue to answer the questions of transport of energy-related contaminants on and off the continental shelf. ($6,901)

III. Environmental Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Marine Transport (Cont'd)	due to bacterial activity so that much of the organic material does not fall to the bottom (as is present along the east coast) but remains in the water column with possible gas metabolite discharges into the atmosphere. ($5,779)		
	$ 5,779	$ 6,040	$ 6,901
Terrestrial Transport	Continued research in environmentallly related radon studies to determine aspects of soil types depth and porosity to radon levels, as well as humidity and moisture factors. ($2,417)	Complete research in radon transport from environment to households. ($2,320)	Begin to summarize research findings in radon program on soil mobility through the near surface soils of the U.S. ($2,377)
	Continued development of accurate non-invasive, inexpensive methods including fiber optic sensors to eliminate need of drilling costly wells for monitoring. Strengthened research in understanding capacity of natural soils and subsurface systems to degrade and transport organic chemicals. Began development of expert systems for mixed wastes of organics, radionuclides and trace metals through soils and subsurface systems by targeting on unifying concepts. Continued research in deep microbiology with one new site at Savannah River. Increased technology transfer of newly discovered microbiota to pharmaceutical, waste cleanup, and other industries. Awarded 23 proposals out of 216 submitted in response to a Federal Register Notice for subsurface contaminant research. Areas included radionuclide/organic mixture dynamics, colloid interactions, biodegredation and field scale validation of models. Completed mid- to	Complete first national comparative information base in deep microbiology drawing on western drilling site and the Savannah River site. Initial conclusions on subsurface chemical and physical variables that control microbial presence, abundance and activity are early steps leading to the use of microbial communities for bioremediation of deep aquifers. Maintain long term research on the immobilization and transport of organic-chemical-radionuclide mixtures, and in the physical, chemical and microbiological properties of natural subsoils and groundwater. Initiate first integrated geochemical-microbial experiments where multiple organic contaminants with different sorptive capacities are degraded in presence of microorganisms. No comparable research to clarify coupled processes that operate simultaneously is being done nationally; with time, these systems will be used for research on	Maintain research to develop the first national comparative information base on microbial communities in deep sediments/aquifers to determine if microbial communities in ground water can be predicted based on available physical-chemical monitoring data. Maintain research in the microbial degradation, abiotic degradation and sorptive-desorptive processes that mobilize organic-radionuclide chemical mixtures, and in the hydraulic, geochemical and microbiological properties that encourage their stabilization in subsoils and ground water. Continue research in new generation expert systems related to chemical, and bacterial transport/ degradation that will contribute to biochemical cleanup of contaminated subsurface systems. Increase coordination with all Departmental units by selecting the first validation field site to test scientific concepts and speed transfer

III. Environmental Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Terrestrial Transport (Cont'd)	long-term Department research problem definition report directed at cost reduction with safe implementation of environmental remediation, and restoration required in the 5 to 20 year time frame. ($8,075)	alternative remedial action strategies to determine unexplained failures and the boundary conditions for application of new methods. Initiate university-national laboratory cooperation that bridges the gap between experimental research and field demonstrations of effective and economically-improved in situ waste stability. Test and demonstrate new instrumentation within an intermediate scale experimental system. Increase coordination with all Departmental units by selecting the first of five DOE-wide research sites to verify predictions in the field and to speed transfer of new scientific technologies to DOE sites. Hold workshops to develop research implementation of specific areas for cost reduction of environmental remediation and cleanup as a follow up to the mid- to long-term Departmental research problem definition report. ($11,987)	of new scientific methods, such as microbial degradation of organic chemical mixtures under pressure and water flux. ($13,311)
	No activity. ($0)	Implementation plans for the Energy Sciences Network (ESNET) project, identified in the applied mathematical sciences subprogram of the Basic Energy Sciences program will proceed. This subprogram's share for the implementation of ESNET is $49.	Upgrades of ESNET to conform to the National Research and Education Network standards will continue to be pursued and will be shared among ER programs that benefit from ESNET.
	$ 10,492	$ 14,356	$ 15,688

III. Environmental Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Ecosystem Functioning and Response	Began development for next phase of Arctic tundra study in collaboration with NASA, DOI and NSF to broaden understanding of land/atmosphere ecosystem programs as targeted on water balance and atmosphere/land interactions for determination of resiliency of ecosystems to stresses from natural and human induced disturbance. Continued research in watersheds and wetlands to determine effects of multiple stresses. Publication in FY 1989 of 2 synthesis volumes of 3 to 4 decades of research conducted at Hanford and Oak Ridge has provided an important and unique record of ecosystem processes at watershed and landscape sized areas that will form the foundation for enhanced studies now being considered by several agencies related to the global change issue. ($7,166)	State-of-the-art technologies and instruments that are being developed at the national laboratories will be incorporated into field studies to support vertical integration processes and spatial and temporal dynamics. Planning of the hydrosphere/atmosphere/biosphere interactions in terrestrial arctic/arid terrain (HABITAT). The HABITAT program will emphasize processes related to large scale disturbances including evapotranspiration and changes in water balance to understand critical events leading to such an extreme as desertification or resiliency. ($6,044)	The CES global change research plan has identified research on interaction of physical and biological processes as an important priority of ecological systems and dynamics. The existing BER program has had a track record in innovative research in this area through novel instrumentation development and mulidisciplinary research teams. In FY 1991 we will further develop the HABITAT program in both the arctic region and at arid and semi-arid DOE sites to determine biogeochemical cycling and the significant physical and biological driving forces that control ecosystems dynamics. A multiagency program in the arctic centered on the comprehensive DOE Arctic program will begin. ($7,000)
	A comparative study by the DOE Environmental Research Parks network will be conducted using data bases extending over 40 years to establish a regional and national environmental transect. ($523)	The DOE National Environmental Research Park Network with established data bases operating interactively since FY 1990 will be enhanced to become closely integrated with the theoretical ecology program so that field validation of theoretical concepts developed in the FY 1989 and FY 1990 time frame can be effectively accomplished. PARKNET, the interactive DOE Research Park data base network, will be interlinked with the NSF Long-Term Ecological Reserves (LTER) network and the international Man and the Biosphere (MAB) network to begin developing intercontinental transects to identify critical gradients for forecasting global changes. ($600)	The DOE National Environmental Research Park Network with established data bases operating interactively since FY 1990 will be enhanced to become closely integrated with the theoretical ecology program so that field validation of theoretical concepts developed in the FY 1989 and FY 1990 time frame can be effectively accomplished. PARKNET, the interactive DOE Research Park data base network, will be interlinked with the NSF Long-Term Ecological Reserves (LTER) network and the international Man and the Biosphere (MAB) network to begin developing intercontinental transects. ($600)

III. Environmental Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Ecosystem Functioning and Response (Cont'd)	Continued momentum in theoretical ecology to provide an underpinning for DOE ecosystem research and for the national global program which is severely lacking in mathematical theory for multiple space-time scales. Augmentation of funds for this program came by terminating the marine physiology program. Sixty proposals were submitted in response to a Federal Register Notice; and 8 were awarded after panel evaluation. ($884)	The freshwater program will be terminated in order to provide additional funds for the DOE theoretical ecology program. ($1,200)	Funding for the theoretical ecology program will continue with no new grants awarded in FY 1991. The awards made from the competition resulting from the Federal Register notices in FY 1989 and FY 1990 will be continued as three year grants from date of inception. This program although small is a crucial underpinning for the entire U.S. national program in terrestrial ecosystem dynamics in global change because of the focused, highly competitive, advanced theory that is required for appropriate experimental implementation and model development that must be based on relevant parameters for cost effective use of funds. ($1,200)
	$ 8,573	$ 7,844	$ 8,800
Environmental Research	$ 36,292	$ 40,521	$ 44,681

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Health Effects

Research in this program is conducted to develop a broad, scientifically sound data base for evaluating the potentially adverse health effects that could result from exposures to radiation and chemical agents most relevant to Department of Energy programs. One subprogram utilizes human epidemiolgical data obtained from selected human populations known to have been acutely exposed to moderately high, or to chronically low levels of external radiation, internally deposited radioactive materials, or energy-related materials. The second subprogram is designed to provide experimental health effects data, including data on mechanisms by which health effects are induced and expressed, which cannot be obtained from human studies. This subprogram makes use of experimental animals, as they are useful models for human beings. In addition, animal organ and tissue cultures, as well as aminal and human cell cultures, are extensively used. Both subprograms will increasingly emphasize molecular-level studies. There is also a small subprogram in radiation and chemical physics that addresses the physical mechanisms of radiobiological action.

II. A. Summary Table: Health Effects

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Human Health Research				
RERF Epidemiology	$ 17,000	$ 17,255	$ 18,000	+ 4
DOE Workers and Other Epidemiology	8,187	12,789	13,636	+ 7
Other Human Health	1,468	2,453	2,406	- 2
Subtotal, Human Health Research	$ 26,655	$ 32,497	$ 34,042	+ 5
Biological Research				
Radiation Biology	$ 23,360	$ 24,683	$ 22,923	- 7
Chemical Toxicology	8,387	7,884	9,155	+ 16
Subtotal, Biological Research	$ 31,747	$ 32,567	$ 32,078	- 2
Radiological and Chemical Physics	$ 6,464	$ 6,395	$ 7,000	+ 9
Total, Health Effects	$ 64,866	$ 71,459	$ 73,120	+ 2

II. B. Major Laboratory and Facility Funding

	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Argonne National Laboratory	$ 7,072	$ 6,596	$ 7,072	+ 7
Brookhaven National Laboratory	$ 626	$ 1,048	$ 687	- 34
Inhalation Toxicology Research Institute	$ 7,890	$ 7,258	$ 7,868	+ 8
Laboratory of Radiobiology and Environmnetal Health	$ 788	$ 791	$ 845	+ 7
Lawrence Berkeley National Laboratory	$ 1,864	$ 1,841	$ 1,888	+ 3
Lawrence Livermore National Laboratory	$ 1,304	$ 1,607	$ 1,175	- 27
Los Alamos National Scientific Laboratory	$ 2,251	$ 2,633	$ 2,378	- 10
Oak Ridge Associated Universities	$ 3,900	$ 4,494	$ 4,157	- 7
Oak Ridge National Laboratory	$ 7,584	$ 6,349	$ 6,453	+ 2
Pacific Northwest Laboratory	$ 5,752	$ 6,420	$ 6,803	+ 6
Radiation Effects Research Foundation	$ 17,000	$ 17,255	$ 18,000	+ 4
Sandia National Laboratories	$ 500	$ 737	$ 950	+ 29

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

Program Activity	FY 1989	FY 1990	FY 1991
Health Effects			
Human Health Research			
RERF Epidemiology	Studies of atomic bomb survivors begin to incorporate new dosimetry. Studies of immunological responses, somatic, mutations and biological dosimetry published. ($17,000)	Maintain level of effort for atomic bomb survivor studies. ($17,255)	Maintain level of effort for atomic bomb survivor studies. ($18,000)
	$ 17,000	$ 17,255	$ 18,000

III. Health Effects (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
DOE Workers and Other Epidemiology	Studies of workers at the Savannah River Plant (SRP), Hanford Site, and Mound Facility are published in peer-reviewed scientific journals. National and international data pooling efforts result in report to be submitted for publication and development of cooperative study protocol. Development of a Centralized Epidemiologic Data Resource (CEDR) begins. ($8,187)	Data pooling efforts using data from published studies reach conclusion. CEDR development accelerates with survey of DOE sites and establishment of interim data repository. Plutonium morbidity study begins. Initiate data collection at remaining National Laboratory sites (Idaho Engineering, Argonne, Brookhaven and Ames). Initiate feasibility study of hazardous waste cleanup workers. Expand Health Surveillance Sytem and Study of Injuries and Accidents to additional facilities. ($12,789)	Develop standardized system for determining exposures to chemicals throughout the DOE system. Complete autopsies/tissue analyses now on hold. Install data from completed studies in interim CEDR. Initiate roster construction/verification for National Laboratory workforces in preparation for submission to Social Security Administration (SSA) for vital status determination. Continue Pu morbidity study data collection. Accelerate CEDR data collection. Obtain computerized detailed work history data for SRP workers. Prepare rosters of Nevada Test Site civilian workers, including employees of Holmes and Narver and REECo. Continue data collection at National Laboratories and expansion of Health Surveillance System and Injury/Accident Study. Initiate study of hazardous waste cleanup workers, if feasible. Begin incorporation of chemical exposure information in data collection. Install PAREP data in CEDR. ($13,636)
	$ 8,187	$ 12,789	$ 13,636
Other Human Health	Support continues for interagency radiation policy and radon work-group efforts. Two technical publications on radon completed, uranium miner tissue bank begun and DOE human subjects policies development begun. Indoor exposure model developed. ($1,468)	Continue interagency radon and radiation efforts, accelerate efforts on radon publications, and DOE implementations, and DOE implementation of human subject protection. Complete major radon program review. Begin radon risk analysis task to evaluate new science versus uncertainty reduction. ($2,409)	Continue to expand radon publication series, implement radon review recommendations, begin Human Subject research system, and increase interagency coordination efforts for radiation, radon, human subjects protection. ($2,406)

III. Health Effects (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Other Human Health (Cont'd)	No activity. ($0)	Implementation plans for the Energy Sciences Network (ESNET) project, identified in the applied mathematical sciences subprogram of the Basic Energy Sciences program will proceed. This subprogram's share for the implementation of ESNET is $44.	Upgrades of ESNET to conform to the National Research and Education Network Standards will continue to be pursued and will be shared among ER programs that benefit from ESNET.
	$ 1,468	$ 2,453	$ 2,406
Subtotal, Human Health Research	$ 26,655	$ 32,497	$ 34,042
Biological Research			
Radiation Biology	Long-term carcinogenesis studies are in the data analysis and writing stages at all laboratories, although several experiments still have living animals. The direction and approach to archiving the information from past experiments was formalized. A peer review was held of the plans to store tissues from these experiments for use in cellular and molecular biology studies. Radon/radon daughter research matured and an increased level of project integration was attained. Cellular dosimetry and effects in the respiratory tract following inhalation of radon and radon mixed with cigarette smoke were pursued. The integration of animal research models with cellular and molecular research models continued toward the end of understanding the mechanisms underlying radiation carcinogenesis. ($11,710)	Continue data analysis and publication of information from the long-term Beagle dog studies. Implement the interlaboratory collaboration necessary to create an integrated radiobiology database for the long-term experiments. This will require increased support for the repository and archiving processes. Continue radon studies, standardize approaches to dosimetry of radon exposures. Start new multi-level studies which implement a combined whole animal, cellular and molecular level approach to the mechanisms of radiation carcinogenesis. Increase support for the animal and cellular-molecular studies of the effects of low level doses and dose rates of neutrons and gamma rays at the Argonne National Laboratory using the Janus reactor. Increase support for high-LET research at the Bevatron, to observe effects on Harderian gland cells. ($12,430)	Support will be continued for the repository and archiving process on the tissues and information from the long-term animal studies. Experiments on stored tissues will aid in elucidating the mechanisms of radiation-induced cancers. Some of the radon/radon daughter experiments will be nearing completion and publication. As the whole animal studies phase down, there will be more emphasis on intergrated research approaches which simultaneously span molecules, cells and whole animals. These new approaches promise to produce an in-depth understanding of the mechanisms involved in tumor development. Support will continue for the animal and cellular-molecular studies of radiobiological effects of low level neutron and gamma ray exposures and for the high-LET studies using different heavy nuclei at various doses and dose rates. The subcontracted research effort between the University of Utah and the Inhalation Toxicology Research Institute will continue its phase down. ($10,155)

III. Health Effects (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Radiation Biology (Cont'd)	Continued research on the molecular biology of radiation-induced heritable mutations in mice and on somatic mutations in human skin and blood cells. Research on radiation-induced DNA damage and repair sustained. Studies on the role of radon-induced gene damage in relation to the initiation of tumor development continued. Research continued on the development of new and improved molecular and cellular based systems to measure possible radiation-induced somatic and heritable mutations in human populations. ($11,650)	Cellular and molecular studies selectively increase. The molecular level analysis of germ life and somatic mutations induced by high--as well as low-LET radiation continues. Research emphasizes the confirmation of observations of the perferential repair of damaged DNA that is inactive. Studies on the molecular and cytogenetic characterization of radiation-induced damage that is biologically significant and the role of such damage in lung carcinogenesis continue. Validate improved molecular and cellular based mutation assays for the quantitation of somatic and heritable mutations in radiation exposed human populations. ($12,253)	Research investigating the molecular and cellular mechanisms underlying radiobiological damage and carcinogenesis will be increased. Studies of malignant transformation using human cell cultures and combined in vitro and in vivo approaches will be emphasized. Increased effort will be placed on understanding the relationship between DNA repair capacity and tumor development. Some of these studies will utilize transgenic mice in which particular DNA repair genes have been introduced. Studies on the molecular and cytogenetic characterization of radiation-induced damage to pulmonary tissue components will continue. Molecular analysis and characterization of tumor tissue from radium dial painters will continue. Studies to perfect assays for the quantitation of somatic and heritable mutations in humans will be increased in scope as new technologies are developed in the human genome program. ($12,768)
	$ 23,360	$ 24,683	$ 22,923
Chemical Toxicology	Multilevel fundamental research to elucidate general principles of chemical effects was emphasized. This research emphasizes understanding the cellular and molecular events following exposure and used novel systems designed to bridge in vivo and in vitro generated information. Emphasis remained on carcinogenesis and genetic effects. ($8,387)	This research includes studies on the interactions of defined multiple exposures and extends the use of molecular biology approaches involving effects of inhaled chemicals and metabolic changes in the respiratory tract. Continue to emphasize mechanisms of carcinogenesis and mutagenesis as primary effects and inhalation toxicity as the primary exposure route. Increased emphasis on integration of research efforts across the program element. ($7,884)	The program will continue developing data for the evaluation of potential adverse effects of energy-related chemicals on humans through multifaceted biological research. The focus will be on fundamental principles of chemical interactions with living systems, emphasizing cellular and molecular mechanisms. The research will include studies on mechanisms of synergistic and antagonistic interactions and mechanisms of carcinogenesis, including DNA adducts, cellular oncogene activation and tumor promotion. Research will be continued

III. Health Effects (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Chemical Toxicology (Cont'd)			to bridge information between molecular and cellular studies and animal studies. Emphasis will remain on carcinogenesis and mutagenesis, and upon inhalation as a primary route of exposure. ($9,155)
	$ 8,387	$ 7,884	$ 9,155
Subtotal, Biological Research	$ 31,747	$ 32,567	$ 32,078
Radiological and Chemical Physics	Maintain radiation biophysics research to obtain insights into the basic mechanisms of radiation interactions with matter. Apply this understanding to the interpretation of radiobiological response. Emphasize the extrapolation of gas phase data to the condensed phase. Initiate theoretical studies on conformation and configuration changes in model systems produced by interaction with physical and chemical agents. ($3,431)	Continue radiation biophysics research and basic studies of radiation interactions with matter. Emphasis will be on condensed phase data which will provide insight into reactions with biological tissues. Sustain theoretical studies on structural and conformational changes in model systems caused by chemical and physical agents. ($3,377)	Radiation biophysics and fundamental studies on interaction of radiation with matter will continue. Application of this research to the understanding of radiobiological effects at low doses and dose rates will continue. Continued emphasis will be placed on obtaining data in condensed phase. Theoretical studies on understanding of conformational and structural changes in biomolecules caused by radiation and chemical agents will continue. ($3,700)
	Sustain the fundamental studies on energy transfer and transport properties of model liquids. Emphasize studies on model liquids that are similar in chemical composition to that found in cellular environment. An advanced qualitative image processing system will be developed for fluorescence hybridization studies of the response of cells to low doses of radiation or other agencts. ($3,033)	Continue to maintain basic studies on understanding of energy transfer pathways and influence of these energy transfers on the physical and chemical properties of the liquid. Strengthen the computation and calculation capabilities to better define the structure-reacting relationship in liquids. Hardware and software improvements will be developed for dual beam flow cytometry to incorporate light scatter measurements. ($3,018)	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. ($3,300)
	$ 6,464	$ 6,395	$ 7,000

III. Health Effects (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Health Effects	$ 64,866	$ 71,459	$ 73,120

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: General Life Sciences

Research in General Life Sciences contributes to the base of fundamental biological knowlege that is required for the effective study and interpretation on energy-related health effects. It also identifies early indicators of biological damage, develops new techniques and experimental systems for research use, and provides knowledge that eventually becomes used in the estimation of human health risk. This research area will provide additional support to accelerate mapping of the entire human genome by improving the DNA-sequencing technology, developing new instrumentation and applying robotics technology where possible. This program applies modern molecular biology to the study of radiation and chemical health effects and also exploits unique Departmental facilities for structural biology and genome research.

II. A. Summary Table: General Life Sciences

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Structural Biology	$ 6,804	$ 8,382	$ 10,400	+ 24
Molecular Biology	12,604	13,446	14,400	+ 7
Cellular Biology	8,478	8,441	9,470	+ 12
Genome	17,505	25,975	45,892	+ 77
Total, General Life Sciences	$ 45,391	$ 56,244	$ 80,162	+ 43

II. B. Major Laboratory and Facility Funding

Ames Laboratory	$ 150	$ 172	$ 200	+ 16
Argonne National Laboratory	$ 1,348	$ 1,383	$ 1,708	+ 23
Brookhaven National Laboratory	$ 5,826	$ 5,902	$ 6,495	+ 10
Laboratory of Radiobiology and Environmnetal Health	$ 2,240	$ 2,236	$ 2,375	+ 6
Lawrence Berkeley National Laboratory	$ 4,922	$ 6,071	$ 5,854	- 4
Lawrence Livermore National Laboratory	$ 6,504	$ 8,003	$ 6,229	- 22
Los Alamos National Scientific Laboratory	$ 7,691	$ 8,949	$ 9,239	+ 3
Oak Ridge Associated Universities	$ 500	$ 497	$ 540	+ 9
Oak Ridge National Laboratory	$ 5,405	$ 6,248	$ 6,595	+ 6
Pacific Northwest Laboratory	$ 355	$ 390	$ 411	+ 5

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

Program Activity	FY 1989	FY 1990	FY 1991
General Life Sciences			
Structural Biology	Continued support of the user facilities at the national laboratories. At the National Synchrotron Light Source, developed the use of extremely intense non-monochromatic x-ray beams for special crystallography. Continue development of high counting rate two-dimensional detectors to realize the full capabilities of the x-ray beams from the light source. Began studies of an unusual RNA that catalyzes changes in itself, a self-processing RNA, and of the use of antibodies to create specific catalytic sites. Began development of a low Q diffractometer for biological experiments at the LANL pulsed neutron source. Began development of microimaging techniques using high brightness electron and x-ray sources to study protein and DNA structure. ($6,804)	Maintain support of the user program in structural biology at the National Laboratories. At the UV ring of the NSLS, expand the range and capabilities of vacuum ultraviolet spectroscopy, especially for studies of nucleic acids. Continue development of the high counting rate 2-D detectors for counting photons at Brookhaven and Argonne. With completion of construction of the low Q diffractometer and development of data reduction software, initiate structural studies at the pulsed neutron source of proteins and chromatin. Determine the atomic structure of several forms of cancer-related proteins coded by oncogenes. Develop plans and priorities for biological research at the planned Advanced Neutron Source at Oak Ridge, and the planned synchrotron light sources at Argonne and the Lawrence Berkeley Laboratory. ($8,382)	Studies will be made of the structure of chromosomes and ribosomes by means of small angle neutron scattering and scanning transmission electron microscopy and will include the construction of a synthetic chromatin to model chromosome fragments. Development of advanced high speed X-ray detector systems for use at synchrotron facilities will be accelerated. At the NSLS the techniques for single crystal X-ray diffraction will be expanded by the use of multi-wavelength anomalous diffraction, and Laue diffraction. A small angle X-ray spectrometer that will permit rapid automated structural studies will be in routine use for studies of oriented biological materials such as membranes. At LANL, a ferrofluid has been designed in which suspensions of chromatin or an enlongated virus could be aligned by a small magnetic field. This development raises the possibility for understanding higher order structures in chromatin fibers. Studies of the structure of proteins and nucleic acids in several laboratories, principally by X-ray analysis and nuclear magnetic reasonance are providing important information on the forces keeping molecules stable and the differences between normal and abnormal molecules. Research on direct microimaging techniques for biological structures will be conducted using high brightness, coherent X-ray sources which will permit construction of high spatial resolution X-ray microscopes and X-ray holographic imaging devices. ($10,400)

III. General Life Sciences (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Structural Biology (Cont'd)	$ 6,804	$ 8,382	$ 10,400
Molecular Biology	Continued molecular characterization of DNA damage from radiation and of the genes coding for DNA repair with particular emphasis on characterizing the molecular mechanisms and controlling factors in human DNA repair; sustained research on the molecular characterization of gene structure and expression. ($12,604)	Emphasize chemical and physical characterization of biologically significant DNA damage from high LET radiation; continue research on nonrandom repair of genomic damage in mammalian cells; investigate the functional and evolutionary significance of the conserved telomeric repeat sequences of mammalian chromosomes; characterize the molecular nature of heritable mutations in mice. ($13,446)	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. New fluorescent techniques utilizing molecular probes for the detection and quantitation of genetic damage will be developed. A variety of model systems will be exploited to understand the factors regulating the expression of particular genes. Efforts to isolate, clone and characterize human DNA repair genes will expand. ($14,400)
	$ 12,604	$ 13,446	$ 14,400
Cellular Biology	This research emphasized development of the basic knowledge of cell structure and function necessary to understand cellular responses to radiation and chemical exposures and development of better experimental models. Selected mammalian cells and specific cellular processes were studied to identify the genetic and epigenetic factors that control cell transformation, cell division, and cell differentiation. Much of this program is related to basic cancer biology focusing on the role of karyotype instability, and other cytogentic and molecular changes in the initiation and progression of tumorigenesis. ($8,478)	Continue fundamental research on cell replication and regulation in normal amd perturbed mammalian cells that are progressing toward a malignant state. Continue exploitation of a battery of repair-deficient mutants to characterize and clone human DNA repair genes. Sustain efforts to determine the mechanisms by which perturbation in the extracellular matrix and cell membrane receptors influence carcinogenesis. Continue investigations of the cells at risk and the cellular mechanisms involved in the development and progression of lung diseases caused by inhaled substances. ($8,441)	The overall scope of the program will continue. Studies will continue 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 will be placed on improving flow cytometric analytical cytology methodology and the validation and 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 will be initiated. ($9,470)

III. General Life Sciences (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Cellular Biology (Cont'd)	$ 8,478	$ 8,441	$ 9,470
Genome	Maintained the production and application of human chromosome-specific gene libraries at the National Laboratories; substantially accelerated the development of linearly ordered sets of large DNA fragments from human chromosomes. Increased development of human monochromosomal hybrid cell lines. Developed new approaches to creation of physical maps of human chromosomes. Increased efforts to improve, develop and evaluate DNA-sequencing and related technologies, including microimaging techniques, needed for characterization of the human genome. Supported development of productive interdisciplinary human genome centers at LANL and LLNL. In conjunction with NIH and other organizations, sponsored joint workshops and began to develop a joint plan for the national human genome program. ($17,505)	Enhance DOE effort in the human genome program by expanding the program to include the following activities: initiate ordering of cloned DNA fragments for several chromosomes where this is not already underway; provide necessary support to DOE Human Genome Centers and other large interdisciplinary efforts to create the necessary critical mass; build prototype technology for testing and validation; evaluate new sequencing technologies, including direct microimaging approaches; develop and test new computer hardware and software for analysis of nucleic acid sequences and the relationship between nucleic acid sequences and protein structures. With NIH, complete the national plan for the human genome program. ($25,876)	Continue the development of resources and technologies and emphasize automation and robotization of state-of-the-art capabilities for sequencing DNA; promote the development of innovative DNA sequencing technologies including direct imaging methods; design and apply the software needed to manage and analyze data; begin the linear ordering of sets of DNA fragments for additional chromosomes; provide support for distribution of these resources from National Laboratories; establish human genome postdoctoral fellowships for training interdisciplinary specialists; and facilitate transfer of technologies from labs to the private sector. Emphasize the development of new innovative DNA sequencing strategies and the computational capabilities needed to manage and manipulate physical map and DNA sequence data; expand the effort to construct physical maps of each human chromosome. ($45,892)
	No activity. ($0)	Implementation plans for the Energy Sciences Network (ESNET) project, identified in the applied mathematical sciences subprogram of the Basic Energy Sciences program will proceed. This subprogram's share for the implementation of ESNET is $99.	Upgrades of ESNET to conform to the National Research and Education Network standards will cotinue to be pursued and will be shared among ER programs that benefit from ESNET.
	$ 17,505	$ 25,975	$ 45,892
General Life Sciences	$ 45,391	$ 56,244	$ 80,162

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Medical Applications

Medical Applications research involves a wide range of projects directed to clinical and other benefical applications of energy-related technologies. Radiopharmaceuticals research involves development of and/or biomedical studies with new radiopharmaceuticals, largely in studies of brain and heart metabolism, but also in diagnosis and therapy involving other organs. Clinical feasibility research includes in-vivo testing of new radiopharmaceuticals in animals and subsequently in selected patients. Methods are evaluated for the study, diagnosis, and treatment of disease such as cardiopulmonary disease, mental disorders, cancer, and metabolic disorders. The instrumentation program focuses primarily on advanced detector research, improved resolution of positron emission tomography and other imaging techniques. Particle beam, heavy ion therapy, and boron neutron capture therapy research is conducted to treat inoperable tumors in the brain.

II. A. Summary Table: Medical Applications

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Stable Isotope Research	$ 800	$ 788	$ 940	+ 19
Radioisotope Development	3,153	2,552	2,600	+ 2
Radiopharmaceuticals	16,000	18,397	18,400	0
Instrumentation	3,097	3,333	3,315	- 1
Clinical Feasibility	3,757	4,616	4,525	- 2
Boron Neutron Capture Therapy	9,346	7,621	7,235	- 5
Total, Medical Applications	$ 36,153	$ 37,307	$ 37,015	- 1

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory	$ 392	$ 378	$ 380	+ 1
Brookhaven National Laboratory	$ 6,777	$ 7,358	$ 8,500	+ 16
Idaho National Engineering Laboratory - EG&G	$ 6,527	$ 5,191	$ 3,200	- 38
Lawrence Berkeley National Laboratory	$ 2,885	$ 2,775	$ 2,705	- 3
Lawrence Livermore National Laboratory	$ 560	$ 607	$ 400	- 34
Los Alamos National Scientific Laboratory	$ 2,900	$ 1,908	$ 2,435	+ 28
Mound Facility	$ 750	$ 493	$ 500	+ 1
Oak Ridge Associated Universities	$ 1,024	$ 855	$ 881	+ 3
Pacific Northwest Laboratory	$ 13	$ 12	$ 13	+ 8
Oak Ridge National Laboratory	$ 1,700	$ 1,771	$ 1,818	+ 3

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

Program Activity	FY 1989	FY 1990	FY 1991
Medical Applications			
Stable Isotope Research	Completed studies of the applications of stable isotopes to the study of biological systems at LANL. Continued FY 1988 activities on the development and separation technique for stable isotopes and on the development of microwave spectroscopy for determining isotope ratios. ($800)	Continue FY 1989 program level of activity. Initiate research on the applications of NMR spectroscopy to provide a noninvasive, non-radioactive method to investigate structure and metabolism in vivo in real time. ($788)	Continue research on the development of advanced nuclear magnetic reasonance techniques for imaging the distribution of stable isotopes in humans and animals in real-time without use of ionizing radiation. ($940)
	$ 800	$ 788	$ 940
Radioisotope Development	Continued FY 1988 program level of activity. Initiated feasibility study for single photon emission computed tomography. ($3,153)	Continue FY 1989 program and initiate efforts to produce new radionuclides to support the research on monoclonal antibodies and PET. ($2,552)	Identify new radionuclides which provide new methods of diagnosis and therapy and aid in quantitative assessment of biochemical processes and perform nuclear and chemical research for their production. ($2,600)
	$ 3,153	$ 2,552	$ 2,600
Radiopharmaceuticals	Continued FY 1988 program for new radiopharmaceuticals labeled with positron and single photon radionuclides to study details of biochemical processes on a quantitative and non-invasive basis. Continued immunoconjugates/PET research.	Continue FY 1989 program and initiate efforts to apply advanced computational techniques from the field of quantum pharmacology to increase our knowledge of identifying mechanisms and pathways of diffusion, transport and segregation of chemical compounds in target tissues and organs.	Continue FY 1990 program and improve development of receptor-binding agents for more selective localization of various radionuclides in specific tissues or organs. Develop a more complete understanding of the basic radiochemistry for improved Tc-99m agents for brain and heart imaging. ($18,400)
	$ 16,000	$ 18,397	$ 18,400

III. Medical Applications (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Instrumentation	Research on positron emission tomography, magnetoencephalography and other medical imaging instrumentation continued. The feasibility of magnetic resonance imaging of stable isotopes in the body was explored. Development of a new portable device for rapid, bedside evaluation of pulmonary edema was completed. ($3,097)	A new approach to ultra-high resolution positron emission tomography which will eliminate the need for mechanical sampling motion and which can be extended to a multi-ring configuration will be tested. Single photon emission computed tomography (SPECT) is an established and very useful technique to detect a variety of tumors and other lesions. New detection concepts will be examined which offer high sensitivity and spatial resolution along with mechanical simplicity. High intensity monochromatic x-ray beams from synchrotron light sources share great promise in imaging coronary arteries for early detection of heart disease. Development of technology for other potential applications in neuroradiology and tumor diagnosis will be initiated. ($3,333)	Research on high resolution Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) systems will be 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 will be 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 will be 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 will be completed. Development of magnetoencephalography instrument for non-invasive brain function studies will be continued. ($3,315)
	$ 3,097	$ 3,333	$ 3,315
Clinical Feasibility	Rubidium-82 was studied as a possible blood brain barrier permeability marker for evaluation of the radiation effects from heavy ion radiotherapy.	Pet with Rb-82 will be used to evaluate the integrity of the blood-brain barrier in 50 patients who have undergone radiotherapy. The study will be 2 to 5 years in duration.	Continue FY 1990 program, and develop pharmacologic strategies to enhance retention of radiolabeled monoclonal antibodies (MoAbs) in tumor cell targets.
	Approximately 15 patients were studied for the response of normal tissue at periods of one month and six month post treatment. The usefulness of copper-64 in cardiovascular disease and soft tissue tumors as well as hepatic disease was investigated.	Absolute measurement of radionuclide uptake in patients will be validated using a calibration phantom methodology.	Develop a novel method to covalently link stable clusters of gold atoms to antibodies to improve antigenic specificity and capacity.

III. Medical Applications (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Clinical Feasibility (Cont'd)	Verification of dosimetry predictions and therapy feasibility in patients using selected iodine-131 and copper-67 radioimmunopharmaceuticals was studied.	Continue development and assessment of new radiochemically engineered radioimmunopharmaceuticals.	Use clinically relevant isotopes Iodine-131, Indium-111, and Yttrium-90, conjugated to monoclonal and polyclonal antibodies to develop improved SPECT imaging for treatment planning for cancer patients undergoing radioimmunotherapy.
	Research into the therapeutic and diagnostic applications of heavy ion beams was expanded and the possibility of applying radioactive beam techniques to cerebral blood flow measurement was explored. Continued clinical trials of synchrotron x-ray angiography. ($3,757)	Develop stereotactic heavy-ion radiosurgery using heavier charged particles at the Bevalac, taking advantage of the physical characteristics of carbon and neon for improved dose-localization and dose-distribution in brain and to transfer the technology to the public sector. ($4,616)	Develop a better understanding of time-dose-volume-fractionation relationships for heavy-ion focal irradiation of human brain. ($4,525)
	$ 3,757	$ 4,616	$ 4,525
Boron Neutron Capture Therapy	Data on the second generation compound, boron sulfhydrl (BSH) has been submitted to FDA for an IND for pharmacokinetic studies involving critically ill glioma patients.	New chemical approaches to third generation boron compound development will be initiated. The most promising boron-containing compounds, nucleosides, porphyrins, low density lipoproteins, amino acids, antibodies and liposomes will be tested in animal tumor models.	Work described in the previous years will continue. BNCT clinical trials with second generation compounds will be initiated. Efforts will be initiated to target boron to other types of tumors.
	Pharmacokinetics of boron compounds in normal and tumor-bearing rats was continued as well as studies of toxic effects and survival of irradiated glioma cells with and without boron.	The development of rapid methods for measuring boron concentrations in blood and tissues will continued.	Continue to develop a more thorough knowledge of the boron kinetics and the toxicity of the third generation compounds.
	Pharmacokinetics studies of spontaneous canine brain tumors, blood clearance studies in normal dogs, effectiveness studies of beam components, and tolerance of normal brain to neutron irradiation was also conducted.	Examination of normal endothelial cell damage will be further evaluated. Complete sufficently detailed studies of crucially important biological and biochemical parameters of BNCT using proven in vivo experimental brain tumor models.	

III. Medical Applications (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Boron Neutron Capture Therapy (Cont'd)	Studies were begun on the treatment of human malignant melanoma cell lines in vitro. Boron compound biodistribution and tumor uptake experiments with the human melanoma cells in nude mice were initiated.	The in vitro cell irradiations will be finished. Fractioned dose experiments will be initiated in human melanoma models. Studies will be initiated to directly compare the efficiency of thermal and epithermal neutron beams for treatment of malignant melanoma.	The BNCT experiments of single session irradiations in the human melanoma model will be finished. The fractionated BNCT experiments will continue; the results will be compared to single session treatment. The comparison of thermal and epithermal neutron beams for BNCT in the rabbit eye tumor model will be completed.
	Studies were initiated on the development of a non-reactor source of epithermal neutrons. The aim is to develop a versatile neutron irradiation facility for BNCT based on accelerator production of epithermal neutrons via 7Li(p,n)7Bc nuclear reaction.	Neutron and proton transport simulations will be completed to aid in the design of neutron collimators and shielding for tissue and tumor irradiation. Studies will be initiated to characterize the proton beam interaction with lithium and verify the characterisitcs of the epithermal neutrons.	Neutron and proton transport studies will be completed. Experiments will be designed to measure neutron and photon spectra to verify the calculated performance of the lithium target and the neutron collimator.
	$ 9,346	$ 7,621	$ 7,235
Medical Applications	$ 36,153	$ 37,307	$ 37,015

DEPARTMENT OF ENERGY
FY 1991 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, 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 1991 to accelerate global warming research particularly in the area of rapidly improving the capability to predict global and regional climate change. Empahsis is placed on experimental studies of the cloud-climate feedback and on innovative hardware-software applications to the advanced climate models.

II. A. Summary Table: Carbon Dioxide Research

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Carbon Cycle	$ 3,425	$ 3,200	$ 3,200	0
Climate Modeling and Diagnostics	6,954	20,000	24,000	+ 20
Oceans Research	714	3,000	3,000	0
Quantitative Links	0	13,000	21,000	+ 62
Vegetative Effects	3,787	7,200	7,200	0
Resource Analysis and Education	1,200	1,800	5,700	+217
Information and Integration	1,289	1,846	1,800	- 2
Total, Carbon Dioxide Research	$ 17,369	$ 50,046	$ 65,900	+ 32

II. B. Major Laboratory and Facility Funding

Brookhaven National Laboratory	$ 1,030	$ 1,134	$ 1,445	+ 27
Oak Ridge Associated Universities	$ 0	$ 142	$ 0	-100
Lawrence Berkeley National Laboratory	$ 0	$ 0	$ 250	>999
Lawrence Livermore National Laboratory	$ 3,770	$ 4,551	$ 7,079	+ 56
Oak Ridge National Laboratory	$ 4,845	$ 2,506	$ 5,710	+128
Pacific Northwest Laboratory	$ 1,714	$ 886	$ 2,800	+216

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

Program Activity	FY 1989	FY 1990	FY 1991
Carbon Dioxide Research			
Carbon Cycle	Continued to study global sources and sinks of CO2 and other greenhouse gases. ($3,425)	Continue to study global sources and sinks of CO2 and other greenhouse gases. Start the development of an operational carbon cycle model. ($3,200)	Continue acquisition of emissions and atmospheric CO2 data; pursue the development of ocean-atmosphere CO2 models and initiate the parameterization of terrestrial-atmospheric CO2 exchange. Develop an operational global carbon cycle model and apply to scenarios of global energy emissions and changing properties of the global carbon system. Expand acquisition of data on global sources and sinks of CO2, methane and other greenhouse gases and incorporate biological process functions into global carbon cycle models. Explore how natural processes (e.g. reforestation) and biotechnology can alter fluxes of CO2 and methane to slow the rate of atmospheric increase. Identify natural and anthropogenic feedbacks between the global carbon system and climate. ($3,200)
	$ 3,425	$ 3,200	$ 3,200
Climate Modeling and Diagnostics	Implemented the global climate diagnosis and intercomparison program with added scientific collaboration with Canada, Germany and the USSR, and conducted research to improve global data and methods to simulate clouds. ($6,954)	Continue implementation of the climate modeling diagnostic program at LLNL. Commence diagnostic experiments with fixed ocean surface termperature and continue comparisons of model output to observe data for various historical records. Start development of required data bases over long time periods and multiple climate elements. ($12,000)	Complete implementation of the climate modeling diagnostic program at LLNL. Complete diagnostic experiments with fixed ocean surface temperatures and begin experiments to test model validity on select cases of regional interannual variability; continue comparisons of model output to observe data for the prehistorical, historical and modern records. Expand development of required data bases over long time periods and multiple climate elements (e.g. extreme events). Expand numerical experiments within the model diagnostic research program to include

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Climate Modeling and Diagnostics (Cont'd)			increased model resolution and improved convection algorithms. ($12,000)
		Launch research activities associated with the DOE Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP) program. Through an open solicitation process a science team will be selected to identify and explore the most promising approaches to rapidly improving climate modeling capabilities. ($5,000)	Expand research activities associated with the Computer Hardware, Advanced Mathematics and Model Physics (CHAMMP) initiative. Applications of innovative hardware systems such as massively-parallel processing or "thinking machine" concepts will be made to the set of differential equations simulating the climate system. Corresponding advances are expected in the associated software algorithms. Hardware and software improvements are expected to pave the way to the next generation physical parameterizations of the key processes of the climate system. The objective is to develop climate change predictive capability at the regional level. ($5,000)
		Utilize the eight-processor Cray 2 and its successor Cray 3 to provide enhanced supercomputing capability to the climate modeling community. ($2,699).	A significant fraction of DOE's Cray 3 supercomputer will be dedicated to climate modeling activities. This will allow extended climate prediction runs for both the current climate models as well as for the first version of the Advanced Climate Model (ACM) being developed by CHAMMP. ($3,000). A critical data needs study will be undertaken to determine suitability of data sets to first detection potentials as well as to climate model initialization and validation. ($4,000).

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Climate Modeling and Diagnostics (Cont'd)	No activity. ($0)	Implementation plans for the Energy Sciences Network (ESNET) project, identified in the applied mathematical sciences subprogram of the Basic Energy Sciences program will proceed. This subprogram's share for the implementation of ESNET is $301.	Upgrades of ESNET to conform to the National Research and Education Network standards will continue to be pursued and will be shared among ER programs that benefit from ESNET.
	$ 6,954	$ 20,000	$ 24,000
Oceans Research	Supported ocean carbon measurements in cooperation with the international World Ocean Circulation Experiment (WOCE). ($714)	Continue to support the ocean carbon measurements in cooperation with the international World Ocean Circulation Experiment (WOCE) and the Global Ocean Flux Study (GOFS), including the sea measurements, onshore laboratory verification and data processing. Expand the research to include the ocean's ability to store and transport carbon particularly by studying the ocean's biology and the climate feedback on ocean biology. ($3,000)	Continue to support the ocean carbon measurements in cooperation with the international World Ocean Circulation Experiment (WOCE) and the Global Ocean Flux Study (GOFS), including the sea measurements, on shore laboratory verification and data processing. Expand the research to include the ocean's ability to store and transport carbon particularly by studying the ocean's biology and the climate feedback on ocean biology. Initiate experiments and ocean modeling with high resolution grids to explore processes such as those controlling the formation of deep water. ($3,000)
	$ 714	$ 3,000	$ 3,000
Quantitative Links	No activity.	Launch the Atmospheric Radiation Measurement (ARM) Program to validate the radiative codes used in climate models as well as improve the cloud-climate feedback parameterizations. Through an open solicitation create the science team to develop the research strategy and start instrument development activity. ($10,000)	Principal activity is the Atmopsheric Radiation Measurement (ARM) Program; this research involves the acquisition of high quality radiation measurements in the atmospheric column as well as the vertical profiles of the atmospheric characteristics responsible for the radiative balance. 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 for this

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Quantitative Links (Cont'd)			fiscal year include the development of ground based remote sensing instrumentation, site selection and preparation of the first fixed ARM site. Also planned is participation in campaign studies associated with the First International Satellite Cloud Climatology Project Research Experiment (FIRE) field study primarily with instruments of the mobile ARM unit. ($17,000)
		Commence research activities to quantify the link between the rise of atmospheric greenhouse gases and climate change. ($3,000)	Support experimental studies to quantify the link between the rise of atmospheric greenhouse gases and climate change. Examples inlcude a sound propagation field program to identify an ocean warming signal and studies of stratospheric temperature measurements. ($4,000)
	$ 0	$ 13,000	$ 21,000
Vegetative Effects	Continued experiments and began agro-ecological systems modeling. ($3,787)	Continue experimental research and modeling to determine the simultaneous influence of CO2 and climate change on selected plants. Plan a large scale field study to control/manipulate ecological, atmospheric and other environmental conditions to provide validation information for ecological models. ($7,200)	Continue experimental research and modeling to determine the simultaneous influence of CO2 and climate change on selected plants, with emphasis on photosynthesis and growth in relation to variable CO2 and temperature. Launch a large scale field study to control/manipulate ecological, atmospheric and other environmental conditions to provide validation information for ecological models. Search for existing evidence of biological response to changes in atmospheric CO2 and climate of the past few decades. Explore approaches for enhancing plant productivity to accelerate CO2 removal from the atmopshere. ($7,200)

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Vegetative Effects (Cont'd)	$ 3,787	$ 7,200	$ 7,200
Resource Analysis and Education	Conducted analysis to investigate potential CO2 reductions through energy strategic planning. Identified regions in jeopardy and the potential effects on resources. ($1,200)	Conduct a study of the Midwestern United States to identify the methodology for identifying the resources in jeopardy from climate change. ($1,800)	A preliminary study of the Midwestern United States will demonstrate the methodology for identifying the resources in jeopardy from climate change. Expand the methodology for resource analysis to include China and Western Europe as well as additional regions in the USA. ($1,700) 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. ($4,000)
	$ 1,200	$ 1,800	$ 5,700
Information and Integration	Continued activities of the Carbon Dioxide Information and Analysis Center and expanded global networking. ($1,289)	Further develop the Carbon Dioxide Information and Analysis Center in order to meet the requirements of a World Data Center. Start newsletters on ARM and CHAMMP. Perform studies of the balance and scope of the climate change research program. ($1,846)	The Carbon Dioxide Information and Analysis Center will continue to compile, evaluate and distribute CO2-related information. The Center identifies research needs for data, models and information; obtains, evaluates and quality assures the data; and works with other national and international data centers to promote useful data exhanges. This fiscal year the Center will be fully developed to meet the additional requirements imposed by its pending membership as a World Data Center. The Center will continue to issue newsletters on ARM and CHAMMP. ($1,800)
	$ 1,289	$ 1,846	$ 1,800

III. Carbon Dioxide Research (Cont'd):

Program Activity	FY 1989	FY 1990	FY 1991
Carbon Dioxide Research	$ 17,369	$ 50,046	$ 65,900

DEPARTMENT OF ENERGY
FY 1991 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.

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

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Salaries and Expenses	$ 3,441	$ 4,281	$ 5,530	+ 29
Other	559	255	270	+ 6
Total, Biological and Environmental Research Program Direction	$ 4,000	$ 4,536	$ 5,800	+ 28

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

Program Activity	FY 1989	FY 1990	FY 1991
Biological and Environmental Research Program Direction			
Salaries and Expenses	Provided funds for salaries, benefits, and travel for 54 full-time equivalents (FTE's) in the Office of Health and Environmental Research and related program and management support. Provided guidance and support for over 850 active research projects (reviewing and evaluating many hundreds more throughout the proposal selection process) and conducted major reviews of the numerous BER-sponsored programs at laboratories and universities. Addressed escalating environment, safety and health (ES&H) issues as they pertained to program facilities and was heavily involved in research on the human genome, radon and nuclear medicine as well as international collaboration on radiation biology programs. Increased staff effort on global warming, mixed waste remediation, and technology transfer issues. Maintained close liaison with other DOE programs, other Federal agencies, and the scientific, academic and industrial communities and provided the program and management support services required to carry out the program.	Provide funds for salaries, benefits, and travel for 55 FTE's included in the FY 1990 budget including normal increased personnel costs. A revised request for ten additional FTE's will provide enhanced management oversight of ES&H activities and for basic research in support of National goals to promote health and safety. Two of the additional FTE's will provide increased line management capability to ensure compliance with ES&H directives and regulations at numerous nonreactor research facilities. Appraise contractor ES&H performance and ensure safe disposal of spent fuels and other byproducts and wastes. Two additional FTE's are also required to enhance the Office of Energy Research's independent ES&H oversight capability to carry out responsibilities involving nuclear safety, health physics, occupational safety and industrial hygiene, environmental protection, hazardous waste management, safeguards and security, emergency preparedness, and quality assurance. Perform safety appraisals and environmental compliance audits. Six additional FTE's will provide technical expertise for the human genome program which is experiencing significant growth and which has been identified by several advisory groups as having major health and economic benefits; for expansion and increased emphasis nationally and internationally on global climate change and global warming; and for the Secretary's initiative for an expanded epidemiology program including	Provide funds for salaries, benefits and travel for 65 FTE's. The increased funding will provide for 10 additional FTE's above the FY 1990 budget level, as discussed in FY 1990, and for normal increased personnel costs resulting, for example, from within-grade and merit increases and the impact of the FY 1990 general and executive pay raises. In addition to enhanced ES&H line management and independent oversight, provide increased management capability for increased R&D and liaison activities in areas such as human genome, global warming, and epidemiology. The latter includes establishing a Comprehensive Epidemiological Data Repository for use by any qualified researcher. Staff will manage access to the data in the Repository as well as manage additional projects and studies. The global warming program requires additional effort to manage the significant expansion into untapped research communities, including critical atmospheric experiments, advanced computer networks, and understanding the processes of climate change and the carbon cycle. Contribute directly to the safety of DOE's operations and programs, and advance knowledge and instruments for application in the medical field. Continue to closely coordinate programs with other programs and agencies, nationally and internationally, to meet needs and avoid duplication. The research conducted in the Biological and Environmental Research program

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

Program Activity	FY 1989	FY 1990	FY 1991
Salaries and Expenses (Cont'd)		establishment of a Comprehensive Epidemiological Data Repository and a new effort in offsite studies.	continues to support other DOE programs and development of sound energy policy and has significant human health benefits.
	$ 3,441	$ 4,281	$ 5,530
Other	Provided for a variety of program support such as printing and editing, supplies, services, materials, 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.	Continue the variety of program support required in FY 1989.	Continue the variety of program support required in FY 1990.
	$ 559	$ 255	$ 270
Biological and Environmental Research Program Direction	$ 4,000	$ 4,536	$ 5,800

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

I. Preface: Facilities Operations

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

II. A. Summary Table: Facilities Operations

Program Activity	FY 1989 Actual	FY 1990 Estimate	FY 1991 Request	% Change
Capital Equipment	$ 8,965	$ 11,272	$ 11,621	+ 3
Construction	23,500	22,149	3,485	- 84
Total, Facilities Operations	$ 32,465	$ 33,421	$ 15,106	- 55

II. B. Major Laboratory and Facility Funding

Ames Laboratory	$ 65	$ 34	$ 35	+ 3
Argonne National Laboratory	$ 730	$ 621	$ 630	+ 1
Brookhaven National Laboratory	$ 1,093	$ 937	$ 950	+ 1
Environmental Measurements Laboratory	$ 380	$ 384	$ 390	+ 2
Inhalation Toxicology Research Institute	$ 1,155	$ 453	$ 1,145	+153
Laboratory of Radiobiology and Environmnetal Health	$ 150	$ 148	$ 150	+ 1
Lawrence Berkeley National Laboratory	$ 1,305	$ 666	$ 800	+ 20
Los Alamos National Scientific Laboratory	$ 1,854	$ 1,030	$ 750	- 27
Oak Ridge Associated Universities	$ 300	$ 295	$ 300	+ 2
Oak Ridge National Laboratory	$ 1,175	$ 1,159	$ 1,175	+ 1
Pacific Northwest Laboratory	$ 3,255	$ 5,313	$ 5,350	+ 1
Savannah River Ecology Laboratory	$ 25	$ 24	$ 25	+ 4
Savannah River Laboratory	$ 20	$ 19	$ 20	+ 5
Lawrence Livermore National Laboratory	$ 850	$ 798	$ 800	0

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

Program Activity	FY 1989	FY 1990	FY 1991
Facilities Operations			
Capital Equipment	Capital equipment budget was maintained at FY 1988 level with a minor adjustment for cost of living. ($8,965)	Maintain basic capital equipment budget at FY 1989 level with adjustment for cost of living. ($8,057) Provide advanced technologies for subsurface research program to design and instrument a prototype intermediate scale experimental system for integrated experiments in geochemistry/microbiology under conditions of simulated groundwater flow. No such capability exists nationally. ($1,775) Equipment funds are required for the carbon dioxide research program connection to the MFENET and for the special work stations required to support the advanced graphic display and analyses of the output of the General Circulation Models (GCMs) experiments, and for Geographic Information System (GIS) equipment for data digitizing and analysis. ($1,440)	Maintain capital equipment budget at approximately last years level, while providing for increased emphasis to needs of the human genome and carbon dioxide research.
	$ 8,965	$ 11,272	$ 11,621
Construction	The general plant project budget was maintained at the FY 1988 level. ($3,500) Funds were provided to support university construction projects. ($20,000)	Maintain general plant project budget at approximately FY 1989 level. ($2,429) Funds are provided to support university construction projects. ($19,720)	Maintain general plant project budget at last years level. ($3,485)
	$ 23,500	$ 22,149	$ 3,485
Facilities Operations	$ 32,465	$ 33,421	$ 15,106

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Biological and Environmental Research

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1990 Appropriation	FY 1991 Request	Unappropriated Balance	TEC
GPE-120	General Plant Projects	$ XXX	$ 2,429	$ 3,485	$ 0	$ XXX
-------	University Construction Projects	XXX	19,720	0	0	XXX
Total, Biological and Environmental Research Construction		$ XXX	$ 22,149	$ 3,485	$ 0	$ XXX

DEPARTMENT OF ENERGY
FY 1991 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: $ 3,485
Start Date: FY 1991
Completion Date: FY 1993

2. Financial schedule:

		Costs			
Fiscal Year	Obligations	FY 1989	FY 1990	FY 1991	After FY 1991
Prior Year Projects	XXXXXXX	$ 2,640	$ 1,405	$ 450	$ 485
FY 1989 Projects	$ 3,500	597	350	400	2,153
FY 1990 Projects	$ 2,429	0	700	450	1,279
FY 1991 Projects	$ 3,485	0	0	700	2,785

3. Narrative:

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

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 needs as a landlord responsibility for the Pacific Northwest Laboratory and for other laboratories and universities.

4. Total Project Funding (BA)	Prior Years	FY 1989	FY 1990	FY 1991 Request	To Complete
Construction	XXX	$3,500	$2,429	$3,485	XXX

DEPARTMENT OF ENERGY
FY 1991 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
ENVIRONMENTAL R & D
BIOLOGICAL AND ENVIRONMENTAL RESEARCH
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General plant projects

2. Project No.: GPE-120

3. Date A-E work initiated: 1st Qtr. FY 1991

3a. Date physical construction starts: 2nd Qtr. FY 1990

4. Date construction ends: 2nd Qtr. FY 1993

5. Previous cost estimate: None
Date:

6. Current cost estimate: $3,485
Date: September 1989

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1989	Costs FY 1990	Costs FY 1991	Costs After FY 1991
Prior Year Projects	XXXXXXXX	$ 2,640	$ 1,405	$ 450	$ 485
FY 1989 Projects	$ 3,500	597	350	400	2,153
FY 1990 Projects	2,429	0	700	450	1,279
FY 1991 Projects	3,485	0	0	700	2,785

8. Brief Physical Description of Project

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

1. Title and location of project: General plant projects 2. Project No.: GPE-120

8. Brief Physical Description of Project (Continued)

Although it is difficult to detail this type project in advance, all of the subprojects identified below are under consideration. In general, the estimated costs for each of the subprojects are preliminary in nature, with a project limitation of $1,200,000, and primarily indicative of the size of the project. Since needs and priorities may change, other projects may be substituted for the examples listed below, and some of these may be located on non-Government owned property. These general plant projects will provide facilities for conducting critical research programs, contribute to greater efficiency, eliminate health and safety hazards, and will reduce maintenance and operational costs.

The estimate is based on requirements by office as follows:

Summary by Office	
Albuquerque Operations Office	$ 685
Oak Ridge Operations Office	50
Richland Operations Office	2,000
San Francisco Operations Office	350
Headquarters	400
Total	$ 3,485

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

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

Albuquerque Operations Office

Inhalation Toxicology Research Institute..... $ 685

Animal buildings HVAC upgrade and other emergency repairs.

1. Title and location of project: General plant projects — 2. Project No.: GPE-120

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

Oak Ridge Operations Office	
Oak Ridge Associated Universities	50
Building addition to Vance Road Facility.	
Richland Operations Office	
Pacific Northwest Laboratory	2,000
Miscellaneous capital work orders, e.g., laboratory additions, improvements, and modifications.	
San Francisco Operations Office	
Lawrence Livermore National Laboratory	350
New biomedical facilities.	
Washington Headquarters	
Unanticipated emergency repairs	400

10. Details of Cost Estimate

Based on preliminary conceptual design.

11. Method of Performance

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