

DEPARTMENT OF ENERGY  
FY 1990 CONGRESSIONAL BUDGET REQUEST  
OFFICE OF ENERGY RESEARCH

OVERVIEW

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

The mission of the Department of Energy (DOE) has brought with it major responsibilities and opportunities in the life sciences. The responsibilities stem from concerns that the energy technologies, which contribute so substantially to the material well being of the American people, may also have adverse health and environmental impacts. The opportunities arise because many of these same technologies, and the intellectual and physical resources underlying their development, have made major contributions to the health and welfare of society, and hold promise for even greater contributions in the future. A central goal of the Biological and Environmental Research (BER) program is to maximize the opportunities of new technologies for the nation while helping to minimize the dangers and adverse affects due to them.

The BER program has two main objectives: (1) to develop the knowledge base necessary to identify, understand and anticipate the long-term health and environmental consequences of energy use and development; and (2) to utilize the Department's unique scientific and technological capabilities to solve major scientific problems in medicine and biology.

Major program activities performed to achieve these objectives include:

- 0 Biological research to quantify human health risks of exposure to radiation and chemicals via epidemiological studies, with increasing emphasis on molecular, biochemical and cellular endpoints; and research to correlate the relation between local dose, molecular changes and biological responses, especially carcinogenesis and mutagenesis with model cellular and animal systems. Such efforts are contributing to the resolution of: hazards of indoor radon exposure; attributable risk of cancer and genetic damage from radiation and copollutant exposures; risk coefficients for actinides and fission products; and neutron quality factors for the nuclear industry.

- 0 Life science research emphasizing molecular and cellular studies to elucidate how key biological processes operate, including structural biology to define structure/function relationships of macromolecules so crucial for advances in biotechnology. Another major focus is in molecular genetics to reveal DNA damage and repair mechanisms and to improve tools and methodology for deciphering the nature of the human genome. Success will establish at the genetic level: the basis for individual susceptibility to disease (e.g. cancer, heart disease); the technology to define risks; and the data base for establishing health protection standards. Other technology transfer benefits will also be derived from such research by improving options for environmental waste control, producing and utilizing biomass, agriculture, industrial biotechnology and the diagnosis and treatment of genetic disease.
- 0 Measurement science and dosimetry research to develop new and more sensitive technologies for physical, chemical and biological measurements of energy-related emissions, human exposures and their responses.
- 0 Nuclear medicine research to develop new radioisotopes, labeled compounds, clinical procedures, including boron neutron capture therapy, and visualization devices for improved diagnosis and treatment of human diseases and the study of human physiological processes, such as brain and heart function. Current efforts are beginning to develop high field nuclear magnetic resonance spectroscopy for studying metabolic regulation in intact organs and to exploit synchrotron radiation for a safer angiography assay.
- 0 Environmental sciences research to determine the pathways and mechanisms by which energy-related agents move through and are modified by the atmosphere, oceanic and terrestrial ecosystems to impact humans; and to determine how the environment itself may be affected and the impacts mitigated. Issues being addressed include acid rain; carbon dioxide and global climate effects; resiliency of ecosystems and marine coastal areas to energy activities; management of radiation and chemical wastes; and atmospheric and landscape modeling of impacts from energy development in different terrains.

This program has sponsored research into the biological consequences of exposure to ionizing radiation since the initial stages of the Manhattan Engineering District. A National Radiobiology Repository is needed to bring together this information in a common, comprehensive resource. One DOE laboratory will be designated as the repository site and will gather and catalog materials from researchers throughout the United States. The database and information repositories will be a resource for those interested in interspecies modeling to humans, comparison of various modalities of radiation exposure, extrapolation to low doses, and microdosimetry.

The structural biology program, although small, is a highly regarded program of research built primarily around unique user-type facilities at DOE laboratories. This program is ready to expand, and thus stimulate progress in biotechnology and technology transfer by taking advantage of unique research resources that exist in DOE laboratories.

An ongoing effort will be expanded in FY 1990 to develop new information for cost-effective management and remediation of contamination from DOE wastes. Research will: emphasize the development of accurate, noninvasive and inexpensive methods such as fiber optic sensors and seismic tomography to eliminate costly well drilling with its potential for cross contamination of aquifers when assessing subsurface wastes; improve our understanding of the factors influencing mobility of mixed wastes through soil in order that shallow low-level burial sites can be operated more safely and cost effectively; and develop new methods for decontaminating subsurface toxic organic wastes.

The human genome project, formally initiated by BER in FY 1987, is increasingly being recognized by the scientific community here and abroad as one of modern biology's most significant initiatives. The Department's role reflects: the necessary combination of intellectual and physical resources (including engineering, computational and biomedical expertise); the experience and infrastructure for managing high technology, interdisciplinary projects involving national laboratories, universities and industry; and, of course, the mission need for the project's results. The new tools and methodologies to be developed under this project will markedly increase the pace and lower the cost for mapping and sequencing the human genome, saving 1-2 billion dollars and 50-100 years in time over current capabilities. The proposed level of effort will enable DOE to maintain its momentum in this area. This year, the program will include initiation of physical mapping efforts for chromosomes where this is not already underway, provide necessary support to DOE Human Genome Centers and other large interdisciplinary efforts to create the critical mass necessary to most effectively develop needed new technologies, build prototype technology for testing and validation, and begin pilot sequencing projects to evaluate and compare new sequencing technologies.

Carbon dioxide and the greenhouse effect linked to global climate change has become a national and international science and energy policy issue and is emerging as a major issue. The current science base for the carbon dioxide issue is not ready for energy policy action. Additional funds are requested in FY 1990 to provide for the extension of data necessary for developing future energy policy options.

DEPARTMENT OF ENERGY  
 FY 1990 CONGRESSIONAL BUDGET REQUEST  
 OFFICE OF ENERGY RESEARCH  
 (Dollars in Thousands)

LEAD TABLE  
 Biological and Environmental Research

Activity	FY 1988 Actual	FY 1989 Estimate	FY 1990 Base	FY 1990 Request	Program Change Request vs Base	
					Dollar	Percent
Biological and Environmental Research.....	\$198,379	\$221,002	\$221,002	\$250,865	+ 29,863	+ 14%
Program Direction.....	4,000	4,000	4,000	4,600	+ 600	+ 15%
Capital Equipment.....	8,500	9,000	9,000	12,500	+ 3,500	+ 39%
Construction.....	56,200	23,500	23,500	3,500	- 20,000	- 85%
<b>Total.....</b>	<b>\$267,079 a/</b>	<b>\$257,502</b>	<b>\$257,502</b>	<b>\$271,465</b>	<b>+ 13,963</b>	<b>+ 5%</b>
Operating Expenses.....	(\$202,379)	(\$225,002)	(\$225,002)	(\$255,465)	+ 30,463	+ 14%
Capital Equipment.....	(8,500)	(9,000)	(9,000)	(12,500)	+ 3,500	+ 39%
Construction.....	(56,200)	(23,500)	(23,500)	(3,500)	- 20,000	- 85%
Staffing Total FTE's						
Headquarters.....	54	55	55	55	--	--
Field.....	86	87	87	87	--	--
<b>Total.....</b>	<b>140</b>	<b>142</b>	<b>142</b>	<b>142</b>	<b>--</b>	<b>--</b>

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

a/ Total has been reduced by \$2,401,000 which has been transferred to SBIR.

DEPARTMENT OF ENERGY  
 FY 1990 CONGRESSIONAL BUDGET REQUEST  
 ENERGY SUPPLY RESEARCH AND DEVELOPMENT  
 (dollars in thousands)

SUMMARY OF CHANGES

Biological and Environmental Research

FY 1989 Appropriation.....	\$257,502
- Continue radiation and chemical dosimetry, sustain measurement technology and instrumentation.....	+ 1,418
- Increase field and laboratory studies on transport and transformation of chemicals through atmospheric and marine systems related to global warming.....	+ 2,379
- Enhance studies in understanding movement, immobilization and degradation of mixtures of radioactive, organic and trace elements in relation to physical, chemical and microbiological properties in the subsurface.....	+ 4,575
- Maintain epidemiologic, biological markers studies, and long-term experimental animal research on radiation and complex chemical mixtures provide for a National Radiobiology Respository.....	+ 2,955
- Expand structural biology research; continue research in molecular genetics, cell biology, and chemical physics.....	+ 4,171
- Increase efforts on nuclear medicine feasibility studies and related instrumentation..	+ 2,164
- Continue boron neutron capture therapy program at INEL.....	- 1,139
- Expand carbon dioxide research program to reduce uncertainties concerning the effects of increased atmospheric CO2, expand programs for policy analysis and research concerning the global climate change issue.....	+ 3,240

- Continue to enhance efforts on mapping the entire human genome.....	+10,100
- Provide for salary increases and related expenses.....	+ 600
- Maintain capital equipment for base program needs and provide increase for carbon dioxide and subsurface research programs.....	+ 3,500
- No provision for funding of Congressional initiated university construction projects in FY 1989.....	<u>-20,000</u>
FY 1990 Congressional Budget Request.....	\$271,465

DEPARTMENT OF ENERGY  
 FY 1990 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.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Dosimetry Research.....	\$ 8,933	\$ 9,364	\$ 9,886	+ 6
Measurement Science.....	6,280	5,429	6,325	+ 17
Total, Analytical Technology.....	\$ 15,213	\$ 14,793	\$ 16,211	+ 10

II. B. Major Laboratory and Facility Funding

Ames Laboratory.....	\$ 503	\$ 514	\$ 416	- 19
Argonne National Laboratory....	627	682	626	- 8
Brookhaven National Laboratory.	92	86	106	+ 23
Idaho National Engineering Lab.	92	85	109	+ 28
Lawrence Berkeley Laboratory...	1,619	1,651	1,711	+ 4
Lawrence Livermore Nat. Lab....	2,262	839	487	- 42
Oak Ridge National Laboratory..	2,528	2,289	2,386	+ 4
Pacific Northwest Laboratory...	1,227	1,247	1,281	+ 3
Inhalation Toxicology Research Institute.....	113	170	173	+ 2
Environmental Measurements Lab.	4,066	4,184	4,560	+ 9
Total.....	\$ 13,129	\$ 11,747	\$ 11,855	+ 9

### III. Activity Descriptions

Program Activity -----	FY 1988 -----	FY 1989 -----	FY 1990 -----
Analytical Technology			
Dosimetry Research	<p>Radiological characterization studies are being sustained. The Chernobyl data base activity will interact with the scientific community to provide data for the purpose of testing, validating, and enhancing environmental transport computational models.</p>	<p>Maintain radiological characterization and Chernobyl data base activities.</p>	<p>Complete compilation of a comprehensive Chernobyl data base. Maintain characterization studies of radiation sources and defining pathways from source to humans.</p>
	<p>Redirect Japanese dosimetry activity to development of advanced methodology applicable to occupational health protection. Continue development of techniques and methodology for assessing chemical exposure. Enhance radon research with emphasis on studies of the physical mechanisms of high LET radiation interaction with biomolecules and on development of improved exposure-dose concepts for critical targets. (\$8,933)</p>	<p>Maintain radiation and chemical dosimetry research with emphasis on mixed field radiation dosimetry techniques and methodology for DNA adduct measurement. Continue extension of advanced external dosimetry computational techniques to occupational health applications. Sustain 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. (\$9,364)</p>	<p>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. (\$9,886)</p>



III. Analytical Technology (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Measurement Science	Continue development of advanced measurement technologies. New approaches to development of position sensitive radiation detectors using amorphous semiconductor materials will be explored. Such detectors would have important applications in radiation monitoring and medical imaging. Research will be initiated on advanced instrumentation to separate and quantitatively measure complex biological materials using a laser scanning and imaging technique. (\$6,280)	Sustain measurement technology and instrumentation development research. Continue development of advanced laser techniques for sensitive and selective chemical measurements. Maintain a focus on biologically active materials and detection of damage to biological systems. Complete development of instrumentation to measure primary biomass production in the oceans. (\$5,429)	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. (\$6,325)
Total Analytical Technology	\$15,213	\$14,793	\$16,211

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 and precipitation, air-surface exchange and the role of organics. The second explores transport and diffusion over complex terrain with a goal of enhancing the emergency preparedness and response systems at key DOE installations.

I. Environmental Research (Cont'd)

The marine program concentrates on the exchange of materials between the continental shelf and the open ocean. Close collaboration with 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.

The terrestrial transport program concentrates on the transport of materials through the subsurface soils and ground water systems and in evaluating microbial communities in deep sediments.

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.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Atmospheric Science.....	11,200	11,494	13,000	+ 13
Marine Transport.....	5,059	5,964	6,955	+ 17
Terrestrial Transport.....	6,540	10,881	15,202	+ 40
Ecosystem Response.....	8,263	8,262	8,398	+ 2
Total, Environmental Research.....	\$ 31,062	\$ 36,601	\$ 43,555	+ 19

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory....	1,243	1,307	1,414	+ 8
Brookhaven National Laboratory.	3,380	4,556	4,365	- 4
Idaho National Engineering Lab.	0	60	60	--
E.I. DuPont DeNemours.....	199	382	480	+ 26
Fermi National Laboratory.....	40	50	50	--
Lawrence Berkeley Laboratory...	632	770	820	+ 7
Lawrence Livermore Nat. Lab....	1,244	1,493	1,125	- 25
Los Alamos National Laboratory.	1,639	1,470	1,015	- 31
Oak Ridge National Laboratory..	2,666	2,806	2,882	+ 3
Pacific Northwest Laboratory...	5,832	5,987	7,991	+ 34
Environmental Measurements Lab.	2,106	2,190	2,240	+ 2
Georgia, University of.....	696	409	450	+ 10
Total.....	19,677	21,480	22,892	+ 7

III. Environmental Research (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Atmospheric Science (Cont'd)	<p>A modest field effort will be undertaken by ASCOT (Atmospheric Studies in Complex Terrain) to reduce certain key modeling uncertainties. A principal ASCOT activity will be the consolidation of the major scientific advances with the publication of a scientific journal volume dedicated to the presentation of these advances. Certain modeling activities will be geared toward streamlining ASCOT models for assessment purposes such as for Emergency Response and the study of visibility deterioration in the West. Other emergency response activities will include a modest field study of dispersion in the stable atmospheric boundary layer. (\$2,828)</p> <p>Primary and secondary organic compounds in the atmosphere will be studied during field studies "of opportunity" (such as the PRECP program's field studies) and in the laboratory. The role and influence of biogenic organic emissions in atmospheric chemistry will be assessed. Participation by some laboratory programs in a major southern California air quality study will take place. Research</p>	<p>Transport and dispersion research by ASCOT will move 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 will be compensated by more elaborate modeling parametric studies. Emergency response research activities will concentrate on the incorporation of a forecasting dimension to the Atmospheric Release Advisory Capability (ARAC) system. (\$2,890)</p> <p>The study of organic compounds in the atmosphere will continue with field measurements taken in conjunction with the PRECP field efforts. Laboratory studies of fundamental chemical processes along with applications of the tracer technology will be pursued. (\$3,175)</p>	<p>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. (\$4,785)</p> <p>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. (\$3,939)</p>

III. Environmental Research (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Atmospheric Science (Cont'd)	<p>A modest field effort will be undertaken by ASCOT (Atmospheric Studies in Complex Terrain) to reduce certain key modeling uncertainties. A principal ASCOT activity will be the consolidation of the major scientific advances with the publication of a scientific journal volume dedicated to the presentation of these advances. Certain modeling activities will be geared toward streamlining ASCOT models for assessment purposes such as for Emergency Response and the study of visibility deterioration in the West. Other emergency response activities will include a modest field study of dispersion in the stable atmospheric boundary layer. (\$2,828)</p> <p>Primary and secondary organic compounds in the atmosphere will be studied during field studies "of opportunity" (such as the PRECP program's field studies) and in the laboratory. The role and influence of biogenic organic emissions in atmospheric chemistry will be assessed. Participation by some laboratory programs in a major southern California air quality study will take place. Research</p>	<p>Transport and dispersion research by ASCOT will move 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 will be compensated by more elaborate modeling parametric studies. Emergency response research activities will concentrate on the incorporation of a forecasting dimension to the Atmospheric Release Advisory Capability (ARAC) system. (\$2,890)</p> <p>The study of organic compounds in the atmosphere will continue with field measurements taken in conjunction with the PRECP field efforts. Laboratory studies of fundamental chemical processes along with applications of the tracer technology will be pursued. (\$3,175)</p>	<p>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. (\$4,785)</p> <p>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. (\$3,939)</p>

III. Environmental Research (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Atmospheric Science (Cont'd)	on gas-to-particle conversion and heterogeneous reactions will continue. The tracer technology will be applied to oil-drilling applications. Several problems related to the dispersion of radionuclides in the atmosphere will be researched. (\$2,512)		
Total Atmospheric Science	\$11,200	\$11,494	\$13,000
Marine Transport	Phase II of the Shelf Edge Exchange Program (SEEP) in the Northeast began a 15 month field program in February 1988 to determine dynamics of transport of energy related materials from the Northeast to the Cape Hatteras area where it appears there is entrainment of coastal material in the Gulf Stream current with subsequent dispersion in the North Atlantic. The California Basin program (CABS) will complete its final year of data collection and analysis. The Southeast program will continue to focus on flushing rates of energy related materials from the continental shelf--particularly during storm events. A synthesis volume of the Southeast research was published by Pergaman Press as part of the series on "Progress in Oceanography." (\$5,059)	Continue field work in SEEP II and begin to synthesize data. Complete final planning of a multiagency global program where the on-going BER marine research will become a central focus on the ocean margins to understand global implication of biogeochemical cycling and interaction between the deep ocean waters and coastal inputs. (\$5,964)	Begin a multiagency international cooperative effort to understand the role of continental margin processes in the global biochemical cycles. DOE contractors with their multidisciplinary capability will provide the template to determine the exchange between the ocean margins. The DOE program will organize, prepare and construct equipment for the Global and Continental Ocean Margin Flux Studies (COMPS) which is the U.S. ocean margin component of the international Global Ocean Flux program. (\$6,955)
Total Marine Transport	\$5,059	\$5,964	\$6,955

III. Environmental Research (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Terrestrial Transport	<p>Expanded research through open solicitation for proposals in radon transport from ground systems to households. (\$1,662) Maintained research in transport of mixed contaminants in soils and groundwater on sorption/desorption and microbial interactions. Published announcement in Federal Register for FY 89 initiative to accelerate fundamental, research in physical, chemical and microbiological mechanisms that control mobilization/sequestration and transport of contaminants in subsoils and groundwater to help in developing cost effective, appropriate cleanup practices at DOE sites. Completed drilling of research well in uncontaminated area at Savannah River Site to investigate detailed spatial distribution of microbiota in groundwater systems at depths to 2000 ft. Demands to use discovered microorganisms for bioremediation of contaminated groundwater, for pharmaceuticals, for processing of low grade coal, and for other industrial uses continues to increase. (\$4,878)</p>	<p>Continue research in environmentally related radon studies to determine aspects of soil types depth and porosity to radon levels, as well as humidity and moisture factors. (\$2,187) Develop accurate non-invasive, inexpensive methods including fiber optic sensors and seismic tomography to eliminate need of drilling costly wells for monitoring. Strengthen research in understanding capacity of natural soils and subsurface systems to degrade and transport organic chemicals. Begin development of expert systems for mixed wastes of organics, radionuclides and trace metals through soils and subsurface systems by targeting on unifying concepts. Increase research in deep microbiology to new exploratory areas at DOE Research Parks. Increase technology transfer of newly discovered microbiota to pharmaceutical, waste cleanup, and other industries. (\$8,694)</p>	<p>Continue research in radon transport from environment to households. (\$2,200) Initiate three year program to develop comprehensive information base in deep microbiota. Begin research to determine whether deep microorganisms have common physiological and/or phylogentic characteristics and if groundwater microbial communities can be predicted based on monitored data. Initiate transitional deep microbiology sampling at INEL and/or PNL with long term goal of developing new scientific approaches for remediation of deep biosphere. Expand program to transfer newly-discovered cultures to industry (\$3,840)</p> <p>Maintain long term research in the immobilization and transport of organic-chemical-radionuclide mixtures, and in the physical, chemical and microbiological properties of natural subsoils and groundwater. (\$1,153) Accelerate research leading to new generation predictive models and expert systems to predict contaminant movement in groundwater. Quantify the complex interactions among microbial degradation, abiotic degradation, and sorption-desorption processes that retard contaminant movement in natural subsurface systems.</p>

III. Environmental Research (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Terrestrial Transport (Cont'd)			<p>Initiate university-national laboratory cooperation that bridges the gap between experimental research and field demonstrations of effective and economically-improved in situ waste stability. Enhance research to investigate geochemical microbiological hydraulic interactions and to study new microorganisms from deep aquifers. Test and demonstrate new instrumentation within an intermediate scale experimental system. Increase research in microbial degradation of chemical mixtures under representative subsurface conditions. 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 (\$8,009).</p>
Total Terrestrial Transport	\$6,540	\$10,881	\$15,202

III. Environmental Research (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Ecosystem Functioning and Response	<p>Completed three year study in Arctic and began to synthesize data on impacts of disturbance on a tundra ecosystem. Published 2 volume synthesis of the Natural History of Enewetak based on 30 years of DOE basic research that has quickly become the definitive text on oceanic atolls. Research on resiliency of ecosystems to multiple impacts continue in comprehensive programs centered primarily at the National Environmental Research Parks. A sound theoretical base is essential for understanding the functioning of ecological systems to provide direction for future field research and the ability to predict the consequences of energy-related disturbances and stresses. The existing small program will be enhanced through an open solicitation for proposals in late FY 1988. Physiological research that is not closely integrated into multidisciplinary programs will be phased out. (\$8,263)</p>	<p>Begin development for next phase of Arctic tundra study in collaboration with NASA, NOAA, and NSF to broaden understanding of land/atmosphere ecosystem programs at DOE desert sites targeted on water balance and atmosphere/land interactions. Continue research in watersheds and wetlands to determine effects of multiple stresses. (\$6,866) DOE will begin to tap the data that is available at the DOE Research Parks through a formalized approach of computer analysis and protocols. This will propel the DOE lands into a lead status of biological observatories documenting global processes at minimal cost by utilization of existing vast DOE land resources at Environmental Research Parks. (\$512) Continue 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. (\$884)</p>	<p>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. The HABITAT program will emphasize processes related to large scale disturbances including evapotranspiration and changes in water balance to understand critical events leading to desertification or rehabilitation. 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 program related to global processes. The freshwater program will be terminated. Research in theoretical ecology will be continued. (\$8,398)</p>
Total Ecosystem Functioning and Response	\$8,263	\$ 8,262	\$ 8,398
Total Environmental Research	\$31,062	\$36,601	\$43,555



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 epidemiological 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 other subprogram is designed to provide detailed 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 animal 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 and development of new instruments to analyze biological systems.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Human Health Research				
RERF Epidemiology.....	\$ 21,500	\$ 17,000	\$ 17,500	+ 3
DOE Workers Epidemiology....	4,173	4,411	4,924	+ 12
Other Epidemiology.....	4,492	5,246	6,519	+ 24
Subtotal, Human Health Research	\$ 30,165	\$ 26,657	\$ 28,943	+ 9
Biological Research				
Radiation Biology.....	\$ 21,785	\$ 27,977	\$ 27,894	--
Chemical Toxicology.....	7,807	8,314	8,718	+ 5
Subtotal, Biological Research..	\$ 29,592	\$ 36,291	\$ 36,612	--
Radiological and Chemical Physics.....	6,468	6,305	6,653	+ 6
Total, Health Effects.....	\$ 66,225	\$ 69,253	\$ 72,208	+ 4

II. B. Major Laboratory and Facility Funding

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Argonne National Laboratory....	\$ 6,580	\$ 6,641	\$ 6,849	+ 3
Brookhaven National Laboratory.	1,575	1,320	1,205	- 9
Lawrence Berkeley Laboratory...	1,907	1,786	2,042	+ 14
Lawrence Livermore Nat. Lab....	975	3,299	1,120	- 66
Los Alamos National Lab.....	1,684	2,211	2,337	+ 6
Oak Ridge National Laboratory..	6,757	7,456	7,542	+ 1
Pacific Northwest Laboratory... California, Univ. of at San Francisco.....	5,682 532	5,527 773	5,750 806	+ 4 + 4
Inhalation Toxicology Research Institute.....	7,632	8,040	8,472	+ 5
Oak Ridge Associated Univ.....	3,847	3,695	4,254	+ 15
NAS/Radiation Effects Research Foundation, Japan.....	21,500	17,000	17,500	+ 3
Total.....	\$ 58,671	\$ 57,748	\$ 57,877	--

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Human Health Research RERF Epidemiology	Research at the Radiation Effects Research Foundation involves epidemiologic, dosimetric, and clinical studies of Japanese atomic bomb survivors and offspring. (\$21,500)	Continue studies of atomic bomb survivors and offspring. (\$17,000)	Maintain level of funding for atomic bomb survivor studies. (\$17,500)
DOE Workers Epidemiology	In order to substantially increase our ability to statistically identify potential health effects, efforts to combine data on several facilities, job categories, and causes of death	Studies expand to include workers from additional DOE facilities, including LLNL and LBL. Data pooling efforts continue with studies of multiple myeloma and sharing of data	Data pooling efforts will reach conclusion. Expansion to other facilities continues. Pu morbidity study enters subject location and mailing of questionnaires phase. (\$4,924)

III. Health Effects (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
DOE Workers Epidemiology (Cont'd)	receive increased priority. Results from studies of SRP, congenital malformations, brain cancers, and Y-12 are published. (\$4,173)	on an international scale. Data analysis will be completed on 5 rem study and lung cancer case-control study. Pu morbidity study begins. (\$4,411)	
Other Epidemiology Studies	Study of nuclear shipyard workers reaches conclusion with report expected soon. Database on mortality and environmental factors is updated. Maintain uranium and transuranium registries, and continue autopsy studies. Continue radon studies in Pennsylvania. Initiate model development of human lung deposition studies of children, women, and males related to patterns of inhaled radon at various concentrations of attached and unattached fractions. These will be used for dosimetric calculations as well as providing data to validate prior and ongoing studies. Complete study of New Mexico uranium miners. (\$4,492)	Initiate molecular epidemiology studies of radiation and nuclear medicine procedures. Maintain registries, health surveillance system, and development of database. Continue radon studies in Pennsylvania. Continue lung deposition studies and begin application of data previously obtained. (\$5,246)	Molecular epidemiology studies continue. Health surveillance system expands to SRP and Rocky Flats. Partial funding for radium studies redirected to accelerate and emphasize radon/lung cancer study. Intensify data collection efforts on radon/lung cancer study in Pennsylvania. (\$6,519)
Total Human Health Research	\$30,165	\$26,657	\$28,943

III. Health Effects (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Biological Research Radiation Biology	<p>Continue long-term studies of radiation carcinogenesis in dogs and rodents following external gamma and neutron radiation, and internally deposited radionuclides. Expand programs to study biological effects of radon and its daughter products to meet the national needs. These studies will expand ongoing projects related to initiation-promotion models and to other aspects of oncogenesis. Continue to develop new methods for extrapolation to humans from animal experimentation. Develop plans for archiving radiobiological data and for formulating an integrated data base for information obtained from experiments of the past four decades. (\$11,085)</p>	<p>Long-term carcinogenesis studies are in the data analysis and writing stages at all laboratories and experiments with animals are decreasing in magnitude. The directions and approaches to archiving the information from past experiments will be formalized and the effort will begin to materilize at a low level of activity. Plans will be laid for intensifying this program in future years. The radon/radon daughter research will already begin to bear some results, and an increased level of project integration will be attained. Cellular dosimetry and effects in the respiratory tract following inhalation of radon and radon mixed with cigarette smoke will be pursued. The integration of animal research models with cellular and molecular research models will continue toward an end of understanding the mechanisms related to radiation carcinogenesis. (\$13,130)</p>	<p>As long-term animal studies begin to reach conclusion, implement the necessary interlaboratory collaboration to bring about a full scale integration of the radiobiology data base. Begin preparation of facilities for archiving the samples from long-term animal studies and to build up the necessary personnel to give each participating laboratory its ability to work its data into the central database system. Continue the radon studies and encourage early results to be published, as a means of meeting the national goals. Complete the phasing out of the Management and Operating contract at the University of California, Davis, and trim the University of Utah staffing to a level commensurate with the workload associated with the residual long-term studies. (\$14,516)</p>

III. Health Effects (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Biological Research Radiation Biology	<p>Emphasize the analysis of selected heritable germ line mutations in irradiated mice using state-of-the-art recombinant DNA techniques. Complete the definitive report on the spontaneous and possible radiation-induced heritable mutations in the Japanese A-bomb survivors and further develop the database of human DNA-repair capabilities as an indicator of individual radiation sensitivity. Continue multispecies comparative research on the induction of DNA damage by high- and low-LET radiations. Sustain work on cytogenetics of chromosome damage. Initiate research on radon-induced gene damage as a key event in the initiation of tumorigenesis in the respiratory tract. (\$10,650)</p> <p>Begin preliminary planning and assessment activities associated with Decontamination and Decommissioning (D&amp;D) of University of California, Davis (UCD). (\$50)</p>	<p>Continue research on the molecular biology of radiation-induced heritable mutations in mice and on somatic mutations in human skin and blood cells. Sustain research on radiation-induced DNA damage and repair. Continue studies on the role of radon-induced gene damage in relation to the initiation of tumor development. Develop new and improved molecular and cellular based systems to measure possible radiation-induced somatic and heritable mutations in human populations. (\$11,647)</p> <p>Funding for initiation of environmental cleanup activities at UCD will be provided. Termination of the Management and Operating contract with UCD is scheduled for the end of FY 1989. Transfer of title to DOE-owned facilities will occur after D&amp;D of the site. Initial FY 1989 funding will allow cleanup of SR-90 trenches, sludge, leach fields, and Ra-226 septic tanks to begin. (\$3,200)</p>	<p>Selectively increase cellular and molecular studies; sustain the molecular level analysis of germ line and somatic mutations induced by high-, as well as low-LET radiation; emphasize research on the preferential repair of damaged DNA that is inactive; continue studies on the molecular and cytogenetic characterization of radon-induced damage that is biologically significant and the role of such damage in lung carcinogenesis; apply improved and validated molecular and cellular based mutation assays to the quantitation of somatic and heritable mutations in radiation exposed human populations. (\$11,878)</p> <p>Continue the D&amp;D operations at UCD at a level that will insure completion of the cleanup procedure on the necessary schedule. Completion of the D&amp;D work is necessary before the facility can be safely returned to the University. (\$1,500)</p>
Total Radiation Biology	\$21,785	\$27,977	\$27,894

III. Health Effects (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Biological Research Chemical Toxicology	<p>The trend towards emphasizing research involving cellular and molecular mechanisms of chemical effects is being continued. Activities focus on single chemicals and simple mixtures of chemicals in well-characterized model systems. Fundamental research on mechanism of synergistic and antagonistic interactions uses well defined mixtures. Molecular and cellular studies of mechanisms of carcinogenesis, including formation of DNA adducts, cellular oncogene activation and tumor promotion are emphasized. Continue research of genetic effects and of the absorption and biotransformation of chemicals. Emphasis remains on inhalation as the primary route of exposure. (\$7,807)</p>	<p>Multilevel fundamental research to elucidate general principles of chemical effects will be emphasized. This research will emphasize understanding the cellular and molecular events following exposure and will use novel systems designed to bridge in vivo and in vitro generated information. Emphasis will remain on carcinogenesis and genetic effects. Where appropriate, information from molecular and cellular studies will be related to effects data from animal studies. (\$8,314)</p>	<p>This research will include research on the interactions of defined multiple exposures and will extend the use of molecular biology approaches involving effects of inhaled chemicals and metabolic changes in the respiratory tract. It will continue to emphasize mechanisms of carcinogenesis and mutagenesis as primary effects and inhalation toxicity as the primary exposure route. There will be an increased emphasis on integration of research efforts across the program element. (\$8,718)</p>
Total Chemical Toxicology	\$7,807	\$8,314	\$8,718
Total Biological Research	\$29,592	\$36,291	\$36,112

III. Health Effects (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Radiological and Chemical Physics	<p>Continue radiation biophysics research emphasizing further development of radiobiological response models. Investigate the mechanisms of energy transfer from the physical stage to the chemical stage of radiation interaction with biological molecules. Maintain efforts to strengthen the coupling between radiation biophysics and molecular biology. (\$3,618)</p>	<p>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. (\$3,365)</p>	<p>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. (\$3,518)</p>
	<p>Studies will continue to investigate fundamental process that govern energy transfer and migration in model liquids. Results from these studies will be extended to study similar characteristics in biological material such as cell environment. Research in specialized instrumentation and data analysis procedures for analytical cytology will focus on flow cytometry and cell sorting, quantitative microscopy and development of fluorescent monoclonal antibodies as probes for gene mapping. (\$2,850)</p>	<p>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 agents. (\$2,940)</p>	<p>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. (\$3,135)</p>
Total Radiological and Chemical Physics	\$6,468	\$6,305	\$6,653
Total Health Effects	\$66,225	\$69,253	\$72,208

### III. General Life Sciences

#### Preface: General Life Sciences

Research in General Life Sciences contributes to the base of fundamental biological knowledge that is required for the effective study and interpretation of 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.

#### II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Structural Biology.....	\$ 6,842	\$ 7,544	\$ 9,892	+ 31
Molecular Biology.....	12,006	12,760	13,726	+ 8
Cellular Biology.....	8,781	8,331	9,188	+ 10
Genome.....	10,754	17,500	27,600	+ 58
Total, General Life Sciences.....	\$ 38,383	\$ 46,135	\$ 60,406	+ 31

#### II. B. Major Laboratory and Facility Funding

Ames Laboratory.....	\$ 137	\$ 150	\$ 175	+ 17
Argonne National Laboratory....	1,687	1,318	1,558	+ 18
Brookhaven National Laboratory..	5,509	5,634	6,259	+ 11
Lawrence Berkeley Laboratory...	3,094	3,794	4,663	+ 23
Lawrence Livermore Nat. Lab....	4,569	5,894	5,789	- 2
Los Alamos National Laboratory..	6,462	7,441	8,350	+ 12
Oak Ridge National Laboratory...	4,732	5,089	5,259	+ 3
Pacific Northwest Laboratory...	32	275	325	+ 18
California, Univ. of, at San Francisco.....	2,406	2,240	2,317	+ 3
Oak Ridge Associated Univ.....	569	450	520	+ 16
Total.....	\$ 29,197	\$ 32,285	\$35,215	+ 9



III. General Life Sciences

Program Activity	FY 1988	FY 1989	FY 1990
Structural Biology	<p>Maintain support of the user programs at the National Synchrotron Light Source, High Flux Beam Reactor, and Scanning Transmission Electron Microscope. Upgrade the protein crystallography station at the HFBR with improved instrumentation and new software for studies of transport proteins and biological complexes. Begin biological studies at the pulsed neutron source by determining the structure of chromosomes and nucleosomes. Continue studies of a group of antibodies with binding sites against other antibodies to determine how they regulate antibody activity. Evaluate plans for a Center for Molecular Biotechnology at BNL. (\$6,842)</p>	<p>Continue support of the user facilities at the national laboratories. At the National Synchrotron Light Source, develop the use of extremely intense non-monochromatic x-ray beams for special applications in protein crystallography. Continue development of high counting rate two-dimensional detectors to realize the full capabilities of the x-ray beams from the light source. Begin 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. Begin development of a low Q diffractometer for biological experiments at the light source. Begin development of microimaging techniques using high brightness electron and x-ray sources to study protein and DNA structure. (\$7,544)</p>	<p>Maintain support of the user programs in structural biology at the national laboratories. At the light source, expand the range and capabilities of vacuum ultraviolet spectroscopy especially for studies of nucleic acids and continue development of the high counting rate two-dimensional detector. Complete construction of the low Q diffractometer and development of data reduction software for full use of the pulsed neutron source. Determine how the interactions between a nucleic acid and protein change when the nucleic acid has been damaged by radiation, or chemicals, or has undergone mutation. Determine the atomic structure of proteins coded for oncogenes. Support the development of computational facilities for determining the conformation of proteins by energy minimization calculations and initiate theoretical studies of protein structure. 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 at the Lawrence Berkeley Laboratory. Expand microimaging research for biological macromolecules. (\$9,892)</p>

III. Health Effects (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Molecular Biology	<p>Emphasize research aimed at deciphering the mechanisms of gene damage and repair, mutation and gene expression in mammalian somatic and germ cells; increase effort to elucidate DNA repair processes in humans; continue research on the structure-function relationship of chromatin and chromosomes. (\$12,006)</p>	<p>Continue 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; sustain research on the molecular characterization of gene structure and expression. (\$12,760)</p>	<p>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. (\$13,726)</p>
Cellular Biology	<p>Sustain research on the role of specific genes and classes of genes, chromosome instability, extracellular signal molecules, and cell membrane receptors in normal cell growth and differentiation and in the development of malignant cells. (\$8,781)</p>	<p>Emphasize research on the role of oncogenes and other classes of genes involved in normal cell growth and differentiation and in the development of malignant cells; sustain efforts to determine the mechanisms by which perturbations in the extracellular matrix and cell membrane receptors influence carcinogenesis. (\$8,331)</p>	<p>Continue fundamental research on cell replication and regulation in normal and perturbed mammalian cells that are progressing toward a malignant state. (\$9,188)</p>

III. Health Effects (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
General Life Sciences (Cont'd)			
Genome	<p>Continue producing libraries of larger human chromosome-specific DNA fragments in the Gene Library Project; significantly expand the effort to develop and apply technologies from preparation of linearly ordered DNA fragments from each of the human chromosomes; develop new concepts and techniques for sequencing DNA; improve capabilities to input, store, analyze and retrieve centralized data on ordered DNA fragments and sequences; sponsor interagency and DOE workshops, meetings and symposia. (\$10,754)</p>	<p>Maintain the production and application of human chromosome-specific gene libraries at the national laboratories; substantially accelerate the development of linearly ordered sets of large DNA fragments for human chromosomes, co-sponsor with other federal agencies the establishment of a central repository for the storage, replication and distribution of these ordered fragments; significantly increase efforts to improve, develop and evaluate DNA-sequencing and related technologies, including microimaging techniques, needed for molecular characterization of the human genome; support development of productive interdisciplinary human genome centers at LANL and LBL. (\$17,500)</p>	<p>Enhance DOE effort in the human genome program by expanding the program to include the following activities: initiate ordering of cloned DNA fragments for 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 the new computer hardware and software for analysis of nucleic acid sequences and of the relationship between nucleic acid sequence and protein structure. (\$27,600)</p>
Total General Life Sciences	\$38,383	\$46,135	\$60,406

I. Preface: Medical Applications

Medical Applications research involves a wide range of projects directed to clinical and other beneficial 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 diseases 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

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Stable Isotopes Research.....	\$ 680	\$ 600	\$ 600	--
Radioisotope Development.....	2,237	2,863	3,073	+ 7
Radiopharmaceuticals.....	12,835	18,460	20,197	+ 9
Instrumentation.....	2,923	2,574	3,070	+ 19
Clinical Feasibility.....	5,449	5,696	5,417	- 5
Subtotal Medical Applications..	24,124	30,193	32,357	+ 7
Boron Neutron Capture Therapy, INEL.....	9,776	6,427	5,288	- 19
Total, Medical Applications.	\$ 33,900	\$ 36,620	\$37,645	+ 3

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory....	\$ 380	\$ 392	\$ 380	- 3
Brookhaven National Laboratory.	6,270	6,399	6,450	+ 1
Lawrence Berkeley Laboratory...	2,281	2,618	2,710	+ 4
Lawrence Livermore Nat Lab.....	145	560	305	- 46
Los Alamos National Laboratory.	2,200	2,160	2,200	+ 2
Oak Ridge Associated Univ.....	963	1,014	972	- 4
Oak Ridge National Laboratory..	1,135	1,700	1,852	+ 9
Pacific Northwest Laboratory...	0	13	13	--
Idaho National Engineering Lab.	9,776	6,527	5,488	- 16
Total.....	\$ 23,150	\$ 21,383	\$ 20,370	- 5

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Medical Applications			
Stable Isotopes Research	Continue FY 1987 program to explore the uses for stable, magnetic isotopes of carbon, nitrogen, and phosphorus in the study of biological systems by means of advanced nuclear magnet resonance (NMR) detection methods. (\$680)	Complete studies of the applications of stable isotopes to the study of biological systems at LANL. Continue FY 1988 activities on the development and separation technique for stable isotopes and on the development of microwave spectroscopy for determining isotope ratios. (\$600)	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. (\$600)
Radioisotope Development	Continue FY 1987 program of activity with emphasis on development of radionuclides suitable for therapy. (\$2,237)	Continue FY 1988 program level of activity. Initiate feasibility study for single photon emission computed tomography. (\$2,863)	Continue FY 1989 program and initiate efforts to produce new radionuclides to support the research on monoclonal antibodies and PET. Nuclides to be investigated will include Sn-153, Se-47, and Rh-188. (\$3,073)
Radiopharmaceuticals	Continue FY 1987 program level of activity in the development of new radiopharmaceuticals labeled with short-lived/medium-lived radionuclides. Research includes the development of the in-vivo generator system for radioimmunotherapy. Expand research on tumor reactive immunoconjugates and monoclonal	Continue 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. Continue 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.

III. Medical Applications (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Radiopharmaceuticals (Cont'd)	<p>antibodies imaging and treatment methods with the use of positron emission tomography (PET).</p> <p>Continue syntheses of new boron compounds and develop rapid methods for measuring boron concentrations in blood and tissues. (\$12,835)</p>	<p>Studies will be carried out on the pharmacokinetics of boron compounds in normal and tumor bearing rats. Studies of toxic effects and survival of irradiated glioma cells with and without boron, and studies of tolerance of normal brain to neutron radiation will be conducted. (\$18,460).</p>	<p>Continue FY 1989 program and expand studies of boron uptake in isolated tumor cells relative to that in blood, normal cells, and the main body of the tumor mass. (\$20,197)</p>
Instrumentation	<p>Completion of a new, hexagonal ring PET system at the University of Pennsylvania is planned. This instrument has advantages in simplicity and relatively low cost which make it attractive for clinical applications in hospitals as well as basic biomedical research. Performance should be adequate for many medical purposes. Research to develop technology to noninvasively</p>	<p>Research on positron emission tomography, magnetoencephalography and other medical imaging instrumentation will continue. The feasibility of magnetic resonance imaging of stable isotopes in the body will be explored. Development of a new portable device for rapid, bedside evaluation of pulmonary edema will be completed. (\$2,574)</p>	<p>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</p>

III. Medical Applications (Cont'd)

Program Activity

FY 1988

FY 1989

FY 1990

Instrumentation

image human brain function will be pursued using a technique called magnetoencephalography. In this technique, the weak magnetic fields produced by neuronal activity are detected and used to produce a three-dimensional image of the brain activity underway. Significant clinical applications are anticipated to detect and locate brain lesions and to characterize functional disorders as well. (\$2,923)

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. (\$3,070)

Clinical Feasibility

Six patients have been studied using PET with Rb-82 to probe the blood-brain barrier integrity.

Rubidium-82 will be 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.

Patient studies using Cu-64 have been stopped. Shut-down of HFIR and ORR have resulted in cessation of production of Cu-64 needed for these studies.

Approximately 15 patients will be 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 will be investigated.

Absolute measurement of radionuclide uptake in patients will be validated using a calibration phantom methodology.

III. Medical Applications (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Clinical Feasibility (Cont'd)	<p>Ten patients have been treated with the I-131 labeled antibody, Lym-1; seven patients had tumor regression of greater than 30% and three of these patients had greater than 70% tumor regression.</p> <p>Of the 300 intracranial arterial veinous malformation patients treated with helium ion beams at 184" Synchrocyclotron, 75% were cured, over 85% afforded protection against farther intracranial hemorrhage. (\$5,449)</p>	<p>Verification of dosimetry predictions and therapy feasibility in patients using selected iodine-131 and copper-67 radioimmunopharmaceuticals will be studied.</p> <p>Research into the therapeutic and diagnostic applications of heavy ion beams will be expanded and the possibility of applying radioactive beam techniques to cerebral blood flow measurement will be explored. Continue clinical trials of synchrotron x-ray angiography. (\$5,696)</p>	<p>Improve procedures at Bevatron/Bevalac using carbon and neon ions with greater precision and efficacy.</p> <p>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. (\$5,417)</p>
Subtotal Medical Applications	\$24,124	\$30,193	\$32,357



III. Medical Applications (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Boron Neutron Capture Therapy, INEL	Complete design of an epithermal neutron beam filter for the Brookhaven Medical Research Reactor (BMRR).	Install the epithermal neutron beam filter in the BMRR and measure the neutron beam characteristics.	Continue dosimetry studies on the epithermal neutron beam.
	Continue large animal studies of boron compound clearance from blood and critical organs.	Initiate large animal irradiation studies using the epithermal neutron beam at BMRR.	Continue irradiation of large animals with the epithermal neutron beam.
	Continue dosimetry verification measurements in support of the initial canine irradiations.	Develop procedures for defining the irradiation areas for the phantom and dog irradiations.	Continue dosimetry support for dose ranging studies in dogs.
	Continue removal of experimental hardware remaining from the last NRC experimental program. (\$9,776)	Provide qualified supervision, maintenance and safety for three-shift surveillance of the PBF facility. (\$6,427)	Continue maintenance and surveillance of the PBF facility. (\$5,288)
Total Medical Applications	\$33,900	\$36,620	\$37,645

I. Preface: Carbon Dioxide Research

The goal of the Carbon Dioxide Research program is to develop a sound, quantitative atmospheric carbon dioxide knowledge base to aid in energy policy decision making. This goal involves the following objectives: improve knowledge of the global carbon cycle; improve estimates of future atmospheric carbon dioxide; project global and regional climatic response to increasing atmospheric CO<sub>2</sub>; improve understanding of the direct carbon dioxide effects on productivity of natural and agricultural systems; develop and verify methods for the first detection of global climate change due to increasing atmospheric CO<sub>2</sub>; develop the means to understand and quantify the consequences of the direct and indirect effects of CO<sub>2</sub> and climate change on defined resources on a regional basis; define possible options for mitigating long-term consequences of a higher CO<sub>2</sub> atmosphere. Increased emphasis will be placed on the oceans and clouds program due to great uncertainty of their effects on global climate change.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Sources and Sinks.....	\$ 3,200	\$ 3,400	\$ 3,500	+ 3
Climatic Effects.....	4,750	7,000	10,090	+ 44
Vegetative Effects.....	3,400	3,900	4,000	+ 3
Resource Analysis.....	875	1,700	1,750	+ 3
Information Requirements.....	1,150	1,200	1,000	- 17
Integration Activities.....	221	400	500	+ 25
Total, Carbon Dioxide Research.....	\$ 13,596	\$ 17,600	\$ 20,840	+ 18

II. B. Major Laboratory and Facility Funding

Brookhaven National Laboratory.	\$ 1,008	\$ 1,030	\$ 1,340	+ 30
Lawrence Livermore Nat. Lab....	1,915	3,770	4,821	+ 28
Oak Ridge National Laboratory..	5,066	4,845	4,800	- 1
Pacific Northwest Laboratory...	640	1,075	2,775	+ 158
Total.....	\$ 8,629	\$ 10,720	\$ 13,736	+ 28

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Carbon Dioxide Research			
Carbon Dioxide	<p>The basic program to reduce CO2 issue uncertainties will continue and a few of the highest priority recommendations from the state-of-the-art reports planned in FY 1987 will be continued. Specifically:</p> <p>Continue to study global CO2 sources and sinks of CO2 and other greenhouse energy related gases. (\$3,200)</p> <p>Continue global climate model intercomparison and improvement initially with collaboration of Chinese and British modeling groups, and start organizing a global climate model diagnosis and applications program. (\$4,750)</p>	<p>The basic program to reduce CO2 issue uncertainties will continue and high priority recommendations from the state-of-the-art reports covering global consideration will be continued, and expanded. Specifically:</p> <p>Continue to study global sources and sinks of CO2 and greenhouse gases emissions. (\$3,400)</p> <p>Implement the global climate diagnosis and intercomparison program with added scientific collaboration with Canada, Germany and the USSR, and conduct research to improve global data and methods to simulate clouds. (\$7,000)</p>	<p>Continue to study global sources and sinks of CO2 and greenhouse gas emissions. (\$3,500)</p> <p>Complete development of Diagnostic Center at LLNL concentrating on having suite of international models to describe climate variability (range of interannual variability and extremes); continue computer capability for testing model improvements indicated by the research. Expand research for the development of improved climate models. Conduct studies of cloud processes and radiation to investigate relationships between rise of greenhouse gases and global warming. (\$10,090)</p>

III. Carbon Dioxide Research (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Carbon Dioxide (Cont'd)	Continue experiments and planning for system level Agro-Ecological systems modeling. (\$3,400)	Continue experiments and begin Agro-Ecological systems modeling. (\$3,900)	Acquire basic data in support of system analysis of CO2 and climate effects with vegetation. (\$4,000)
	Continue the development of regional resource data bases and develop the methods to quantify CO2 reductions through energy conservation and policy research methods. (\$875)	Expand the development of regional resource and analysis techniques covering key global regions, e.g. China and Western Europe as well as regions within the U.S. Conduct analysis to investigate potential CO2 reductions through energy strategic planning. Identify regions in jeopardy and the potential effects on resources. (\$1,700)	Continue development of geographic and resource data bases. (\$1,750)
	Continue activities of the Carbon Dioxide Information and Analysis Center. (\$1,150)	Continue activities of the Carbon Dioxide Information and Analysis Center and expand global networking. (\$1,200)	Continue activities. (\$1,000)
	Perform integration and evaluation of the overall program. (\$221)	Perform integration and evaluation of the overall program and expand contact with the international science community. (\$400)	Continue activities and expand global network. (\$500)
<b>Total Carbon Dioxide Research</b>	<b>\$13,596</b>	<b>\$17,600</b>	<b>\$20,840</b>

I. Preface: 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.

II. A. Summary Table

Program Activity -----	FY 1988 -----	FY 1989 -----	FY 1990 -----	% Change -----
Program Direction.....	\$ 4,000	\$ 4,000	\$ 4,600	+ 15
Total, Program Direction....	\$ 4,000	\$ 4,000	\$ 4,600	+ 15

III. Activity Descriptions

Program Activity -----	FY 1988 -----	FY 1989 -----	FY 1990 -----
Salaries and Expenses	<p>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 nearly 700 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. Maintained close liaison with other DOE programs, other Federal agencies, and the scientific, academic and industrial communities and provided the program and management support</p>	<p>Provide funds for salaries, benefits, and travel for 55 FTE's including normal increased salary and benefits costs. Additional effort is required to address escalating environment, safety and health (ES&amp;H) issues and for review, coordination, and implementation of ES&amp;H, safeguards and security, transportation, and emergency preparedness orders and regulations as they pertain to program facilities; i.e., improved management oversight of reactors at Oak Ridge, Brookhaven, and Argonne National Laboratories. Staff will also continue to be heavily involved in research on the human genome, a program which is experiencing</p>	<p>Provide funds for salaries, benefits, and travel for 55 FTE's. The increased funding will provide for normal increased personnel costs resulting, for example, from within-grade and merit increases and greater employee participation in the Federal Employees Retirement System. Provide continued management oversight of ES&amp;H activities and for basic research to understand the fundamental processes in the subsurface to deal with site related cleanup and contamination problems. Continue to support ongoing program efforts including the expanded human genome program which has been recommended by several advisory</p>

III. Program Direction

Program Activity	FY 1988	FY 1989	FY 1990
Salaries and Expenses (Cont'd)	<p>program. This staff has become increasingly involved in international affairs including research collaboration and program coordination with the Europeans on radiation biology programs. There has also been substantial increased effort in support of research on radon, nuclear medicine, and the human genome program. (\$3,660)</p>	<p>lead to major health and economic benefits. (\$3,900)</p>	
Other	<p>Provided for a variety of program support such as printing and editing, supplies, services, materials, contractual services and time-sharing on various information systems and communications networks. (\$340)</p>	<p>Continue a variety of program support such as that required in FY 1988. (\$100)</p>	<p>Continue the variety of program support required in FY 1988 and FY 1989. Increased funding will provide for contractual support to assist with ES&amp;H workload required by current regulations and directives and provide for support costs of Automated Office Support Systems workstations including hotline support, hardware modifications, upgrades, moves, and telecommunications/network support. (\$317)</p>
Total Program Direction	\$4,000	\$ 4,000	\$4,600

I. Preface: Facility 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

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Capital Equipment.....	\$ 8,500	\$ 9,000	\$ 12,500	+ 39
Construction.....	56,200	23,500	3,500	- 85
Total, Facility Operations.....	\$ 64,700	\$ 32,500	\$ 16,000	- 51

II. B. Major Laboratory and Facility Funding

Ames Laboratory.....	\$ 30	\$ 35	\$ 35	--
Argonne National Laboratory....	675	630	630	--
Brookhaven National Laboratory.	1,304	950	950	--
E. I. DuPont DeNemours.....	20	20	20	0
Lawrence Berkeley Laboratory...	690	800	675	- 16
Lawrence Livermore Nat. Lab....	990	850	810	- 5
Los Alamos National Lab.....	1,150	1,650	1,045	- 37
Oak Ridge National Laboratory..	1,200	1,175	1,175	--
Pacific Northwest Laboratory...	2,982	3,200	5,625	+ 76
California, Univ. of at San Francisco.....	140	150	150	--
Environmental Measurements Lab.	324	380	390	+ 3
Georgia, University of.....	35	25	25	--
Inhalation Toxicology Research Institute.....	1,275	1,190	1,285	+ 8
Oak Ridge Associated Univ.....	600	300	300	--
Total.....	\$ 11,415	\$ 11,355	\$ 13,115	+ 16

III. Activity Description:

Program Activity	FY 1988	FY 1989	FY 1990
Capital Equipment	The FY 1988 capital equipment budget is allowing the program to continue providing essential instrumentation. (\$8,500)	Capital equipment budget will be maintained at FY 1988 level with a minor adjustment for cost of living. (\$9,000)	Maintain basic capital equipment budget at FY 1989 level with adjustment for cost of living. (\$9,240) 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. (\$1,800) 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. (\$1,460)
Total Capital Equipment	\$8,500	\$ 9,000	\$12,500



.II. Facilities Operations (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Construction	The FY 1988 general plant project budget allows for continued support of GPP needs. Funds were provided to support university construction projects. (\$56,200)	The general plant project budget will be 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. (\$3,500)
Total Construction	\$56,200	\$ 23,500	\$3,500
Total Facility Operations	\$64,700	\$ 32,500	\$16,000
Total, Biological and Environmental Research	\$267,079	\$257,502	\$271,465

DEPARTMENT OF ENERGY  
 FY 1990 CONGRESSIONAL BUDGET REQUEST  
 ENERGY SUPPLY RESEARCH AND DEVELOPMENT  
 (dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Biological and Environmental Research

IV. Construction Project Summary

<u>Project No.</u>	<u>Project Title</u>	<u>Total Prior Year Obligations</u>	<u>FY 1989 Appropriated</u>	<u>FY 1990 Request</u>	<u>Unappropriated Balance</u>	<u>TEC</u>
90-R-120	General Plant Projects	\$ XXX	\$ 3,500	\$ 3,500	\$ 0	\$ XXX
-----	University Construction Projects	XXX	20,000	0	0	XXX
<hr/>		<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Total, Biological and Environmental Construction		\$ XXX	\$ 23,500	\$ 3,500	\$ 0	\$ XXX

DEPARTMENT OF ENERGY  
 FY 1990 CONGRESSIONAL BUDGET REQUEST  
 ENERGY SUPPLY RESEARCH AND DEVELOPMENT  
 (dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Biological and Environmental Research

1. Project title and location: 90-R-120 General Plant Projects

Project TEC: \$ 3,500  
 Start Date: FY 1990  
 Completion Date: FY 1992

2. Financial schedule:

<u>Fiscal Year</u>	<u>Obligations</u>	<u>Costs</u>			
		<u>FY 1988</u>	<u>FY 1989</u>	<u>FY 1990</u>	<u>After FY 1990</u>
Prior Year Projects	XXXXXX	\$ 2,913	\$ 925	\$ 1,105	\$ 804
FY 1988 Projects	\$ 3,000	854	1,200	300	646
FY 1989 Projects	\$ 3,500	0	875	350	2,275
FY 1990 Projects	\$ 3,500	0	0	700	2,800

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.

Department of Energy  
FY 1990 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.: 90-R-120

3. Date A-E work initiated: 1st Qtr. FY 1990

5. Previous cost estimate: None  
Date:

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

6. Current cost estimate: \$3,500  
Date: December 1988

4. Date construction ends: 2nd Qtr. FY 1992

Costs

7. Financial Schedule:

<u>Fiscal Year</u>	<u>Obligations</u>	<u>FY 1988</u>	<u>FY 1989</u>	<u>FY 1990</u>	<u>After FY 1990</u>
Prior Year Projects	XXXXXXXX	\$ 2,913	\$ 925	\$ 1,105	\$ 804
FY 1988 Projects	\$ 3,000	854	1,200	300	646
FY 1989 Projects	3,500	0	875	350	2,275
FY 1990 Projects	3,500	0	0	700	2,800

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.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: General plant projects

2. Project No.: 90-R-120

8. Brief Physical Description of Project

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:

<u>Summary by Office</u>	
Albuquerque Operations Office.....	\$ 1,090
Oak Ridge Operations Office.....	50
Richland Operations Office.....	2,000
San Francisco Operations Office.....	<u>360</u>
Total.....	\$ 3,500

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

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

<u>Albuquerque Operations Office</u>	
<u>Inhalation Toxicology Research Institute</u> .....	\$ 795
PCB transformers replacement, controlled material storage facility, fuel oil distribution system, waste treatment facility, and other emergency repairs.	
 <u>Los Alamos National Laboratory</u> .....	 295
Genome laboratory modification, NIH-approved animal care facility, other emergency repairs.	

CONSTRUCTION PROJECT DATA SHEETS

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1. Title and location of project: General plant projects

2. Project No.: 90-R-120

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

Oak Ridge Operations Office

Oak Ridge Associated Universities..... 50  
Sprinkler and halon systems.

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..... 360  
Refurbish marine biology laboratory, relocate biomedical computers, addition  
to machine shop, and other emergency repairs.

10. Details of Cost Estimate

Based on preliminary conceptual design.