DOE/ER-0029

(Previously Printed as DOE/ER-0006)

MASTER

HR 2896

DOE Research and Development and Field Facilities

June 1979

U.S. Department of Energy
Office of Energy Research
Office of Field Operations Management

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DOE Research and Development and Field Facilities

June 1979

U.S. Department of Energy
Office of Energy Research
Office of Field Operations Management
Washington, D.C. 20585

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Stock Number 061-000-00318-5

This document is
PUBLICLY RELEASABLE
Larry E. Williams
Authorizing Official
Date: 05/16/2007

~~DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED~~

RECEIVED
JAN 10 1964

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

The Department of Energy's extensive scientific, engineering, technology and production facilities, and related administrative units, are dispersed nationwide. They consist of field and project offices, Government-operated laboratories, and contractor-operated laboratory, engineering and production facilities in 26 states. The Office of Energy Research provides an overall coordination function for the Under Secretary in managing these resources to carry out important research and development missions of the Department of Energy (DOE).

This document, therefore, has been prepared by the Office of Field Operations Management in Energy Research to provide comprehensive information on these diverse field resources. The text describes DOE's management structure, program activities, staffing and funding levels, and the capabilities of each DOE facility.

Toni Grayson Joseph

Antionette Grayson Joseph
Associate Director
for Field Operations Management
Office of Energy Research

June 1979

FOREWORD

Federal involvement in energy technology research and development (R&D) has experienced spectacular growth since 1973. In that year, the various predecessor organizations of the Department of Energy (DOE) managed 93 programs authorized by Congress. By 1978, the number had grown to 225. In terms of 1978 dollars, this project management responsibility expanded from about \$2.2 billion in fiscal 1973 to over \$20 billion in 1978.

This growth in scope and magnitude of DOE's energy R&D activities has been accompanied by a significant enlargement of the department's constituencies, public and private. At the same time, the range of potential R&D performers available to the department has expanded. Much of the vital energy technology expertise required to accomplish the department's missions exists in the university and industrial sectors as well as in DOE facilities. The developments of the past few years have had a significant impact on the role and management of the operations offices, laboratories and other R&D facilities which are known collectively as the "field organization." The challenge before the department is to make appropriate use of the laboratories in light of the department's mission and in the context of the capabilities of universities and industry to support the department's goals.

As DOE's activities have multiplied and become more diverse in nature, there has been a greater need to decentralize day-to-day project management. In response to this need, the organization plan approved by the Secretary of Energy at the time of DOE's activation provides that the execution of DOE outlay programs will be decentralized to the maximum extent practicable. Generally, the execution, management and control of approved projects can best be performed in the field. Toward this end, several efforts have been undertaken, including better definitions of mission, role, responsibility and structure of the field establishment; lead operation center and lead laboratory mission assignments; and improved relationships between and among headquarters and field elements.

In keeping with the policy of decentralizing project management and program execution activities, the Assistant Secretaries responsible for outlay programs and I are making lead mission assignments to the field organization. Implementing these assignments requires, in many cases, that the operations offices and laboratories in combination provide the necessary mix of managerial and technical expertise. Consequently, there will be a continuing buildup of management capability at the operations offices and an increasing role in systems engineering and integration as well as technical support at the laboratories.

The components of the DOE field organization are entering into this new phase of their existence with a distinguished record of past technological achievements. They are now moving ahead to maintain that record in meeting the challenges of the future.

John M. Deutch
Director of Energy Research

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION	I-3
II. DOE HEADQUARTERS OFFICES WITH ASSIGNED FIELD FACILITIES	
Energy Research	II-3
Energy Technology	II-7
Environment	II-11
Defense Programs	II-15
Conservation and Solar Applications	II-19
Resource Applications	II-23
III. FIELD AND PROJECT OFFICES	
Albuquerque Operations Office	III-3
Chicago Operations Office	III-13
Idaho Operations Office	III-23
Nevada Operations Office	III-33
Oak Ridge Operations Office	III-45
Richland Operations Office	III-57
San Francisco Operations Office	III-69
Savannah River Operations Office	III-81
Grand Junction Office	III-89
Pittsburgh Naval Reactors Office	III-95
Schenectady Naval Reactors Office	III-95
Clinch River Breeder Reactor Plant Project Office	III-97
Fast Flux Test Facility Project Office	III-101
IV. RESEARCH AND DEVELOPMENT FACILITIES	
Introduction	IV-3
<u>Multiprogram Laboratories</u>	IV-4
Ames Laboratory	IV-5
Argonne National Laboratory	IV-13
Brookhaven National Laboratory	IV-23
Hanford Engineering Development Laboratory	IV-29
Idaho National Engineering Laboratory	IV-41
Lawrence Berkeley Laboratory	IV-53
Lawrence Livermore Laboratory	IV-65
Los Alamos Scientific Laboratory	IV-77
Oak Ridge National Laboratory	IV-89
Pacific Northwest Laboratory	IV-103

TABLE OF CONTENTS (cont'd.)

	<u>Page</u>
Sandia Laboratories	IV-111
Savannah River Laboratory	IV-121
Energy Technology Engineering Center	IV-128
<u>Program-Dedicated Facilities</u>	IV-137
<u>Biomedical and Environmental Facilities (Environment)</u>	IV-141
Center for Energy and Environment Research	IV-142
Comparative Animal Research Laboratory	IV-145
Environmental Measurements Laboratory	IV-148
Inhalation Toxicology Research Institute	IV-151
Laboratory for Energy-Related Health Research*	IV-155
Laboratory for Nuclear Medicine and Radiation Biology	IV-160
Laboratory of Radiobiology	
(University of California, San Francisco)	IV-163
Michigan State University (MSU)-DOE Plant Research	
Laboratory	IV-165
Oak Ridge Associated Universities	IV-169
Radiobiology Laboratory (University of Utah,	
Salt Lake City)	IV-173
Savannah River Ecology Laboratory	IV-175
The Franklin McLean Memorial Research Institute	IV-179
University of Rochester Biomedical Laboratory	IV-181
<u>Fossil Energy Facilities (Energy Technology)</u>	IV-186
Bartlesville Energy Technology Center	IV-187
Grand Forks Energy Technology Center	IV-193
Laramie Energy Technology Center	IV-201
Morgantown Energy Technology Center	IV-209
Pittsburgh Energy Technology Center	IV-219
Carbondale Mining Operations Center	IV-225
Pittsburgh Mining Operations Center	IV-229
<u>Fusion Facility (Energy Technology)</u>	
Princeton Plasma Physics Laboratory	IV-240
<u>Nuclear Development Facilities (Energy Technology)</u>	IV-243
Bettis Atomic Power Laboratory	IV-244
Knolls Atomic Power Laboratory	IV-247

*Name change pending approval by the University of California Board of Regents; formerly, the Radiobiology Laboratory.

TABLE OF CONTENTS (cont'd.)

	<u>Page</u>
<u>Physical Research Facilities</u> (Energy Research)	IV-251
Bates Linear Accelerator Facility	IV-252
Fermi National Accelerator Laboratory	IV-255
Notre Dame Radiation Laboratory	IV-261
Stanford Linear Accelerator Center	IV-264
<u>Safeguards Facility</u> (Defense Programs)	IV-269
New Brunswick Laboratory	IV-270
<u>Solar Facilities</u>	
Solar Energy Research Institute (Energy Technology)	IV-273
Regional Solar Energy Centers (Conservation & Solar Applications)	IV-276
 V. PRODUCTION, TESTING AND FABRICATION FACILITIES	
<u>Nuclear Materials Production Facilities</u>	V-3
Gaseous Diffusion Plants (Oak Ridge; Paducah; Portsmouth)	V-5
Feed Materials Production Center	V-11
Extrusion Plant	V-14
Savannah River Plant	V-16
Hanford Production Operations	V-20
<u>Weapons Testing and Fabrication Complex</u>	V-27
Nevada Test Site	
Kansas City Plant	
Rocky Flats Plant	
Pantex Plant	
Pinellas Plant	
Mound Facility	
Savannah River Weapons Facility	
Y-12 Plant	
 VI. POWER MARKETING ADMINSTRATIONS AND NAVAL PETROLEUM AND OIL SHALE RESERVES	
Introduction	VI-3
Alaska Power Administration	VI-5
Bonneville Power Administration	VI-12
Southeastern Power Administration	VI-17
Southwestern Power Administration	VI-21
Western Area Power Administration	VI-25
Naval Petroleum and Oil Shale Reserves	VI-29

TABLE OF CONTENTS (cont'd.)

	<u>Page</u>
APPENDICES	
APPENDIX A-1 DOE R&D Facility Employees by Occupational Field	A-1-1
APPENDIX A-2 DOE R&D Facility Employees by Academic Degree	A-2-1
APPENDIX A-3 FY 1978 Operating Expenses and Capital Investment	A-3-1
APPENDIX B Organization Charts for Field and Project Offices	B-1
APPENDIX C-1 Location of DOE Field and Project Offices and R&D Field Facilities by State/Territory, City and County/Territory	C-1-1
APPENDIX C-2 Names and Mailing Addresses for DOE Field and Project Offices and R&D Field Facilities	C-2-1
APPENDIX D Names and Telephone Numbers for DOE R&D Field Facilities (by type)	D-1
APPENDIX E DOE Facility/Mission Matrix	E-1
APPENDIX F DOE Facility by Program	F-1

SECTION I

INTRODUCTION

DEPARTMENT OF ENERGY ORGANIZATION

Exhibit 1

INTRODUCTION

The Department of Energy (DOE) formally came into existence on October 1, 1977, marking the beginning of what the White House characterized as giving "... a clear direction and focus to America's energy future by providing the framework for carrying out a comprehensive, balanced national energy policy."

A series of reorganizations and regroupings of energy-related Government agencies preceded the formation of the department. These actions were a stage in the eventual unification of all energy functions under the DOE. Some of this activity stemmed from the 1973-1974 oil embargo and the Nation's growing realization of its dependence upon interruptible supplies of oil and natural gas for meeting general energy requirements.

Public Law No. 95-91, signed by the President on August 4, 1977, established the twelfth cabinet-level department in the Executive Branch of the Federal Government. The law provided for eight Assistant Secretaries. It also established an Office of Energy Research, an Inspector General, an Economic Regulatory Administration, an Energy Information Administration, and the Federal Energy Regulatory Commission. Incorporated into the new department were the predecessor agencies' field organizations including the multiprogram national laboratories and Energy Technology Centers. All report to the Secretary of Energy with the exception of the Federal Energy Regulatory Commission which is an independent entity within the department. The DOE organization chart is shown in exhibit 1.

To accomplish its mission, DOE has a staff of about 20,000 people and a budget of over \$10 billion in fiscal year 1979. Approximately one-half of DOE's employees are located at headquarters in the Washington, D.C. area. The remainder are located in various offices and installations around the country. DOE's activities are supervised from the headquarters and from operations offices as shown in the organization chart (exhibit 1) and in section II.

DOE's budget is illustrated in exhibit 2. Shaded portions of the bars indicate the proportion of funds going to DOE plants and laboratories.

This report describes the roles of DOE's headquarters, field offices, major multiprogram laboratories, Energy Technology and Mining Operations Centers, and other government-owned, contractor-operated (GOCO) facilities which are located in all regions of the United States as shown in exhibit 3. It gives brief descriptions of resources, activities, and capabilities of each field facility (see sections III through V). These represent a cumulative capital investment of \$12 billion and involve a work force of approximately 12,000 government (field) employees and approximately 100,000 contractor employees.

DOE FY 1978 Operating Budget by Major Category and Performer

FY 1978
Budget
Obligations
(\$ in Billions)

Performer:

□ All Other

▨ DOE Plants and Laboratories

¹Excludes Revenues of \$.89 Billion

²Includes Energy Information Administration; Departmental Administration; Energy Production, Demonstration & Distribution; Economic Regulatory Administration; Federal Energy Regulatory Commission; Geothermal Resources Development Fund; and Power Administrations.

Map of DOE R&D Field Facilities

Exhibit 3

DOE R&D MANAGEMENT APPROACH

Headquarters Functions

DOE headquarters in Washington, D.C., concentrates on program management, scheduling, budgeting, and allocating resources, maintaining relations with other Federal agencies and the United States Congress, and providing management directives, broad policy overview and coordination of DOE's programs. The multiprogram laboratories are managed by an agency-level Institutional Planning Process.

Field Organization Functions

The elements of the field organization that are related primarily to research and development are the field and project offices, multiprogram laboratories, and program-dedicated facilities. In addition, this report describes production, testing and fabrication facilities as well as Power Marketing Administrations and Naval Petroleum and Oil Shale Reserves. The field organization carries out both important administrative management and execution functions.

The field and project offices consist of operations offices, which are more general in their scope of activities, and others which are dedicated to specific programs or projects. Responsibilities of these offices include project management; contracting with industry, universities, state and local governments, and others as needed to plan and carry out DOE projects; negotiating, executing, and administering contracts to operate DOE contractor-operated facilities and contractor appraisal. The range of support services provided by these offices typically includes budgetary, procurement, and legal services, and enforcement of health and safety regulations. They also provide contract support services to the program divisions at headquarters for research and development contracts placed with university and industrial contractors within their region or assigned areas of responsibility.

The multiprogram laboratories are government-owned and contractor-operated. In general, they support two or more programs and are large multidisciplinary facilities with broad capabilities in physical, chemical, nuclear and life sciences as well as nuclear, electrical, mechanical, and other branches of engineering. Program-dedicated research and development facilities, on the other hand, provide services primarily to a single program. These facilities are all Government-owned, and some are contractor-operated.

Decentralization Policy

Although there are exceptions, DOE has determined that placing project management close to the site of operations is desirable whenever possible, especially for construction and pilot plant projects. It is DOE

policy to decentralize project management activities outside of Washington, D.C., and to assign management of energy research, development and demonstration projects at an office located near the work, such as at an operations office or a special site project office. The establishment of lead missions is one important element of this policy.

Lead Missions

Lead mission assignments within DOE involve the delegation of significant technical direction or project management authority and responsibilities to elements of the field organization. Overall program management responsibility remains at headquarters.

Lead mission assignments to operations offices involve responsibility for field management, planning and administrative support, and for arranging for technical support from other laboratories or contractors in specified research and development areas. In general, a lead operations office also plays an important role in project management and execution, and is held accountable by headquarters for the required overall Government overview of the assigned work. All formal actions affecting a contractor's assignments flow through the administrative channel of the operations office; thereby receiving one centralized point of review, coordination, interpretation, concurrence, and approval within DOE.

A few major lead assignments to operations offices include both administrative and technical management responsibility. Some involve a combined lead responsibility, including a laboratory to perform technical direction and integration and an operations office accountable to headquarters for overall management. Headquarters program staff formulates policy and program guidance and allocates funding levels to the cognizant field offices which, in turn, implement, direct and control the research and development activities through DOE contractor organizations. The contractors have technical responsibility and broad latitude in operating the facilities owned by the Government. The lead operations office plays the appropriate government role and is the instrument by which many of the decisions are made, with input and advice from a variety of sources. The sources may include industry and appropriate user groups as well as the lead laboratory.

In the case of the laboratory lead mission assignment, major project management and execution assignments have, in a few cases, been made by headquarters to both appropriate laboratories and operations offices. The lead laboratory is held responsible for technical direction and carrying out the overall technical execution of the assigned research and development area. The supporting operations office has an overall federal management responsibility including ensuring that the assignments are performed in accordance with the terms of the contracts, applicable federal regulations, DOE regulations and the headquarters program's instructions and authorization. When a lead role is assigned to a laboratory, work in related areas may also be assigned to other

laboratories and outside contractors with existing capabilities. Placement of such work is done by the lead operations office on the technical recommendation of the lead laboratory.

Field Capabilities

Because of the diversity of resources, activities, and capabilities across the field and project offices, plants and laboratories, the remainder of this report is devoted to discussing each facility in detail. For convenience in presentation, all field and project offices are grouped together, all the laboratories are grouped together, and all the plants are grouped together. To assist the reader in determining which laboratories and plants are involved in which programs, several appendices are provided. In appendix E, DOE plants and laboratories are coded by the mission areas (Energy Supply Research and Development, Energy Conservation, Fossil Energy Research and Development, General Sciences and Research, Uranium Enrichment, Atomic Energy Defense Activities, Departmental Administration and Energy Information Administration). Appendix F presents, for each program area, a list of facilities ranked by the extent of their participation in programs.

SECTION II

DOE HEADQUARTERS OFFICES

WITH

ASSIGNED FIELD FACILITIES

ENERGY RESEARCH

ENERGY RESEARCH

The Office of Energy Research was established on October 1, 1977, by Public Law 95-91, Section 209 (42 U.S.C. 7239), as part of the organization plan for the Department of Energy (DOE). The six specific duties and responsibilities statutorily assigned to the director are:

1. To advise the Secretary with respect to the physical research programs transferred to the department from the Energy Research and Development Administration;
2. To monitor the department's energy research and development programs in order to advise the Secretary with respect to any undesirable duplication or gaps in such programs;
3. To advise the Secretary with respect to the well-being and management of the multipurpose laboratories under the jurisdiction of the department, excluding laboratories that constitute part of the nuclear weapons complex;
4. To advise the Secretary with respect to education and training activities required for effective short- and long-term basic and applied research activities of the department;
5. To advise the Secretary with respect to grants and other forms of financial assistance required for effective short- and long-term basic and applied research activities of the department; and,
6. To carry out such additional duties assigned to the office by the Secretary relating to basic and applied research, including, but not limited to, supervision or support of research activities carried out by any of the Assistant Secretaries, as the Secretary considers advantageous.

In addition to the immediate staff, there are six offices under the Director of Energy Research (see organization chart). Included on the immediate staff of the director is the Associate Director for Nuclear Non-Proliferation, the United States Coordinator for the International Nuclear Fuel Cycle Evaluation (INFCE) and the Director for Nuclear Policy Analysis. The other elements of the organization are: Office of Field Operations Management; Office of Program Analysis; Office of Research Policy; Office of Basic Energy Sciences; Office of High Energy and Nuclear Physics; and Office of Program Administration and Operations.

The Associate Director for Nuclear Non-Proliferation is responsible for analysis, formulation, and implementation of policy directed toward curbing the spread of nuclear weapons, nuclear weapons materials, and their associated production facilities to additional nationals through the uncontrolled use of nuclear technology and/or materials.

their associated production facilities to additional nations through the uncontrolled use of nuclear technology or materials.

The United States INFCE Coordinator serves both as the United States Interagency Coordinator (responsible to the President's United States Special Representative for Non-Proliferation Matters) and the Department of Energy Coordinator (responsible to the DOE Non-Proliferation Policy Committee) on coordination of all United States participation in the INFCE Working Groups and Technical Coordinating Committee.

The Director for Nuclear Policy Analysis is responsible for the integrated analysis and development of policies related to nuclear energy. The primary areas of policy interest are: nuclear fuels with emphasis on fuel enrichment policy and uranium resource development; nuclear waste management; advanced and inexhaustible nuclear systems, with emphasis on policy regarding the nuclear breeder reactor; and environmental, licensing and regulatory policy.

The Office of Field Operations Management supports the Director of Energy Research to ensure effective and efficient utilization of DOE field operations in conducting energy research. This responsibility includes overseeing the administrative well-being and management of the DOE multiprogram laboratories, excluding nuclear weapons laboratories. The office provides a permanent secretariat for the Field and Laboratory Coordination Council, chaired by the Under Secretary, on issues concerning the R&D field installations and on the institutional strength of the multiprogram laboratories. The Field and Laboratory Coordination Council is the highest level coordinating body within DOE on matters related to the multiprogram laboratories and other R&D field installations. Its mission is to advise the Under Secretary in establishment of DOE policy and coordination of departmental activities with respect to these installations and to oversee their performance of assigned tasks. This office also overviews DOE research activities and relationships with universities and industry. It funds and manages the University Coal Research Laboratory Program and provides support for special longer range research programs at both large universities and at predominately minority institutions.

The Office of Program Analysis provides independent review, analysis and recommendations concerning R&D strategies, plans, policy and technology programs. It coordinates DOE involvement in international R&D strategic planning with appropriate DOE organizations, analyzes plans for the commercialization of energy technologies, and provides independent R&D cost/benefit assessments.

The Office of Research Policy is responsible for formulating the basic research policy of the department. It assures comprehensive interface on energy R&D matters with various external communities. It funds innovative scientific and technological initiatives which crosscut

programmatic areas, or are not being supported by the major outlay program. It also provides a permanent secretariat and research capability for the Research and Development Coordination Council.

The Office of Basic Energy Sciences plans, funds and directs the basic energy sciences programs of the department, including, but not limited to chemical, materials, engineering, mathematical, and geosciences, and low energy nuclear research.

The Office of High Energy and Nuclear Physics provides effective planning, funding, and management of departmental programs related to nuclear physics and high energy physics research, including theoretical and experimental work on nuclear and particle research at high and medium energy levels, as well as ion nuclear research facilities.

The Office of Program Administration and Operations ensures that Energy Research management structures, budgetary procedures and systems are responsive to departmental requirements for effective, efficient and economical achievement of planning goals and program objectives. It is also responsible for Energy Research procurement and personnel matters.

Four multiprogram laboratories and four single-purpose laboratories are assigned to the Office of Energy Research. The multiprogram laboratories are the Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley Laboratory, and Ames Laboratory. All have large and significant basic research activities and all are connected with a university or a group of universities. The single-purpose or specialized laboratories are the Bates Linear Accelerator Center, the Fermi National Accelerator Laboratory, Notre Dame Radiation Laboratory, and the Stanford Linear Accelerator Center. The multiprogram laboratories conduct significant research programs for other DOE programs (e.g., Environment) and other Federal agencies while the four specialized laboratories are funded almost totally by the Office of Energy Research.

Detailed descriptions of these laboratories appear later in this report (see Section IV).

ENERGY TECHNOLOGY

ENERGY TECHNOLOGY

The principal responsibilities of the Assistant Secretary for Energy Technology (ET) are policy, management, and direction for engineering development and related applied research, and demonstration in all forms of energy supply, resources and conversion, and permanent storage and control of nuclear wastes.

This includes fossil, solar, geothermal, nuclear energy, magnetic fusion and advanced technology concepts. The Assistant Secretary for Energy Technology is also the primary Department of Energy (DOE) source of technological information.

There are five technical program offices and four administrative offices under the Assistant Secretary for Energy Technology (see organization chart). The program offices are: The Office of Solar, Geothermal, Electric and Storage Systems; the Office of Fossil Energy; the Office of Nuclear Waste Management; the Office of Fusion Energy and the Office of Nuclear Energy.

The administrative offices include: The Office of Field Operations Management; the Office of Planning and Technology Transfer; the Office of Resource Management and Acquisition; and the Office of Institutional Liaison and Communications.

The Office of Field Operations Management is responsible for the development and administration of management operations to assure effective implementation of ET programs and project activities at headquarters and in the field. These operations include decentralization of project management from headquarters to field organizations and evaluation of appropriate roles and performance for ET laboratories and technology centers.

The Office of Resource Management and Acquisition is assigned the ET business management activities. Principal responsibilities include budget formulation and management, economic studies, human resources and career development, business relations, and management of information systems and procedures.

The Office of Institutional Liaison and Communications develops policy and conducts communication within ET organizations, the news media, state and local governments, professional and consumer organizations, the public, and Congress. Also, this office develops and implements methods and techniques for communication to assure timely and widespread dissemination of energy technology information.

The Office of Planning and Technology Transfer provides policy direction and administration of planning and technology transfer activities for ET including planning, strategy analyses and assessment of program potential for transfer from development to commercial application.

The Office of Solar, Geothermal, Electric and Storage Systems provides overall direction for the planning, development, and implementation of research and development programs in solar, geothermal energy and energy storage, and electric energy systems.

The Office of Fossil Energy directs the planning, development, and execution of all DOE research and technology development activities associated with coal, oil, gas, improved conversion efficiency, and advanced environmental control.

The Office of Nuclear Waste Management provides direction for the planning, development, and execution of DOE programs for civilian and defense nuclear waste, processing and isolation, spent fuel storage and transfer, transportation of nuclear waste materials, and decommissioning and decontamination of Energy Technology nuclear facilities.

The Office of Fusion Energy directs the planning, development, and implementation of research and development programs in magnetic fusion energy. These programs include fusion theory, alternate confinement concepts, magnetic confinement of fusion plasmas, development of present and next-generation plasma devices, fusion reactor technology, and fusion power reactor development and commercialization.

The Office of Nuclear Energy is responsible for the administration of nuclear fission power generation, and fuel technology, including breeders, the evaluation of alternative reactor fuel cycle concepts including nonproliferation considerations; development of space nuclear generator systems; and the development of naval nuclear propulsion plants and reactor cores.

The Assistant Secretary oversees and controls, in accordance with other Assistant Secretaries and the Director of Energy Research, the Solar Energy Research Institute, Pacific Northwest Laboratory, Oak Ridge National Laboratory, five Fossil Energy Technology Centers, two Mining Operations Centers, the Hanford Engineering Development Laboratory, Idaho National Engineering Laboratory, Energy Technology Engineering Center, Princeton Plasma Physics Laboratory, Savannah River Plant, Hanford Production Operations, Idaho Chemical Processing Plant, Clinch River Breeder Reactor Plant Project Office, the Fast Flux Test Facility Project Office and, through the Division of Naval Reactors, the Bettis Atomic Power Laboratory, Knolls Atomic Power Laboratory, Shippingport Atomic Power Station, Pittsburgh Naval Reactors Office and the Schenectady Naval Reactors Office.

Detailed descriptions of these facilities appear later in this report.

(THIS PAGE INTENTIONALLY LEFT BLANK)

ENVIRONMENT

ENVIRONMENT

The Assistant Secretary for Environment (EV) serves as the independent voice within the Department of Energy (DOE) to ensure the incorporation of national environmental protection goals in the formulation and implementation of energy programs, and to advance the goals of restoring, protecting and enhancing environmental quality, and assuring public health and safety. EV accomplishes its mission through three basic programs: Compliance and overview, policy analysis and impact assessment, and health and environmental research. These programs are planned and implemented so as to maximize the degree of cooperation and coordination between EV units.

There are two staff offices (Office of Program Coordination and Office of Management Support) and three program offices (Office of Environmental Compliance and Overview, Office of Technology Impacts, and Office of Health and Environmental Research) within EV (see organization chart). The Office of Program Coordination (OPC) analyzes and evaluates EV programs and assures that the implemented programs are coordinated with related programs and activities within and external to the Department. OPC develops EV long range goals, objectives, and planning guidance, and coordinates preparation of program plans. OPC evaluates the EV programs for applicability to the National Energy Policy Plan, the energy technology programs, and EV goals and objectives. To ensure the understanding and use of the results of EV programs, OPC promotes interactions with the department and with outside organizations. The Office encourages program and project interaction with Federal, regional, state and local officials, special interest groups, industry, and universities. International cooperation is undertaken where EV, DOE and national interests can benefit.

The Office of Management Support is responsible for the coordination, implementation, and overview of the management and financial functions of EV. It coordinates the administrative interactions between EV and the field offices, national laboratories and other agencies, provides administrative, personnel, records and management support services necessary for the proper functioning of EV.

The Office of Environmental Compliance and Overview (OECO) assures that Departmental facilities and operations are in compliance with DOE operational policies and applicable Federal, state, and local environmental, health and safety regulations and policies. OECO develops DOE National Energy Policy Act guidance, conducts independent reviews of departmental Environmental Impact Statements (EIS) and reviews EIS's of other agencies. It ensures that DOE-controlled activities do not pose undue risks to workers, the general public, property and the environment. OECO develops policies and procedures for implementing the compliance programs, coordinates with programs within the department, and monitors all departmental installations and contractors for compliance.

The office promotes adequate environmental, health and safety practices and assessments throughout the department by maintaining current awareness of the state-of-the-art and distributing such information to departmental programs and contractors. OECO evaluates the technical adequacy of environmental control technologies being developed for DOE energy systems. Advanced safety engineering practices and tests are evaluated and developed by OECO.

The Office of Technology Impacts (OTI) acts as a focal point for analysis of the impact of environmental policies, laws, and regulations of significant interest to the department; analyzes and coordinates the development of departmental environmental policy guidance; and analyzes EV policies. The office estimates environmental regulatory impacts on DOE programs; and in cooperation with technology program offices, prepares Environmental Development Plans which analyze critical environmental issues and provide information for scheduling appropriate environmental, health, and safety research and analyses for individual energy technology systems and subsystems. OTI also develops, maintains and applies regional environmental, land use, and social impact analysis procedures to assess DOE policies and maintains and develops energy-related environmental information systems.

The Office of Health and Environmental Research (OHER) plans, manages, and assesses the results of the EV research program directed at determining the generic environmental, health and safety effects of energy technologies and programs. The office performs assessments of the results of health and environmental effects research, improving methods for epidemiological analysis and control of health and environmental data. OHER investigates the effects of energy-related pollutants on human health, including consequences to exposure, develops diagnostic methods and improves occupational medicine. OHER determines effects of energy-related pollutants on biological systems, developing mitigative and preventive measures, and identifying mutagenic, carcinogenic, and toxic agents. OHER determines effects of energy-related pollutants on ecological systems, investigating terrestrial, fresh water and marine biota, restoration and reclamation, and global impact of carbon dioxide from increased use of fossil fuels. OHER characterizes properties and improves measurement methods for energy-related pollutants, developing instruments and standard research materials. OHER determines risks to workers and the general public from energy systems, studying the safety aspects of resource recovery, energy processes, and disposal of wastes.

Thirteen program dedicated laboratories are assigned to the Office of Environment (see organization chart). Also, the multiprogram laboratories (Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley Laboratory, Lawrence Livermore Laboratory, Los Alamos Scientific Laboratory, Oak Ridge National Laboratory, Pacific Northwest Laboratory and Sandia Laboratories) accomplish research for EV. Other EV research is accomplished by universities, Energy Technology Centers, and contractors.

Descriptions of the EV program-dedicated laboratories appear later in this report (see section IV).

DEFENSE PROGRAMS

DEFENSE PROGRAMS

The Assistant Secretary for Defense Programs (DP) manages and directs the Department of Energy's (DOE's) programs for nuclear weapons research, development, testing, production, and surveillance; laser, heavy ion, and electron beam fusion; safeguards and security program; international security program; and classification. In addition, DP is responsible for the Nuclear Materials Production (NMP) program. DP exercises overview responsibility for the DOE weapon complex. On overriding issues of national security, DP has direct access to the Secretary.

There are six program offices and three staff offices within Defense Programs (see organization chart). The Office of Policy Analysis and Operations serves as the contact point on policy issues for the DP field structure. It also is responsible for the institutional management process for all field facilities assigned to the DP. The Office of Resource Management is responsible for monitoring, coordinating, and analyzing the development and implementation of DP program planning documents, management tracking systems, and budget. The Office of Institutional Liaison and Communications provides advice to the Assistant Secretary on congressional, institutional, and communication matters which fall within the purview of DP.

The Office of Military Application (OMA) is responsible for programs of research, development, testing, production, storage, and readiness assurance of nuclear weapons; the transportation of strategic quantities of DOE special nuclear materials, including weapons; maintaining liaison between DOE and the Department of Defense on nuclear weapons matters; and administering DOE activities under international agreements for cooperation involving nuclear defense.

The Office of Inertial Fusion (OIF) is responsible for DOE's inertial confinement (laser, electron beam and heavy ion) fusion program, the objective of which is to demonstrate scientific feasibility and apply inertial confinement fusion to the solution of national security and domestic energy problems. OIF provides broad programmatic direction to the national weapons laboratories to develop and operate major facilities, and assures a broad base of research in universities and private industry.

The Office of Safeguards and Security (OSS) is responsible for coordination of DOE's safeguards and security efforts to protect special nuclear materials, all classified activities, and DOE facilities. The office develops, tests, evaluates and implements safeguards systems which employ physical protection, material control and material accountability into facility-wide integrated safeguards systems for each installation. The New Brunswick Laboratory supports OSS through research on the security and safeguards of nuclear materials.

The Office of International Security Affairs (ISA) plans, develops, analyzes, coordinates and directs national security aspects of DOE international activities relating to nuclear technology and materials and political, military, economic and energy affairs. These aspects include nuclear nonproliferation, international safeguards and physical security, international agreements for cooperation, export control, and arms control and disarmament.

The Office of Nuclear Materials Production is responsible for DOE's Nuclear Materials Production Program which provides special materials for national defense requirements and for DOE reactor research and development programs; produces reactor fuel, operates production reactors and reprocesses reactor fuel; and provides steam to the Washington Public Power Supply System. This office also ensures that operations are conducted in a safe, environmentally acceptable and cost-effective manner, and directs the development of new and improved technology for nuclear materials production.

The Office of Classification (OC) is responsible for the policies, standards, procedures and guides for classification and declassification of restricted data and other DOE national security information. The office provides classification advice and assistance to DOE field offices, contractors, and other Government agencies.

Three operations offices, five laboratories, eight production plants and the Nevada Test Site are assigned to the Assistant Secretary for Defense Programs. The Operations Offices, Albuquerque, Nevada, and Savannah River, play a significant role in either the development, production, or testing of nuclear weapons. Los Alamos, Lawrence Livermore, and Sandia Laboratories are involved to varying degrees in support of all facets of the weapons program; i.e., design, engineering, test production, and surveillance. The New Brunswick Laboratory supports the security and safeguards program; Savannah River Laboratory is specifically involved in production of nuclear materials. The Mound and Savannah River Weapons Facilities, Amarillo, Kansas City, Pinellas, Rocky Flats, and Y-12 Plants are engaged in the weapon production program. The Savannah River Plant is a major part of DOE's Nuclear Materials Production Program. The Nevada Test Site is reserved for nuclear test operations.

(THIS PAGE INTENTIONALLY LEFT BLANK)

CONSERVATION & SOLAR APPLICATIONS

CONSERVATION AND SOLAR APPLICATIONS

The Assistant Secretary for Conservation and Solar Applications (CS) is responsible for developing and directing the department's overall programs in energy conservation and accelerating the application of solar energy. The immediate office of the Assistant Secretary provides overall direction of policy development and program management, thereby assuring an integrated approach to the nation's efforts in these areas. The Assistant Secretary for Conservation and Solar Applications is also responsible for the Regional Solar Energy Centers, which are described in section IV of this document.

In CS, particular emphasis is placed on technology readiness and commercialization of solar applications and energy-efficient systems and products in the end-use sectors. Offices to facilitate these functions have been established for Solar, Buildings and Community Systems, Industry, and Transportation. These offices are responsible for developing and managing programs designed to improve the efficiency of energy utilization in their respective areas. They are described in greater detail below.

The Office of Solar Applications manages a program to help establish a viable solar industry capable of contributing toward meeting our national energy requirements through effective utilization of solar energy technologies. The FY 1979 program is composed of the Heating and Cooling Demonstration Program, the Federal Buildings Solar Program, Solar Commercialization and research and technology developments consisting of: (1) Thermal Applications (heating and cooling of buildings research and development plus agricultural and industrial process heat applications); and (2) Technology Support and Utilization (environmental, resource assessment and technology transfer programs).

The Office of Buildings and Community Systems manages a program to conduct research, development, demonstration and implementation activities related to more efficient use of energy in buildings, community systems and consumer products. The overall effort is designed to increase energy utilization efficiency and provide options to substitute more abundant domestic energy sources such as coal for natural gas or oil. These program activities include buildings and community systems, urban waste, consumer products, analysis and technology transfer, small business, mandatory appliance standards and the Federal Energy Management Program.

The Office of Industrial Programs manages the CS efforts to pursue cost-shared programs for increased energy utilization efficiency and substitution of more abundant fuels for oil and natural gas in the industrial/agricultural sector. These activities will focus only on industrial energy conservation technologies which are not being expeditiously pursued by industry alone. These activities include waste energy reduction, improved process efficiency, industrial cogeneration,

industrial monitoring and analysis as well as commercialization and technology transfer.

The Office of Transportation Programs manages programs to help conserve energy in transportation through improved energy efficiency and to help reduce and eventually eliminate transportation's almost complete dependence upon petroleum. The primary thrusts are the electric and hybrid vehicle program and the gas turbine and Stirling heat engine program. In addition there are activities aimed at alternative fuels utilization, new concepts, improved vehicle and systems utilization and vehicle mileage guides.

The Office of State and Local Programs manages programs designed to provide technical and financial assistance to state and local governments to aid them in their efforts to reduce the rate of growth of energy demand in their jurisdictions.

The Office of Small Scale Technology manages the Department's grants program for assisting in the development of energy sources which are of a smaller, less capital-intensive scale and lend themselves more readily to local applications.

The Office of Commercialization provides the Assistant Secretary and Office Directors with policy direction and program assistance in the development of marketing and overall commercialization planning. This office also will be responsible for coordinating the accelerated commercialization of certain energy-efficient technologies and processes that are ready for adoption in the private sector.

The Offices of Policy and Planning and Evaluation; Institutional Liaison and Communications; and Budget and Administrative Support report to the Assistant Secretary and serve as vehicles for communicating policy and direction and providing monitoring and control.

(THIS PAGE INTENTIONALLY LEFT BLANK)

RESOURCE APPLICATIONS

RESOURCE APPLICATIONS

The Assistant Secretary for Resource Applications (RA) is responsible for managing and coordinating an array of programs which affect by actual production or through various incentive arrangements, the supply of energy sources in the United States (see organization chart). RA operational programs include the enriched uranium production to supply fuel for nuclear reactors, electric power supply and marketing through five power marketing administrations, the management of the Naval Petroleum and Oil Shale Reserves in California, Utah, and Wyoming, and policy development for leasing Federal lands. It also functions as DOE's main focal point for introducing into the marketplace proven technologies which are environmentally acceptable and economically viable. This commercialization effort will be conducted primarily through the activities of several resource managers responsible for specific technologies which have reached commercial readiness. Specific emphasis relates to producing synthetic liquids and gas from coal and shale, increasing use of hydroelectric and geothermal energy sources and developing renewable resources such as biomass. In carrying out his responsibilities, the Assistant Secretary for Resource Applications is assisted by the following.

The Deputy Assistant Secretary for Oil, Natural Gas, and Shale Resources is responsible for managing and coordinating activities related to oil and gas production by the government and private sectors and policy development for the leasing of Federal lands. Although our present resources of oil and gas are being rapidly depleted, considerable quantities of oil and gas could be produced using new or more expensive technology or by intensifying the search for resources in unproven areas. The United States is heavily dependent on liquid fuels, especially in the transportation sector, and technology which can displace this dependence is not presently available at economic prices. Therefore, one of the major roles of the Deputy Assistant Secretary is to encourage the greatest possible domestic production of liquid fuels in the 1980's to bridge the time gap until technology can economically provide us with more permanent solutions.

The Deputy Assistant Secretary for Utility and Industrial Applications is responsible for those activities which affect, through actual production or through the influence of various incentive programs, the supply of energy sources required for utility and industrial use. Emphasis is on coal utilization programs, uranium enrichment, and programs dealing with emerging technologies which would effectively displace the use of natural petroleum products as a primary energy source.

The Director of Power Marketing Coordination is responsible for coordinating and overseeing the operations of the Federal Power Marketing Administrations (PMA's) within a framework which preserves their organizational independence but ensures conformance to National Energy Policy objectives. The five PMA's are the Bonneville Power Administration

(Portland, Oregon), Southwestern Power Administration (Tulsa, Oklahoma), Southeastern Power Administration (Elberton, Georgia), Alaska Power Administration (Juneau, Alaska), and Western Power Administration (Denver, Colorado). Power in excess of that necessary to operate Government-owned hydroelectric projects is marketed to help repay the Government's investments in those projects. The PMA's are authorized to construct or acquire transmission lines and related facilities which are necessary to make the power and energy generated available at fair and reasonable prices.

SECTION III

FIELD AND PROJECT OFFICES

Albuquerque Operations Office

EXECUTIVE SUMMARY

Albuquerque Operations Office

LOCATION: Albuquerque, New Mexico

STATISTICS (FY 78) (Excludes weapons activities at Oak Ridge and Savannah River)

NUMBER OF AREA OFFICES:	7
NUMBER OF GOVERNMENT EMPLOYEES:	1,346
NUMBER OF CONTRACTOR EMPLOYEES:	29,800
ANNUAL OPERATING ALLOTMENT (NOA):	\$1,065 million
CAPITAL ALLOTMENT (NOA):	\$229 million
REIMBURSABLE WORK ALLOTMENT (NOA):	\$168 million
NUMBER OF CONTRACTS:	428
TOTAL SIZE OF FACILITIES OCCUPIED:	424,000 acres (includes Tonopah Test Range)

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o Management of the nuclear weapons research, development and production complex
- o Development of conservation and energy-related programs, including 5 megawatt Solar Thermal Test Facility and others involved in solar, geothermal, fossil, and fusion research
- o Transportation safeguards of nuclear materials and physical protection of facilities
- o Development of safe disposal methods for radioactive waste
- o Development and production of radioisotopic, thermoelectric generators
- o Management of Inhalation Toxicology Research Institute

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Los Alamos Scientific Laboratory	University of California
Sandia Laboratories	Western Electric
(Albuquerque, NM; Livermore, CA; and Tonopah Test Range, Nevada)	

<u>Facility Name</u>	<u>Contractor</u>
Rocky Flats Plant	Rockwell International
Pinellas Plant	General Electric
Mound Facility	Monsanto Research Corporation
Pantex Plant	Mason & Hanger-Silas Mason Co., Inc.
Kansas City Plant	The Bendix Corporation
Waste Isolation Pilot Plant	Westinghouse/Bechtel
Inhalation Toxicology Research Institute	Lovelace Biomedical and Environmental Research Institute

ALBUQUERQUE OPERATIONS OFFICE

BACKGROUND AND MISSION

Since the wartime 1940's, national security has been the principal mission of the nuclear weapons research, development and production complex which today embraces thirteen installations in ten states, a major portion of which includes the Department of Energy's (DOE's) Albuquerque Operations Office (AL) organization. AL resources also are assigned to meeting the Nation's energy needs.

The organization includes an operations office headquarters on Kirtland Air Force Base-East in Albuquerque, N. M., and seven area offices in Florida, Ohio, Missouri, Texas, New Mexico, and Colorado. AL employs about 1,346 direct DOE full-time permanent employees (including 545 at Albuquerque). AL's Government-owned, contractor-operated (GOCO) prime contractors employ about 29,800 persons. Within AL, about 502 DOE employees have at least one academic degree. The breakdown is as follows: bachelor's degrees, 368; master's, 104; law degrees, 25; and doctoral degrees, 5. In the field of engineering, the professional staff within AL have over 130 academic degrees.

AL administered GOCO facilities, extending from Florida to California, are located on some 660 square miles of government-owned real estate (including the Tonopah Test Range in Nevada operated by Sandia Laboratories), and have a gross book value of about \$1.9 billion. Annual operating allotments for fiscal year 1978 were \$1,056 million; fiscal 1978 capital allotments totaled about \$229 million. AL also provides support to other Federal agencies through reimbursable projects which totaled some \$168 million.

MANAGEMENT PHILOSOPHY

Individual weapons-systems are followed from earliest design conception through final retirement and disassembly by an integrated AL project team. Other AL programmatic assignments are staffed either by a matrix management or more traditional line management approach, depending on the nature of the assignment and the most efficient deployment of personnel.

In atomic energy defense activities, AL management works with a number of different industrial firms, both at the local and corporate headquarters levels. These include Bendix, General Electric, Rockwell, Monsanto Research, Western Electric, Mason & Hanger-Silas Mason Co. and others. Each contractor has clearly defined responsibilities. This requires considerable flexibility and management expertise from AL in guiding a coordinated production activity at all of the fabrication plants, including facilities located at two other operations

offices--the Y-12 Plant in Tennessee and the Savannah River Plant in South Carolina, operated by Union Carbide and duPont respectively.

AL also participates in programs under each of the six program Assistant Secretaries, although most of the activity is associated with the Defense Programs. This is made possible by scientific and technological resources that exist at the operations office and at AL's laboratories and industrial facilities.

PROGRAM WORKLOAD

In addition to operating the extensive weapons production complex, AL administers two major multiprogram laboratories, the Los Alamos Scientific Laboratory (LASL) and Sandia Laboratories (SL). Both laboratories are key elements of the weapons development complex. LASL scientists developed the first atomic weapon under the Manhattan Engineer District and later the first thermonuclear devices. Today LASL has evolved into a multi-faceted laboratory with work, in addition to its weapons design mission, under each of DOE's Assistant Secretaries. Sandia is also primarily a weapons development laboratory involved in engineering research leading to new weapons concepts and the design of nuclear ordnance in conjunction with device design laboratories like LASL. About 80 percent of Sandia's resources are dedicated to the weapons program and the remaining 20 percent are applied to energy-related program, particularly solar, fusion, fossil and nuclear energy.

AL also administers the contract work done by the Lovelace Biomedical and Environmental Research Institute at the DOE-owned Inhalation Toxicology Research Institute (ITRI) on Kirtland Air Force Base-East in Albuquerque. ITRI addresses problems concerning the effects of airborne noxious particles and gases on man and his environment, along with research associated with the inhalation of plutonium and transplutonium radionuclides.

In AL's growing support of energy programs (solar, geothermal, inertial fusion, magnetic fusion, etc.), some 200 contracts are being administered for energy-related work. Most are associated with energy programs being performed under the technical management of Sandia Laboratories and LASL. The FY 1978 funding for this work was about \$270 million. AL has completed construction in Albuquerque of the 5-Megawatt Solar Thermal Test Facility. It is the world's largest solar installation and is operated by Sandia Laboratories.

Since 1970, Ross Aviation, Inc., of Tulsa, Oklahoma, under contract to AL, has provided regularly scheduled round trip flights between Albuquerque and Los Alamos and other passenger and cargo air transportation as required by AL. Both contractor-owned and government-owned aircraft are used by Ross.

AL also operates the National Atomic Museum on Kirtland AFB-East in Albuquerque. Established by the military in 1969 and transferred to DOE (then the U.S. Energy Research and Development Administration, ERDA)-AL early in 1976, the museum is an educational exhibit for students and others who are interested in the history of nuclear weapons and energy programs.

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

Weapons Fabrication Plants

The weapons fabrication plants manufacture test devices, training weapons and war reserve stockpile weapons designed by the Los Alamos Scientific Laboratory, Lawrence Livermore Laboratory, and Sandia Laboratories in Albuquerque and Livermore, California.

Each plant has certain specific weapons-related production and procurement responsibilities. A DOE staff administers the contract and carries out rigid quality assurance functions.

Individual or shared assignments of the production facilities include: Development support work for the three weapons design laboratories; production of experimental devices and completed training and war reserve weapons; and the stockpile reliability evaluation, modification, and retirement of weapons.

The seven government-owned, contractor-operated nuclear weapon production plants represent an investment in place and authorized of about \$1.8 billion.

Each production plant has a capability that is not duplicated in the other plants or industry. The operating contractors for the plants are from among the most highly regarded industrial contractors in the United States. They are:

- Rockwell International, Rocky Flats Plant at Golden, Colorado;
- The Bendix Corp., Kansas City Plant at Kansas City, Missouri;
- General Electric Co., Pinellas Plant near Clearwater, Florida;
- Monsanto Research Corp., Mound Laboratory at Miamisburg, Ohio;
- Mason & Hanger-Silas Mason Co., Inc., at Pantex Plant near Amarillo, Texas;
- Union Carbide Corp., Y-12 Plant at Oak Ridge, Tennessee;
- duPont de Nemours and Company, at Savannah River Plant at Aiken, South Carolina.

Transportation Safeguards

AL has the responsibility to organize and operate a system for the safe-secure domestic transport of all government-owned DOE-controlled

special nuclear material in strategic amounts. Shipments are transported by rail, truck, and government and contractor-owned and contractor-operated aircraft in specially designed equipment and are escorted by armed couriers. A secure nationwide communication system has been developed to provide continuous contact between escorting security couriers and DOE's special nuclear material shipments. AL works closely with state law enforcement agencies to carry out the safeguards objective of ensuring that special nuclear material will be physically protected against theft, diversion, sabotage or vandalism. Safeguards and security surveillance also extend to nuclear materials at AL laboratories and production plants.

Radioisotopic Thermoelectric Generators

From the start of the Nation's space program, AL contractors have been involved in developing and fabricating plutonium 238-fueled heat sources for use in radioisotopic thermoelectric generators (RTG's). Power for the Voyager 1 and 2 spacecraft, launched toward Jupiter and Saturn in summer 1977 was supplied by RTGs. AL's Mound Facility fabricated the raw fuel into its final form and encapsulated the fuel for the Voyager RTGs. Sandia Laboratories provided quality control monitoring.

In addition to the Voyager missions, nuclear generators are powering five science stations on the moon and the two Jupiter fly-by Pioneer spacecraft. Nuclear generators also powered the two Mars Viking Lander spacecraft. In total, electrical power has been provided by RTGs on 17 space missions.

5 MWe Solar Thermal Test Facility

AL is currently managing the construction and operation in Albuquerque of what is the world's largest solar installation. The 5 MW Solar Thermal Test Facility (STTF), an integral part of DOE's 10 MW pilot plant program, will provide the capability to test scaled prototype receiver designs and may be used to evaluate storage concepts and heliostat designs. The facility is currently operating at the full test level. The STTF is capable of operating at a partial power level of 1 MW and is operated by Sandia Laboratories.

Regional Energy Activities

Working relationships have been established with a number of regional and state offices. AL provides assistance in the form of speakers, information, guidance, and support for state and regional activities. Working relationships have been developed with many state and regional energy organizations such as the New Mexico Department of Energy and Minerals and the three New Mexico Energy Institutes.

SIGNIFICANT ACCOMPLISHMENTS

- o Field program management of a contractor-operated industrial complex that has manufactured all weapon systems since the
- o Until 1962, when the Nevada Operations Office was established, AL was responsible for all full-scale nuclear testing of laboratory-developed devices for both national security and peaceful uses. AL laboratories now participate in testing and AL production plants manufacture nuclear test devices.
- o Beginning in 1962, AL conducted a program to withdraw the Federal Government from ownership and management of community real estate, housing, utilities and municipal facilities at Los Alamos, New Mexico. Community-transfer activities were successfully completed in 1967.
- o Development and operation of a nationwide transportation safeguards system for the transport of weapons, weapon components and DOE-owned special nuclear materials in strategic quantities. This development has extended to the safeguarding and security surveillance of nuclear materials at laboratory, plant and storage locations.
- o AL administered an energy conservation study completed by Grumman Aerospace Corporation during FY 1978. Grumman identified 119 retrofits of existing facilities with a potential savings of 1,693 billion Btu's per year. Total implementation costs for the above projects are estimated at \$21 million.

Studies to identify alternate energy sources for the central steam plants at each AL administered site were in progress at the end of FY 1978. Budget requests for central steam plant conversions at Pantex, Mound, Kansas City, Los Alamos, Pinellas and Rocky Flats are scheduled for FY 1981. The Sandia budget request will be for FY 1982.

A view of the Secure Communications Control Center at DOE's Albuquerque Operations Office as part of the transportation safeguards system that transports DOE-owned special nuclear material. Continuous radio contact is maintained with security couriers who escort the shipments.

One of the safe, secure trailers operated by DOE's Albuquerque Operations Office to provide safe and secure shipment of DOE-owned special nuclear materials.

Chicago Operations & Regional Office

EXECUTIVE SUMMARY

Chicago Operations and Regional Office*LOCATION: Argonne, IllinoisSTATISTICS (FY 78)

NUMBER OF AREA OFFICES:	3
NUMBER OF GOVERNMENT EMPLOYEES:	428
NUMBER OF CONTRACTOR EMPLOYEES:	11,400
ANNUAL OPERATING BUDGET:	\$700 million
CONSTRUCTION COSTS:	\$200 million
TOTAL \$ OF REIMBURSABLE PROJECTS:	\$40 million
NUMBER OF CONTRACTS:	1,800

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o District Heating Through Power Plant Retrofit Demonstration
- o Tokamak Fusion Test Reactor
- o Safety Research Experimental Facilities--Phase One
- o Breeder Reactor Component
- o Grid-Connected Integrated Community Energy System
- o Conversion of Refuse to Methane
- o Solar Heating and Cooling Demonstration Program
- o Battery Energy Storage
- o National Synchrotron Light Source
- o Intense Pulsed Neutron Source
- o Proton-Proton Intersecting Storage Facility
- o Low-BTU Gasification
- o SERI and Regional Solar Energy Research Centers
- o Energy Saver
- o Intersecting Storage Accelerator (ISABELLE)
- o Geothermal Materials
- o MHD Open Cycle
- o MHD Heat Recovery Seed Recovery
- o Solar Technology

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Argonne National Laboratory	The University of Chicago and Argonne Universities Association
Brookhaven National Laboratory	Associated Universities, Inc.

*The Chicago Operations Office and the Region V Office were consolidated on January 25, 1979.

Ames Laboratory
Princeton Plasma Physics Laboratory
Fermi National Accelerator Laboratory

Bates Linear Accelerator Facility

New Brunswick Laboratory
Notre Dame Radiation Laboratory
Franklin McLean Memorial Research
Institute

Radiobiology Laboratory
Michigan State University (MSU)/DOE Plant
Research Laboratory

University of Rochester Medical Laboratory
Solar Energy Research Institute

Iowa State University
Princeton University
Universities Research
Association
Massachusetts Institute
of Technology
Federally Operated
University of Notre Dame
University of Chicago

University of Utah
Michigan State University

University of Rochester
Midwest Research, Inc.

CHICAGO OPERATIONS OFFICE

BACKGROUND AND MISSION

The Chicago Operations Office has always been at the forefront of developing new energy technologies. During the 1950's and 1960's, Chicago Operations was intimately involved in the Nation's reactor development program, participating in the design, engineering and construction of the Nation's first nuclear reactors for submarine propulsion, the first boiling water reactor and early experimental breeder reactors. Chicago also had a lead role in the design and construction of pioneer nuclear power facilities for the Power Reactor Demonstration Program. This represented one of the Nation's first attempts to culminate an energy research and development program with the commercial demonstration of a new technology.

In January 1979, the research and development and regional activities of the department management in the Chicago area were combined into the new Chicago Operations and Regional Office. Located in the Chicago metropolitan area, this new organization is characterized by contract, procurement, project and program management activity involving all of DOE's major program areas. Its 457 employees are stationed at nine offices linking virtually the entire Midwest and Northeast Department of Energy (DOE) system of contractors, laboratories, and major projects.

The office's regional responsibilities involve dealings with the general public, state and local officials, business and labor, and other groups concerned with energy policy and planning in Region V, which includes Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin. In addition, the office is responsible for administering the department's state grant programs and for coordinating energy planning activities in the region.

Professional backgrounds of Chicago employees range from science and engineering to business administration and include attorneys, accountants and auditors, computer and communications specialists and clerical workers. About a quarter of the Chicago Operations employees are technically trained--scientists, engineers and health physicists. This includes the staff of the New Brunswick Laboratory, located at the Argonne site, which is responsible for precise and analytical measurements used to verify nuclear materials inventories in support of the nuclear safeguards program.

MANAGEMENT PHILOSOPHY

The management approach of Chicago Operations and Regional Office is designed to support DOE's efforts to develop new energy alternatives. It attempts to maintain the flexibility necessary to take on new assignments and missions while sustaining effective management of normal workloads.

The selection, negotiation, execution and administration of contracts are organized in contract management groups and in area offices in the East and Midwest.

Chicago management is rapidly identifying resources and organizing efforts to fulfill major project management responsibilities as they are developed by DOE's program managers. Project management is organized either by creating fully dedicated organizational units and staffs or by the flexible assembly of teams or work forces of individuals who report to functional managers. For the duration of a project or as needed, functional specialists support the Chicago program coordinator or project manager selected from engineering or other technical groups.

The management philosophy and organization flexibility provided by the Chicago approach presents a pliable and tailor-made management structure for the planning, execution, control and evaluation of DOE's diverse programs, particularly project management and other program support activities.

PROGRAM WORKLOAD

Chicago Operations and Regional Office facilities and major government-owned installations include multiprogram laboratories such as Argonne and Brookhaven National Laboratories and Ames Laboratory; specialized physical research facilities such as the Princeton Plasma Physics Laboratory in New Jersey, the Notre Dame Radiation Laboratory in Indiana, the Fermi National Accelerator Laboratory (FERMILAB) in Illinois, the Bates Linear Accelerator Facility in Massachusetts and the DOE-operated New Brunswick Laboratory in Illinois; specialized biomedical research laboratories such as the Franklin McLean Memorial Research Institute in Chicago, the Radiobiology Laboratory in Utah, Michigan State University/DOE Plant Research Laboratory, University of Rochester Medical Laboratory in New York and others. Contracts for the national Solar Energy Research Institute (SERI) in Colorado and regional solar energy research centers are administered by Chicago.

In addition, Chicago Operations administers more than 1,800 contracts annually with businesses, industries, educational and non-profit organizations in the 40 states and 10 foreign countries. In total this represents a commitment of more than \$700 million annually in operating costs and a public investment valued in plant and equipment at over \$1.5 billion.

Nineteen grants administered by the Chicago Operations and Regional Office involved approximately \$71.5 million in FY 1979. This includes grants-in-aid to state and local governments, state planning grants under the Energy Policy and Conservation Act (EPCA), and other granting activities designed to provide assistance to state governments in the area of intergovernmental coordination, public education, and residential and non-residential energy audits. Weatherization program activities for the low income and elderly and for schools, hospitals and

public buildings are also carried out through regionally administered state grants authorized by the National Energy Act.

MAJOR PROGRAMS AND PROJECT ASSIGNMENTS

The range of research, development and demonstration projects involved in Chicago-administered contracts is as broad as DOE's mission. It encompasses enhanced recovery of oil, the production of synthetic fuels from coal, demonstrations of conservation, solar heating and cooling, and other alternative energy technologies. Also included are development of energy storage facilities, advanced coal combustion methods, fusion test devices, components and technologies in support of the prototype breeder reactor program, high-level radioactive waste management, nuclear fuel reprocessing and improvements in light water reactors. It includes studies of the biomedical and environmental impacts of energy production. Basic energy science and physics research also receive support from Chicago-administered contracts. Chicago has extensive responsibilities contributing to the success of many important energy research, development and demonstration projects, some of which are described below.

Tokamak Fusion Test Reactor (TFTR)

This \$239 million facility being constructed at the Princeton Plasma Physics Laboratory (PPPL) in Princeton, New Jersey, is expected to be the first fusion device to produce significant fusion energy. Chicago's Princeton Area Office provides on-site administration of contracts for the construction of TFTR and the operation of PPPL, one of DOE's major magnetic confinement fusion laboratories.

Safety Research Experiment Facilities--Phase One

Chicago has been assigned the responsibility for a \$27.7 million modification of the Transient Reactor Test (TREAT) Facility at Argonne's western site in Idaho. In fulfilling this responsibility, a project office has been established to manage this effort.

Breeder Reactor Component Development

Chicago has been assigned responsibility in conjunction with the Argonne National Laboratory for the program management and contract administration of the breeder reactor component development program. The purpose of the program is to develop large breeder reactor plant components, including steam generators, intermediate heat exchangers, pumps, valves, piping and related components.

Grid-Connected Integrated Community Energy System (ICES)

Chicago has program management and contract administration responsibility for this 10-year project to operate and evaluate a community energy

system with substantial energy conservation potential. ICES will provide maximum energy efficiency for a community building complex by producing heat for space heating and cooling while generating electricity as a by-product and making use of plant waste heat for domestic hot water. Municipal solid waste may be burned in the power plant to supplement fossil fuels and surplus electricity will be transmitted to the local utility grid.

Solar Heating and Cooling Demonstrations

Chicago has been assigned responsibility for project management as well as contractor selection and contract management for the DOE solar heating and cooling demonstrations, solar thermal energy storage, passive solar, systems analysis, and agricultural and industrial process heating. Further, Chicago employees were involved in selection boards established to evaluate responses to solar demonstration requests for proposals issued in 1977. Some of the solar demonstrations in which Chicago is involved include the City of Chicago Navy Pier, Bell Telephone Company's Work Center in West Chester, Pennsylvania, and the Basin Electric Power Cooperative headquarters building in Bismarck, North Dakota.

Battery Energy Storage Program

Chicago has been assigned the technical program management responsibility for a major part of DOE's electrochemical energy storage program. Various batteries for electric vehicle applications and utility load-leveling are being developed by DOE contractor under this program.

Battery types include zinc/chlorine, zinc/bromine, lithium/sulfur, iron/air and lithium/air. Chicago also has responsibility for development of key components of battery systems. The Battery Energy Storage and Test (BEST) facility is being constructed in New Jersey by Public Service Electric and Gas Company under a contract with Chicago. The BEST facility will provide an opportunity to test various battery systems in a load-leveling capacity on a working utility grid.

Storage Battery Electrical Energy Demonstratoin (SBEED) Facility

In addition to BEST, Chicago has been given the technical responsibility for Storage Battery Electrical Energy Demonstration (SBEED) facility. The objectives of this project are the design, construction, testing, acceptance and operation of the facility. The SBEED plant will be the first commercial-scale operation of the combined thermal, electrical, and mechanical systems necessary for load-leveling in a peak-shaving battery plant.

Intersection Storage Accelerator (ISABELLE)

Chicago has been assigned responsibility for management and contract administration of the estimated \$275 million ISABELLE project at Brookhaven. The ISABELLE project involves two accelerating storage rings in

The RefCom "Garbage-to-Gas" Plant, completed in 1978, is located in Pompano Beach, Florida. It includes a Shredded Wastes Storage Building (center), Wastes Classification Building (right background), and Digester Tanks (left).

a common tunnel adjacent to the existing Alternating Gradient Synchrotron (AGS). Protons of 29.4 billion electron volts (GeV) will be injected into each ring from the AGS in such a way that the protons stored in each ring rotate in opposite directions. After injection, the protons will be accelerated to approximately 400 GeV, held in storage and, finally, directed into controlled proton-proton collisions. Facilities will be provided at the points of interaction for high energy colliding beam physics experiments.

Breeder Reactor Safety Development

Chicago has been assigned responsibility in conjunction with the Argonne National Laboratory in the program management and contract administration of the Breeder Reactor Safety Development activity. The purpose of this effort is to develop safety technology in support of various breeder reactor concepts.

Magnetohydrodynamics (MHD)--Heat Recovery and Seed Recovery System

Chicago has been assigned the responsibility for the management of selected components and systems to be installed and tested in the University of Tennessee Space Institute. The purpose of this project is to develop the Heat Recovery and Seed Recovery System for the open cycle MHD power cycle.

Low Btu Fuel Gas Demonstration

Chicago has been assigned the responsibility and the delegated authority for the management of the Low Btu Fuel Gasification Projects. The objectives of the fuel gasification projects are to demonstrate the economics and technical viability of substituting coal for natural gas and/or oil to produce a fuel gas for use in electric power generation.

SIGNIFICANT ACCOMPLISHMENTS

With its roots in the early development of nuclear energy, the Chicago Operations and Regional Office has participated in some of the major construction and development projects which created DOE's system of laboratories and facilities. These include:

- o Design and construction of Argonne National Laboratory, including construction and operation of major experimental reactors and research facilities such as Experimental Breeder Reactor I and II, the Experimental Boiling Water Reactor, Zero Power Plutonium Reactor, Zero Power Reactors 6 and 9 and the Zero Gradient Synchrotron.

- o On-site administration of the contract for construction of the Fermi National Accelerator Laboratory, consisting of the world's highest energy proton synchrotron particle accelerator and related facilities.
- o Lead role in the design and construction of the second-round facilities of the Power Reactor Demonstration Program, including the Piqua Nuclear Power Facility, Hallam Nuclear Power Facility, the Elk River Reactor and the LaCrosse Boiling Water Reactor.
- o Successful completion and initial operation of the \$2.8 million RefCOM Facility (Refuse Conversion to Methane). Constructed by Waste Management, Inc., of Oak Brook, Illinois, under a Chicago contract, this facility will soon go into full operation. RefCOM will convert 100 tons of urban solid waste per day into 300,000 cubic feet of methane, the major constituent of natural gas.
- o Construction of the \$4.3 million addition to the New Brunswick Laboratory. This new facility provides expanded technical capabilities to New Brunswick, which serves as the department's primary safeguards analytical laboratory.

In addition to these construction-related activities, Chicago Operations has:

- o Developed a long tradition of successful interaction and communication with the university community as the DOE office with responsibility for the bulk of the agency's university contracts.
- o Awarded, negotiated and administered an ever-increasing number of complex industrial research and development contracts across the full spectrum of energy programs.
- o Promoted the development of effective and competent state radiological assistance capability through Chicago's regional role in the Interagency Radiological Assistance Program (IRAP). Through the IRAP program, Chicago has carried out briefings and training programs for state agencies, law enforcement groups and emergency response teams aimed at improving state capabilities to handle radiological emergencies.

Idaho Operations Office

EXECUTIVE SUMMARY

Idaho Operations Office

LOCATION: Idaho Falls, Idaho

STATISTICS (FY 78)

NUMBER OF AREA OFFICES:	0
NUMBER OF GOVERNMENT EMPLOYEES:	370
NUMBER OF CONTRACTOR EMPLOYEES:	6,119
ANNUAL OPERATING BUDGET:	\$144 million
CONSTRUCTION COSTS:	\$55 million
TOTAL \$ OF REIMBURSABLE PROJECTS:	\$51 million
NUMBER OF ACTIVE CONTRACTS:	353
SIZE OF RESERVATION:	572,267 acres

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o Water Reactor Safety Program
- o Energy Conservation Contracting and Administration
- o Geothermal Energy Project
- o Magnetohydrodynamics Construction Project
- o Low-Lead Hydro Program
- o Reactor Fuel Reprocessing and Waste Management
- o Nuclear Energy Development

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Idaho National Engineering Laboratory	EG&G Idaho, Inc.
Idaho Chemical Processing Plant	Allied Chemical Corporation
Raft River Geothermal Project Management Office	EG&G Idaho, Inc.
MHD-Component Development Integration Facility	Federally operated

IDAHO OPERATIONS OFFICE

BACKGROUND AND MISSION

The National Reactor Testing Station (NRTS) was established in 1949 as an isolated site for testing of various nuclear reactors and for the associated support facilities. The principal mission was to support the demonstration of safe and efficient power generation by using nuclear reactors. The site was renamed Idaho National Engineering Laboratory (INEL) in 1974 to better reflect the engineering development role of the water reactor safety program, and to reflect the expanding operations in the nonnuclear energy programs. Currently INEL supports the missions of all six Department of Energy (DOE) program Assistant Secretaries.

The Idaho Operations Office (ID) administers operations at the INEL from offices centered in the city of Idaho Falls. Various professionals are located on site. The total government employment is 370 employees, 176 are engaged in direction and support of technical programs, contract administration, and industrial-institutional relations. The remaining 194 employees are responsible for security, fire protection, medical services, and for operating the Radiological and Environmental Sciences Laboratory (RESL). The RESL provides analytical chemistry, dosimetry and environmental monitoring for all on-site activities; supports the Nuclear Regulatory Commission's (NRC) Region IV Office of Inspection and Enforcement Division; and administers the National Environmental Research Park represented by the site.

ID staff has extensive experience in:

1. Project management both on- and off-site.
2. Working and advisory relations with state, county, city, and other Federal agencies in support of DOE objectives.
3. Contract and procurement management of 353 active contracts. Four major contracts are cost-plus-award-fee. University and industrial contracts include national programs in the geothermal and conservation areas.
4. University relations involving Associated Western Universities and a graduate education program for the INEL site.

MANAGEMENT PHILOSOPHY

ID advocates an interactive and coordinated program and contract-management approach utilizing matrix management in both ID and contractors. The philosophy for new work is to pursue and encourage it only

to the extent that a management plan can be developed to produce creditable results.

PROGRAM WORK LOAD

ID is responsible for an annual budget of \$199.8 million, which includes \$55.4 million in construction projects. Current active contracts number 353 and include university, large industrial, small and minority businesses, and non-profit organizations. Program direction and management responsibilities include programs under contract for the Nuclear Regulatory Commission (NRC) which constitute approximately one-third of the overall operating budget.

In the non-nuclear program areas, ID operates a construction-management office at Butte, Montana, for the construction phase of MHD-CDIF, and a management office at Burley, Idaho, for the Raft River Geothermal Project.

ID has established a unique contract administration approach to certain conservation and geothermal research and development contracts, utilizing both operating contractor technical expertise and ID management expertise to fulfill the contract administration and program management role as delegated by DOE headquarters divisions.

In the area of nuclear energy development, ID is responsible for spent nuclear fuel reprocessing and recovery of nuclear fuel for several test reactors, the nuclear naval fleets, and other non-commercial type fuels, as well as the processing of liquid waste into a dry (calcine) form for intermediate term storage. A radioactive waste management complex is operated for the storage and disposal of low-level wastes. Other areas of program support include environmental research and development, basic energy sciences, and nuclear materials management and safeguards.

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

Water Reactor Safety Program

The bulk of the Federal Government's longtime program for investigating the safety of water-cooled reactors has been centered at the Idaho National Engineering Laboratory since 1955.

Currently, the Water Reactor Safety Program (WRSP) is directed toward fuel behavior and the behavior of a nuclear power plant and its safety systems during a hypothetical loss-of-coolant accident (LOCA). Such an accident--though none has occurred during some 25 years' experience in operating dozens of water-cooled reactors--is being studied in accordance with the Nation's policy of continuing to seek information that

can be used to resolve safety issues related to reactor design, licensing, and operation. The WRSP is being furthered at INEL by several testing and analysis programs, including the Loss of Fluid Test (LOFT) integral test program.

The major component of LOFT is the test assembly which consists of a 55-thermal-megawatt reactor system and primary coolant system mounted on a double-width, rail-transportable test dolly. The test assembly is installed in a high-pressure containment building.

The LOFT system is heavily instrumented with high-temperature thermocouples and other specially developed in-core instrumentation to measure temperatures, flow, pressures and coolant levels inside the reactor vessel following a simulated LOCA.

The experimental objectives of the LOFT test program are:

1. Providing the numerical data required so that analytical methods or computer codes can be evaluated to see if they are adequate and also modified where needed in order to improve their accuracy. These codes are used to predict: (a) what happens in large pressurized water reactors (PWR) when a LOCA occurs; (b) the manner in which current engineered safety features of commercial nuclear plants, such as emergency core cooling systems (ECCS), perform when activated and how effective they are during a LOCA; and (c) the quantitative margins of safety provided by the current designs of engineering safety features for PWR's in the event of a LOCA.
2. Identifying and then investigating any unexpected events or thresholds which conceivably could occur during the performance of either a nuclear power plant or its engineered safety features and then developing analytical techniques that adequately describe and account for such unexpected behavior, if any.

The test program includes both non-nuclear and nuclear test series. The non-nuclear tests have been completed and nuclear fuel has been loaded. A series of tests with a nuclear fuel core operating is scheduled to begin and continue well into the 1980's.

WRSP work at the INEL is conducted by DOE for the NRC. The experimental data will be used by the NRC to assess the degree of conservatism in analytical codes used to assess reactor safety of large reactors during the licensing process. The data will also permit evaluation of engineering safety systems interactions during and following a loss-of-coolant accident. DOE is funding for the completion and operational checkout of the facility. NRC is funding for the programmatic and experimental instrumentation.

Geothermal Energy Project

DOE's Idaho National Engineering Laboratory is identifying and solving the technical problems associated with using moderate-temperature geothermal water of about 300 degrees Fahrenheit (150 degrees Celsius) either to produce electric power or for food processing and other non-electric uses.

INEL scientists and engineers are developing the technology necessary to apply such moderate-temperature energy sources commercially. These programs involve two basic efforts: to develop advanced systems for generating economic electricity from moderate-temperature geothermal water; and to work with industries and state governments on ways to use the water for industrial process heat and other direct applications.

To develop this new technology, a suitable geothermal resource was developed in the Raft River Valley of south-central Idaho. This phase of the project was a cooperative effort involving the U. S. Geological Survey, State of Idaho, and area universities. New techniques were developed both for finding geothermal water sites and for drilling into the reservoirs. Six successful deep geothermal wells have been completed, and work is continuing on a seventh well. Four of these wells can produce about 600 gallons per minute of artesian flow with bottom hole temperatures of 296 degrees F. Three wells are used for reinjecting the water back beneath the land surface. The depth of the producing wells ranges from 5,000 to 6,500 feet and the depth of the reinjection wells is about 3000 to 4000 feet.

Design has been completed for construction of a 40-megawatt thermal (hot) loop with the capacity to generate 5 megawatts of electrical energy, enough to meet the power needs of about 5,000 people. Construction started in summer 1978 and will be completed in 1980. The facility will provide a field laboratory capable of producing operating information on hot water power systems. Components can be changed for testing new or advanced designs. All aspects of an operating power system will be carefully evaluated, including the environmental impact, management of water withdrawal and reinjection, system scaling and corrosion, component efficiencies, and electric power generating economics.

INEL is also engaged in developing technology and information for commercial, non-electric applications of moderate-temperature geothermal water. Possible applications include food drying and processing, space heating for homes and commercial buildings, fish farming, irrigation, and many others.

Hot water, at about 300° Fahrenheit, flashes to steam above ground at one of DOE's Raft River Geothermal Wells in south-central Idaho. Depth of hot water is about 4,200 feet. Design is underway for an estimated \$15 million pilot plant to study feasibility of using such medium temperature water to generate economic electric power.

DOE programs at INEL are cooperative efforts involving industry, state and local governments, other federal agencies, and area universities. Through this broad base of participation the required talent is being focused on the development effort with the goal of expediting transfer of geothermal technology to industry and the consumer.

Magnetohydrodynamic Construction Project

DOE's Idaho Operations Office is responsible for constructing a facility in Butte, Montana, to develop components for generating electricity direct from hot coal-fired gases--the magnetohydrodynamic (MHD) technology.

Through its Butte project director, DOE-ID administers and has technical direction of a contract to construct the MHD Component Development and Integration Facility (CDIF) and also has technical direction of DOE's architect-engineering contract for construction inspection and engineering support.

MHD systems would convert coal to a hot gas that moves at high velocity through a magnetic field to produce electricity at much higher efficiency than conventional coal-fired steam turbine generators. The CDIF will provide engineering data on test components for DOE's MHD research project aimed at developing a complete MHD electrical generation facility. CDIF test components will include the coal feed system, coal combustor, and MHD electrical generation channel.

The 53-acre CDIF construction site is located in an industrial park 5 miles south of Butte, Montana. Estimated cost of the facility is approximately \$37 million, with completion scheduled for mid-1979. Procurement and other support services will be provided by ID.

Low-Head Hydro Program

The development of new hydroelectric projects in the United States has essentially stopped. The basic reason new hydroelectric projects are not being undertaken is that high-dam sites which are available for development are usually environmentally protected. The low-head hydro technology, which has not been pursued in the U. S., has been popular in Europe for the past three decades and is well understood. The reason the low-head hydro systems have been neglected in the U. S. is one of economics. The high-head hydro systems can generate electric power for a fraction of the cost of low-head systems and where high-head dams could not be constructed, fossil fuels could produce power more economically than the low-head systems. The economics of energy systems have recently changed however, because high-head dam sites are essentially unavailable and because of the rising cost of fossil fuel.

The DOE low-head hydroelectric program is designed to stimulate rapid development of the public and private use of this renewable resource,

which offers a large potential in the U. S. The potential electric power from low-head hydroelectric sites that have been identified could provide 40 to 50 percent of the nation's current electrical usage.

Specifically, the ID program has two objectives: review and recommend action on proposals submitted to DOE and recommend development and demonstration projects for support. Currently, DOE has negotiated a contract with the city of Idaho Falls, involving the installation in the Snake River of three 7 megawatt bulb turbines for electrical generation in low-head dams. This project will also serve as a technology base which will be transferred to the maximum extent to the private sector. ID is presently negotiating 56 contracts for feasibility assessments for installing hydroelectric generation equipment at existing low-head dams in 30 states and Puerto Rico.

Major New On-Site Construction Projects

- o An \$81 million New Waste Calcining Facility (NWCF) will provide the necessary capability to calcine (solidify) into a granular form the liquid wastes stored in the tank farm.
- o The Fluorinel facility (\$175M) will provide the necessary modifications to process advanced fuels and the necessary space to store the fuel prior to being processed.
- o The fifth set of calcine storage bins (\$12.5M) is being constructed to store the calcine after the liquid waste has been processed through the NWCF.
- o The Raft River Thermal Loop Facility (\$8.5 M) will provide a field laboratory capable of producing operating information on hot water power systems.
- o Rover Fuel Processing Facilities (\$7.8 M) is designed for the recovering of uranium from nuclear rocket (Rover) fuel.
- o Radioactive Liquid Waste System Improvements (\$5.8 M) will provide more accurate measurement of liquid levels in waste storage tanks, better leak detection in underground piping, and protection against ground water leakage into waste tank vaults.
- o Personnel Protection and Support Facilities (\$10.5 M) will provide reduced radiation exposure in the recovery of unburned uranium from uranium fuel elements.

SIGNIFICANT ACCOMPLISHMENTS

- o First production of useful amounts of electric power (EBR-I) from nuclear heat. (1951)
- o World's first high flux Material Testing Reactor achieved power operation. (1952)
- o First plant-scale solidification of highly radioactive waste liquids.
- o First plant-scale processing of highly enriched zirconium-uranium alloy reactor fuels. (1965)
- o Establishment and successful implementation of interim storage procedures for transuranic waste. (1970)
- o First nonnuclear blowdown test stimulating a pressurized water reactor loss-of-coolant accident at LOFT. (1976)

Nevada Operations Office

EXECUTIVE SUMMARY

Nevada Operations Office

LOCATION: Las Vegas, Nevada

STATISTICS (FY 78)

NUMBER OF AREA OFFICES:	0 (two support offices)
NUMBER OF GOVERNMENT EMPLOYEES:	255
NUMBER OF CONTRACTOR EMPLOYEES:	5,200
ANNUAL OPERATING BUDGET:	\$201.9 million
CONSTRUCTION COSTS:	\$1.9 million
TOTAL \$ OF REIMBURSABLE PROJECTS:	\$55.7 million
NUMBER OF CONTRACTS:	163
SIZE OF RESERVATION:	814,448 acres

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o Underground Nuclear Test Operations
- o Nuclear Waste Management
- o Gas Recovery
- o Geothermal Energy Development
- o Pacific Area Programs

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Nevada Test Site	Reynolds Electrical & Engineering Co., Inc.

NEVADA OPERATIONS OFFICE

BACKGROUND AND MISSION

The Nevada Operations Office (NV) was created and assumed responsibility for nuclear weapons testing and other operations and programs at the Nevada Test Site (NTS) in March 1962 when nuclear weapons testing became a year-round effort.

The United States Government has announced 604 nuclear tests as of September 30, 1978. Of these, 478 have been conducted at the NTS, including 84 atmospheric tests, seven joint United States-United Kingdom tests, and 27 Plowshare (peaceful purposes) tests at NTS and other locations. NV responsibility at NTS involves operational and logistical support of weapons development testing efforts, including both nuclear and chemical high explosive detonations. NV directs extensive safety and environmental programs in support of this responsibility.

NV's work and interest include not only the 1,350 square mile Nevada Test Site, but several islands in the remote Pacific Ocean and permanent location at Andrews Air Force Base, Maryland. NV has the responsibility for the radiological support associated with the Department of Defense (DOD) clean-up rehabilitation and population resettlement the Enewetak Atoll where atmospheric tests were conducted in the late 1940's and 50's. Partly in support of this cleanup and resettlement effort, NV operates a research ship outfitted for medical surveys and scientific investigations of the long-term effects of radionuclides in the environment and their significance to man. The ship also supports other Department of Energy (DOE) research activities conducted at the mid-Pacific Marine Laboratory on Enewetak. NV has an office in Honolulu, the Pacific Area Support Office, which is responsible for logistics in the Pacific and, in cooperation with the Defense Nuclear Agency, for maintenance of test readiness facilities on Johnston Island.

NV is also assembling a team of scientists and technicians from DOE and laboratory personnel to monitor certain peaceful nuclear explosions (PNE) in the Soviet Union, as required under the terms of the Peaceful Nuclear Explosions Treaties signed in 1976.

In supporting the underground Nuclear Test Program, NV has developed drilling and tunneling experience, especially big-hole drilling at NTS, which probably rivals that of any industrial organization. Ordinary drilling for petroleum uses drill bit diameters of less than one foot. Nuclear weapons canisters containing diagnostic equipment require much larger holes. Nevada contractors Fenix & Scission, Inc., and Reynolds Electrical & Engineering Company have developed drill bits that now can bore holes up to 12 feet in diameter and thousands of feet deep in one pass. Examples of big-hole drilling accomplishments are a 90-inch-diameter hole about 6,100 feet deep on Amchitka and a hole 120 inches in diameter more than 5,000 feet deep in Nevada.

The Government-owned Ideco 2,500 drill rig at the Nevada Test Site. This rig is capable of drilling 10-foot-diameter holes to a depth of 4,000 feet.

NV's expertise in drilling has also been used in several energy research and development programs, including the drilling of geothermal wells in Idaho's Raft River Basin in cooperation with the Idaho Operations Office, and in massive hydraulic fracturing experiments in the Piceance Basin of western Colorado in cooperation with the Bartlesville Energy Technology Center and industry.

NV's management skills, its contractors, and physical resources provide potential for an enlarged role in energy programs.

NV has a highly professional staff. Full-time employees number 255, of which 182 (71 percent) are professionals with 141 (77 percent) holding college degrees. Of the 141 college graduates, 39 have masters degrees, three have doctorates and five juris doctorates of law.

MANAGEMENT PHILOSOPHY

NV has been responsible for design, construction, maintenance, and operations of nuclear weapons and non-weapons experimental sites for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), and DOE. NV management practices, using a matrix management system, include planning, coordinating, programming, and administering contracts for unique technical services. The user organization may be DOE-sponsored or a government organization entirely separate from DOE, such as DOD or the Department of the Interior.

NV has also demonstrated the capability to assist industry in energy-related research and development programs. Specific planning procedures have evolved during the past decade: (1) Proposal phase: the NV staff assists the proponent in developing data required for project development and conducts the necessary studies and evaluation of project proposals; (2) project definition phase: the NV staff (a) coordinates site selection activities, (b) assists in preparing project definition plans, and (c) negotiates contracts and agreements for field execution of a proposed experiment; and (3) project execution phase: executes the contract with the industry partner or otherwise arranges for conducting the project for demonstration.

For each of the major field projects that NV manages, a joint office of information is formed and utilized to carry out public information activities. Principal tasks include holding public meetings with local officials, civic and business groups, and local residents, issuing written and visual information regarding structural programs, preparing fact books for distribution to interested individuals and groups, developing and conducting appropriate official and news media visitor programs, and establishing a visitors bureau. NV has developed a fine image in Nevada. This image has been reflected in the highly favorable attitudes of the governor, other political leaders in the state and local governments, business leaders, and the public at large. It has evolved from professionalism and candor in conducting the underground

test program and openness in the NV public affairs program, and from participation of the many employees in local, civic-oriented programs.

NV, as other field offices, also has developed broad experience in working with laboratories and contractors. Because of this experience, NV management philosophy is one of responsiveness to DOE's energy needs.

Program Workload

In supporting the needs of the laboratories and other DOE Headquarters assignments, NV maintains a diverse mix of contractor resources including universities and individuals. NV administers some 163 contracts and agreements.

The fiscal 1978 operating budget was \$201.9 million. An additional \$55.7 million supported work for other Federal agencies, primarily the DOD.

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

Test Operations

The primary mission at the Nevada Test Site is to conduct underground nuclear tests. The experiments at the NTS represent an extension of the scientific work conducted at the three weapons laboratories (Los Alamos Scientific Laboratory, Lawrence Livermore Laboratory and Sandia Laboratories) and the weapons effects program of the Defense Nuclear Agency. In a real sense, the NTS is actually a well-equipped scientific research laboratory where very complex phenomena are studied under difficult conditions. Underground nuclear experiments involve the release of enormous amounts of energy, and entail very high costs and very short timeframes for performing scientific experiments. The prime purpose of the underground testing is to support the device design development process for the Nation's nuclear weapons programs. The family of NV contractors provides support services in a wide range of activities including construction, drilling, mining, electrical, technical, environmental, and common camp support and maintenance. In total, approximately 4,000 people are employed in support of the underground test program.

Waste Management Program

The Nevada Operations Office has been directed to examine the suitability of geologic formations at the NTS for use in terminal storage of high-level radioactive wastes and/or spent fuel assemblies. Shale, tuff, and granitic formations will be examined.

Studies are being conducted of the candidate media to determine the thermal and radiological effects of radioactive waste on the medium and

the ability of the medium to perform as a geologic barrier to retard nuclide migration. In addition, the program will determine if sufficiently large masses of these media exist on the NTS and if waste management use of these masses is compatible with the nuclear weapons testing program.

As currently planned, the project envisions: (1) preliminary experiments near-surface to determine rock characteristics and effects from a long-term electrical heat source, (2) the construction of a test chamber at depth to measure thermal (and possibly radiation) effects on the medium, and (3) the field surveys and evaluations required for possible selection, certification and recommendation of a terminal waste repository site. Similar investigations will be conducted in other NTS geological formations.

Funding level for fiscal 1978 was \$9.4 million and \$16.1 million for fiscal 1979.

The Nevada Operations Office (NV) has also been directed to assist the Richland Operations Office in a demonstration project for near surface storage of spent unprocessed reactor fuel assemblies at NTS. NV prototype tests and production test operations by 1981 in order to establish a basis for industrial scale designs and operations for a facility by 1985. The overall assignment includes development and evaluation of technical and support studies including the analysis of tunnel storage and assessment of the impact on business and legislative requirements in Nevada.

The funding level for fiscal 1978 was \$6.3 million.

Fossil Energy Program

The DOE has initiated a multi-year Western Gas Sands Project (WGSP) directed toward developing significant additional sources of natural gas in the United States. Four primary study areas have been selected. They are: (1) the Greater Green River Basin, (2) the Northern Great Plains Province, (3) the Piceance Basin, and (4) the Uinta Basin. Under the WGSP, data from massive hydraulic fracturing (MHF) treatments, special core analysis, well logs, and geologic observations will be used to develop a computer model simulating in situ conditions in each of the tight gas sand reservoirs.

To implement this program NV has entered into cost sharing and total funding contracts with industry to acquire the necessary data and analysis to enhance the recovery of gas from these massive tight gas sands. The project, as currently conceived, spans eight years and the DOE's contribution has been estimated at \$150 million. The rate of technological development depends upon the yearly budget levels.

The Handley Event Canister is being lowered down hole at Pahute Mesa. The Handley Test — more than one megaton — was conducted in March, 1970. The platform at right is a cable chute that guides the timing and firing and diagnostic cables down hole without crimping them with a sharp right angle turn.

Geothermal Energy Program

NV has major administrative and technical monitoring responsibilities for geothermal reservoir assessment activities throughout the United States. Areas involved are the Basin and Range and Cascade Mountain provinces which include most of Nevada and parts of Utah, California, Oregon and Idaho; the Atlantic Coastal Plain from New Jersey to Florida; and the Gulf Coast portions of Texas and Louisiana. The activities, initiated primarily through the request for proposal (RFP) process range from the drilling of deep exploratory holes to depths in excess of 10,000 feet to surface geological surveys. Both cost sharing and fixed price contracts with industrial participants are being utilized with total program costs through 1980 expected to exceed \$30 million.

Pacific Area Programs

Since late 1972, NV has been working with the Departments of the Defense and Interior toward the ultimate resettlement of the people of Enewetak. During fiscal 1976 the Defense Department received an appropriation of \$20 million in Military Construction funds to be supplemented by programmed resources of the Military Departments. NV has received \$1.5 million of the \$20 million for its technical support of the DOD project and this funding has been supplemented by DOE funds (\$.3 million in FY 1977 and \$1.1 million in FY 1978). Radiological support to the DOD is provided by a project manager organization and includes the operation of a highly versatile radiological laboratory and in situ field measuring equipment. A complete statistical and data handling capability is operational at the Atoll.

The base support services at Enewetak are provided by Holmes & Narver, Inc., and a full-time site representative is at Enewetak on a rotational basis from NV's Pacific Area Support Office. The first increment of people, numbering approximately 75, arrived at Enewetak on March 15, 1977.

Other significant NV programs in the Marshall Islands consist of:

- o The Brookhaven Medical Program. This program provides continuing medical surveillance of the people of Rongelap and Utirik, who were accidentally injured by fallout from the BRAVO Event on March 1, 1954.
- o The Mid-Pacific Marine Laboratory. This laboratory, operated for DOE by the University of Hawaii under a NV contract, is located at Enewetak. Since 1954, the laboratory users have studied this coral atoll with emphasis in recent years on the distribution and cycling of radionuclides and the potential implications to man of these processes.

- o Support to and coordination of the Environmental Surveillance Programs. These are long-term efforts to monitor the presence, removal, transfer, uptake and decay of radioactive residue of the atmospheric test program. Principal locations studied are Enewetak, Bikini, Rongelap, and Utirik. Late in FY 1978 under NV Project Management, a multi-atoll survey was undertaken to include a one-time visit to 13 locations totaling 288 coral islands.
- o NV maintains the DOE-funded Marshall Islands Research Vessel, the R.V. LIKTANUR, under a commercial charter. This contractor-operated vessel is a converted oceanographic vessel, 118 feet in length. It is based at Kwajalein and is used to support all the programs mentioned above.

SIGNIFICANT ACCOMPLISHMENTS

Supplemental Test Site (STS) Program

During the period from 1967 through 1974 the Nevada Operations Office conducted programs at Central Nevada and at Amchitka Island in the Aleutian Chain in support of the development of the warhead for the Spartan Anti-Ballistic Missile (ABM). Three tests were conducted in the program. The FAULTLESS Event was conducted in Central Nevada in January 1968 and was a calibration test. The MILROW test was completed in October 1969 at Amchitka and was also for calibration purposes, the CANNIKIN test was fired in November 1971 and was the full-scale proof test of the Spartan warhead. The successful, on schedule execution of CANNIKIN required the completion of a complex construction effort in a remote location and often under adverse conditions. The CANNIKIN emplacement hole was drilled at a diameter of 90 inches to a depth of 6,200 feet. A spherical room measuring 52 feet in diameter was then mined at the 5,700 foot level of the lined shaft to house diagnostic equipment. Following the program completion, essentially all (former) AEC/ERDA facilities and equipment were deactivated and removed from the sites in fiscal 1974. Total cost of the STS Program through fiscal 1974 was \$280 million.

NTS Accelerated Program

Beginning in early fiscal 1975 urgent planning began for a revised underground test program at the Nevada Test Site. This revised or accelerated program was based on the need to complete testing on three new high yield weapons systems prior to March 31, 1976, which was the proposed effective date for the Threshold Test Ban Treaty. Between May of 1975 and March of 1976, a total of 12 tests were conducted in the high yield range; that is, from 200 kilotons to 1 megaton. Device designs were successfully completed for all three weapons systems.

During this accelerated program the funding and resources of the NTS were increased significantly in order to accomplish this priority work.

Natural Gas Stimulation Projects

NV successfully executed three joint government industry natural gas stimulation experiments involving nuclear explosive fracturing techniques. The first was Project Gasbuggy in northwestern New Mexico in 1967. Included with NV here were the El Paso Natural Gas Company, the Department of the Interior, and Lawrence Livermore Laboratory. The second experiment was Project Rulison in the Rulison Field in Garfield County, Colorado in 1969. Involved with NV in Rulison were Los Alamos Scientific Laboratory, the Department of the Interior, and the Austral Oil Company, with CER Geonuclear Corporation (CER) acting as program manager. The third nuclear experiment was project Rio Blanco in Rio Blanco County, Colorado. This experiment, conducted in 1973, also involved the Continental Oil Company, CER, and Lawrence Livermore Laboratory.

(THIS PAGE INTENTIONALLY LEFT BLANK)

Oak Ridge Operations Office

EXECUTIVE SUMMARY

Oak Ridge Operations OfficeLOCATION: Oak Ridge, TennesseeSTATISTICS (FY 78)

NUMBER OF AREA OFFICES:	1
NUMBER OF GOVERNMENT EMPLOYEES:	672
NUMBER OF CONTRACTOR EMPLOYEES:	26,500
ANNUAL OPERATING BUDGET:	\$1.34 billion
CONSTRUCTION COSTS:	\$516 million
TOTAL \$ OF REIMBURSABLE PROJECTS:	\$61 million (plus \$925 million toll enriching sales)
NUMBER OF CONTRACTS:	1200
SIZE OF RESERVATION:	36,877 acres

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o Production of enrichment uranium, and management of uranium enrichment expansion program
- o Production of nuclear weapon components
- o Processing of uranium feed materials and related production of uranium fuel cores
- o Direction of research and development programs related to nuclear and other energy sources
- o Direction of education and training programs related to nuclear and non-nuclear technologies
- o Construction and administration of coal, liquefaction demonstration plants (SRC I, SRC II, H-Coal).

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Oak Ridge Gaseous Diffusion Plant	Union Carbide Corp. - Nuclear Division
Paducah Gaseous Diffusion Plant	Union Carbide Corp. - Nuclear Division
Y-12 Plant	Union Carbide Corp. - Nuclear Division

Oak Ridge National Laboratory

Portsmouth Gaseous Diffusion Plant
Feed Materials Production Center
Oak Ridge Associated Universities

Comparative Animal Research Laboratory
Ashtabula Plant
Center for Energy and Environment
Research
Centrifuge Facility

Union Carbide Corp. - Nuclear
Division

Goodyear Atomic Corporation
National Lead Company of Ohio
Oak Ridge Associated
Universities, Inc.

University of Tennessee
Reactive Metals, Inc.
University of Puerto Rico

AiResearch Manufacturing Company

OAK RIDGE OPERATIONS OFFICE

BACKGROUND AND MISSION

Oak Ridge first made its mark in history during World War II when the Army chose the 93-square mile tract in East Tennessee to become the focal point of activities under the Manhattan Project: the successful crash program to build the world's first nuclear weapon. The Oak Ridge Operations (OR) was established as a field office of the Atomic Energy Commission (AEC), and the former wartime mission was reoriented to one of developing beneficial applications of atomic energy. For the next quarter of a century, programs expanded in both scope and magnitude with new research and production facilities being established beyond Tennessee into Kentucky, Ohio, California, and Puerto Rico. In January 1975, the programs of the former AEC, including those conducted by OR, became a part of the new Energy Research and Development Administration (ERDA). In October 1977, the programs were incorporated in the new Department of Energy (DOE). At that time, the research programs of OR, while heavily based by history and function in nuclear science, had already begun to expand and embrace new research in the non-nuclear energy areas. This expansion and diversity has continued under DOE.

MANAGEMENT PHILOSOPHY

OR management philosophy has been shaped over the years of operation under AEC, ERDA, and now DOE. Policy is outlined by DOE headquarters. OR's manager translates that policy into action as it fits the local situation and the objectives of the program. With his course clearly defined, the contractor is then given considerable latitude to organize and manage in the style to which he is accustomed, using his management and technical capability. DOE/OR employees are responsible for planning, directing, reviewing, and measuring the accomplishments of the contractor organizations. OR employs a typical line-staff organization structure.

OR exercises responsibility for seeing that all work assigned is carried out and performed in accordance with terms of the contracts, applicable Federal laws and regulations, DOE regulations and requirements, and the instructions and limitations provided in program authorizations. All formal actions affecting operations and work performed by contractors flow through the OR administrative channel. Thus, all actions receive one centralized point of review, coordination, interpretation, concurrence and approval within DOE. Supporting this formal channel is the close day-to-day interface between OR and contractor personnel in their area of responsibility such as safety, finance, engineering, budget, etc. This vast network of informal relationships not only facilitates the contract administration function but also provides for an appropriate degree of surveillance over the activities.

PROGRAM WORKLOAD

Today, OR represents one of DOE's largest and most diversified field offices, having responsibility for a broad range of production, research, education, and training activities associated with the general field of energy development, demonstration, and application. Approximately 26,500 scientists, technicians, craftsmen, and administrative personnel conduct the programs of OR. The OR staff currently numbers 672 permanent employees, of which 193 are trained in scientific engineering or technical field, and 57 percent hold college degrees.

The major government-owned facilities and their operating contractors are the Oak Ridge Gaseous Diffusion Plant, the Paducah Gaseous Diffusion Plant; the Y-12 Plant, and the Oak Ridge National Laboratory, operated by Union Carbide Corporation-Nuclear Division; the Portsmouth Gaseous Diffusion Plant operated by Goodyear Atomic Corporation; the Feed Materials Production Center operated by National Lead Company of Ohio; the Oak Ridge Associated Universities operated by Oak Ridge Associated Universities, Inc.; the Comparative Animal Research Laboratory operated by the University of Tennessee; and the Ashtabula Plant operated by Reactive Metals, Inc. OR also administers activities at the Center for Energy and Environment Research which is operated by the University of Puerto Rico (this facility, formerly the Puerto Rico Nuclear Center, has been transferred to the university). Major off-site operating contractors include the AiResearch Manufacturing Division of the Garrett Corporation and the University of Virginia who are assisting on gas centrifuge development; the University of Texas for magnetic fusion research; and the University of Maryland for nuclear physics research with a government-owned cyclotron. OR also arranged and administered some 700 offsite research and development (R&D) contracts with educational and non-profit organizations in the southeast. In addition, 30 university traineeship contracts are administered with universities throughout the country.

The fiscal 1978 operating budget for OR was \$1.34 billion, representing about 28 percent of the total DOE national operating budget. Construction activities represent an additional \$516 million, almost one third of the total DOE construction budget. The capital investment in facilities of OR exceeds \$5.5 billion, about 33.3 percent of total department investment.

Design and construction of new and improved production and research facilities are major functions of OR. Currently there are some 33 architect-engineer contractors working on individual projects, and 16 prime fixed-price construction contractors. While the major operating contractors have sizeable engineering design capability and carry out the design of the smaller projects, all construction work is performed by subcontractors or OR prime construction contractors. A prime cost plus fixed-fee construction contractor is also utilized in Oak Ridge for work not susceptible to fixed-price bidding.

Although not a direct part of Oak Ridge Operations, the DOE Technical Information Center (TIC) located in Oak Ridge receives administrative assistance from the operations office. TIC is DOE's central facility for collecting, evaluating, cataloging, reproducing, and disseminating scientific and technical information. In addition, TIC manages DOE's national film-loan library. OR also provides administrative support to the Morgantown (West Virginia) Energy Technology Center (METC). METC's principal programmatic thrust is in the areas of enhanced oil and gas recovery techniques and coal gasification.

MAJOR PROGRAM/PROJECT ASSIGNMENTS

Uranium Enrichment

The largest program under OR, in terms of both budget (some \$900 million) and manpower (approximately 12,000), is associated with providing enriched uranium services. This includes the actual production of enriched uranium product, contracting with electric utilities to provide them with enriching services, and also executing contracts with electric utilities for the large quantities of electrical power required for DOE uranium enrichment production plants. Enriched uranium is produced at three large gaseous diffusion plants under OR responsibility. They are located in Oak Ridge; Paducah, Kentucky; and Portsmouth, Ohio. Union Carbide Corporation-Nuclear Division (UCC-ND) operates the Oak Ridge and Paducah plants and the Goodyear Atomic Corporation operates the Portsmouth Plant. Because of the growth of nuclear power, the three gaseous diffusion plants are undergoing a \$1.4 billion improvement and operating program (to be completed in 1981) to increase their production capacity. When this program is completed, the full capacity of the three plants will still not be adequate to meet anticipated demand.

In order to provide additional enriching capacity, a 4.35 billion dollar Gas Centrifuge Enrichment Plant (GCEP) is under design and construction. The new plant - to provide 8.8 million separative work units - is to be constructed on the site of the Portsmouth Gaseous Diffusion Plant. This newer centrifuge process promises significantly reduced costs and production operation, particularly in electric power requirements. An industrial base is being developed to supply the unique materials and equipment required for use in this new enriching technology. An investment of 100 to 200 million dollars will be needed for new industrial manufacturing capability.

National Defense

The Oak Ridge Y-12 Plant, operated by UCCND, is a highly sophisticated manufacturing complex with a diverse fabrication and precision machining capability probably unmatched in the world. The primary mission of the Y-12 Plant is the fabrication of nuclear weapons components and assemblies in support of activities administered by the DOE Assistant

Secretary for Defense Programs. The unique manufacturing and technical capabilities at the Y-12 Plant have been provided to other Federal agencies, such as NASA and the DOD, when the services are unavailable elsewhere and can be performed concurrently with Y-12's basic mission on a non-interference basis.

Also related to national defense is the work of DOE's Feed Materials Production Center (FMPC) at Fernald, Ohio, operated by the National Lead Company. The principal activities at the FMPC include the production and fabrication of depleted and slightly enriched uranium metal in support of DOE production reactors at Savannah River, South Carolina, and the N-Reactor at Richland, Washington. Both depleted and enriched uranium metal ingots produced at FMPC are extruded at the Ashtabula Plant operated by Reactive Metals, Inc.; the depleted material is returned to the FMPC for final fabrication into target elements for the Savannah River reactors and the slightly enriched material is shipped to Richland for further processing. The FMPC also supplies depleted uranium metal to the Y-12 Plant and Rocky Flats Plant for use in the DOE Nuclear Weapons Program.

Energy Research and Development

In the broad area of energy R&D, principal nuclear programs under OR involve work on the Liquid Metal Fast Breeder Reactor and the gas-cooled reactor concepts along with associated fuel recycle programs as well as research on reactor safety projects related to conventional, light-water reactor systems. A major effort of Oak Ridge National Laboratory (ORNL) involves research on fusion, the process by which the sun produces energy. ORNL is also engaged in a national energy research program for making more efficient use of coal. ORNL programs stress development of cleaner and more efficient means for burning coal and the development of processes for the liquefaction of coal. Energy conservation is another new research effort of ORNL. Scientists are exploring methods for achieving more efficient end-use of energy, including more energy efficient homes, appliances, and heating and cooling systems. In energy conservation, one of the laboratory's most innovative projects is the Annual Cycle Energy System (ACES) which is designed to provide a typical home with space heating and cooling, as well as domestic hot water, from a tank of water. A demonstration ACES house has been built with DOE support in Knoxville, Tennessee. Major, long-standing environmental and biological research programs at ORNL are focusing increasing attention on assessing the impact of energy generating systems. Physical research programs of ORNL cover most areas of physics, chemistry, and material sciences. Of related importance is work for DOE and other federal agencies on solar energy, geothermal energy, and cancer research, as well as assistance to the Nuclear Regulatory Commission in the licensing of nuclear facilities.

Education and Environment Research

Another major programmatic effort under OR is the conduct of a wide-ranging research and development effort with related educational training programs. In this area, the budget totals more than \$20 million annually and more than 600 persons are employed.

Research, education, training, and public information programs are conducted by Oak Ridge Associated Universities (ORAU), a corporation of 46 southeastern area colleges and universities. Research in the field of occupational medicine, environmental health and epidemiology is emphasized. DOE's popular American Museum of Science and Energy in Oak Ridge is operated by ORAU.

The Comparative Animal Research Laboratory (CARL) is also located in Oak Ridge and operated for DOE by The University of Tennessee. Its research program now includes studies of controlled exposures of laboratory and domestic farm animals and plants to toxic materials associated with energy production.

For a number of years the Puerto Rico Nuclear Center (PRNC) was operated for AEC/ERDA by the University of Puerto Rico with facilities in San Juan and Mayaguez. In 1976, ERDA announced that over a 5-year period the agency would transfer the buildings, facilities, and equipment of PRNC to the university to serve as the core of a new Center for Energy and Environment Research. The new arrangement will allow the center to bid on DOE, other federal, and private requests for contract proposals.

The Atmospheric Turbulence and Diffusion Laboratory is operated for DOE by the National Oceanic and Atmospheric Administration. The purpose of the laboratory's program is to to conduct basic and applied research studies of atmospheric turbulence and diffusion by means of theoretical, field, and wind tunnel research, and to provide a continuing meteorological service to DOE and its contractors in the OR area.

Liquefaction Demonstration Plants

The H-Coal Project is directed by the Assistant Manager for Solvent Refined Projects. Although a large number of firms are currently working on the design, construction and operation of the H-Coal Pilot Plant, the four major firms involved are Hydrocarbon Research, Inc. (HRI) and Lummus (providing design and onsite support), Badger Plants, Inc. (responsible for plant construction and construction management), and Ashland Synthetic Fuels, Inc. (ASFI) (plant operation support). The DOE Oak Ridge Operations Office will manage the remaining construction activities and operation of the H-Coal Pilot Plant.

The H-Coal process will convert 200 tons of coal per day to syncrude or 600 tons per day of coal to fuel oil. Construction of the plant is approximately 60 percent complete and the current total estimated cost of the project is \$297,000,000.

An Oak Ridge National Laboratory (ORNL) physicist works with a highspeed mechanical pellet accelerator being developed to fuel fusion reactors. The injection of pellets of frozen hydrogen into the reactor plasma to raise its density and create more fusion fuel is a technique being explored by researchers in ORNL's Fusion Energy Division.

The Solvent-Refined-Coal Projects are directed by the Assistant Manager for Solvent Refined Coal Projects. The firms have been awarded multi-phased contracts for the preliminary design of the first modules of commercial-scale plants that would convert high sulfur coal into clean-burning liquid and solid fuels. Upon completion of the preliminary design, one process will be competitive, and selected to proceed through construction and operation. Management of this work is being administered by the Oak Ridge Operations Office. The two firms are the Denver-based Pittsburgh and Midway Coal Mining Company, a subsidiary of Gulf Oil Corporation; and Southern Company Services, the technical subsidiary of the Atlanta-based Southern Company.

The SRC plant to be designed by the Gulf subsidiary will convert coal into a liquid boiler fuel. A southern team, which will include Air Products and Chemicals, Inc., Allentown, Pennsylvania, and Wheelabrator-Frye, Hampton, New Hampshire, will design a plant to convert coal into a solid boiler fuel. Each of the "first module" plants would convert about 6,000 tons of coal per day into a low-sulfur, nearly ashless fuel, equivalent to 20,000 barrels per day of crude oil.

The initial design phases of the multiphased contracts will require up to 12 months to complete and will cost about \$6 million each. If the designs prove satisfactory, DOE will consider authorizing subsequent phases, including detailed design, construction and operation of the first modules. The first quantities of synthetic fuel could be produced in 1984. An initial estimate of the eventual cost of design, construction and operation of each facility is approximately \$650-700 million.

SIGNIFICANT ACCOMPLISHMENTS

- o In 1978, OR hosted a visit to Oak Ridge by President Jimmy Carter who toured Oak Ridge National Laboratory and the Oak Ridge Gaseous Diffusion Plant. The President also held discussions with members of ORNL scientific staff on their energy-related research and development programs.
- o In 1978, OR was assigned responsibility for the construction and administration of coal liquefaction demonstration plants. Current assignments are SRC I, SRC II and H-Coal.
- o In May 1978, the Advanced Equipment Test Facility for reliable testing of advanced centrifuge designs was placed in operation.
- o In 1978, OR hosted a Gas Centrifuge Enrichment Plant Associated Process Equipment and Materials Information Meeting to interest private industry in establishing the needed industrial base to supply unique items required by the GCEP.

- o In 1976, OR was assigned responsibility for design, construction, contracting and administration functions of the multi-billion dollar expansion of uranium enriching capacity.
- o In 1975, OR served as principal co-sponsor for presenting a series of briefings and tours of energy for members of the Legislature of the State of Tennessee. The meeting represented the first time the full Legislature convened outside of the State Capitol in Nashville.
- o In 1975, OR provided principal support to the White House staff in presenting a Mid-Appalachian Symposium on Energy followed by a White House Conference on Domestic and Economic Affairs.
- o Since 1969, OR has been responsible for all contracting in providing uranium enriching services to 176 private industrial customers. In 1977 it was assigned responsibility for contracting with approximately 136 foreign enrichment customers.

(THIS PAGE INTENTIONALLY LEFT BLANK)

Richland Operations Office

EXECUTIVE SUMMARY

Richland Operations OfficeLOCATION: Richland, WashingtonSTATISTICS (FY 78)

NUMBER OF SITE OFFICES:	1
NUMBER OF GOVERNMENT EMPLOYEES:	254
NUMBER OF CONTRACTOR EMPLOYEES:	11,600
ANNUAL OPERATING BUDGET:	\$366 million
CONSTRUCTION COSTS:	\$138 million
TOTAL \$ OF REIMBURSABLE PROJECTS:	\$13 million
NUMBER OF CONTRACTS:	196
SIZE OF RESERVATION:	362,278 acres

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o Plutonium Production
- o Nuclear Waste Management
- o Fuels and Materials Examination Facility Construction
- o Fusion Materials Irradiation Test Facility Construction
- o Nuclear Waste Vitrification Demonstration
- o Fast Flux Test Facility
- o National Waste Terminal Storage Program

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Pacific Northwest Laboratory	Battelle Memorial Institute
N Reactor & related Fuel Production Facility	United Nuclear Industries, Inc.
Chemical Processing & Waste Management Facilities	Rockwell Hanford Operations
Hanford Engineering Development Laboratory	Westinghouse Hanford Company
Office of Nuclear Waste Isolation	Battelle Memorial Institute

RICHLAND OPERATIONS OFFICE

BACKGROUND AND MISSION

In 1942, "Hanford" was a small orchard community along the Columbia River in the desert of southeastern Washington. A year later, it was the fast developing site for the production of plutonium for use in World War II. The site was selected by the Manhattan Engineer District because of its isolation, plentiful supply of cool water, abundance of reliable electrical power, and arid ground conditions. Wartime construction provided three reactors, three separation plants, fuel fabrication facilities, and 4,300 houses in nearby Richland, Washington, for operating and support staff. After World War II, a second phase of construction added five more reactors, two separation plants, laboratory facilities, and 2,000 additional houses. Later, the dual-purpose N reactor was constructed.

Then, between 1964 and 1971, all of the original eight reactors and most of the chemical processing facilities were shut down. The fact that Hanford continued operation during this period was attributable to:

1. Continued operation of N reactor.
2. Efforts which replaced a single contractor with several contractors who were required to invest private capital in diversification of the local economy.
3. The decision to locate the Fast Flux Test Facility at Hanford.

Hanford in 1978 continues to have responsibility for, control over, and eventual long-term disposition of, high-level radioactive wastes generated from operation of nuclear material production facilities for defense purposes and decontamination and decommissioning of facilities no longer operated.

The Hanford of today is a broadly diversified production and laboratory complex, participating in programs under all of the DOE program Assistant Secretaries. The Hanford Project occupies approximately 570 square miles (see site map); its missions are of national and regional significance; its annual operating costs are over \$360 million; it represents capital investment of about \$1.8 billion in facilities; and it provides employment for about 12,000 people. On-site DOE field operations in charge of these missions are the Richland Operations Office (RL) and the Fast Flux Test Facility Project Office (FFTFPO). The primary on-site DOE organization is RL, which is responsible for research, development and demonstration in solar, conservation, geothermal, fossil and all nuclear programs other than FFTF and the Liquid

HANFORD RESERVATION **Department of Energy**

Metal Fast Breeder Reactor (LMFBR); and site management and support of the DOE Regional Representative's Office in the Pacific Northwest Region.

Hanford facilities managed by RL include the Pacific Northwest Laboratory an operating dual-purpose nuclear reactor, capable of providing both plutonium and by-product steam; major chemical separations and radioactive waste-handling facilities; a plutonium processing plant; extensive multiprogram laboratories; a nuclear fuel production plant; and a 120-square-mile Arid Lands Ecology reserve for environmental and ecological studies. In early 1977, essentially the entire Hanford site was designated as a National Environmental Research Park, significantly extending the opportunities for ecological and environmental research. All of these facilities, and the specific strengths which have evolved from them, provide Hanford with a significant role in the Nation's energy picture.

In addition to on-site activities at Hanford, RL has a strong supporting relationship with the Regional Representative's Office in Seattle and the DOE component in Region X.

All of the Hanford and offsite activities are coordinated by the 254 full-time employees of the Richland Operations Office, which includes 194 professionals, 17 technicians, and 43 clerical personnel. Sixty-four percent of the employees have college degrees.

MANAGEMENT PHILOSOPHY

To fulfill its ongoing Hanford operational responsibilities, RL provides broad program and budgetary direction and overview to multiple operating and support services contractors. To do so, RL management employs a functional organizational structure and management by objectives technique. For complex single-purpose or unique activities such as large research or construction projects, RL uses a matrix project management team approach. This blending of management styles allows the most effective use of staff resources in meeting the particular needs and requirements of the Hanford site.

PROGRAM WORKLOAD

RL is currently responsible for an operating budget of over \$366 million and administers about 200 contracts. The total cost of all activity operating and plant and capital equipment was about \$517 million in FY 1978.

Richland Operations Office's involvement in program activities ranges from full responsibility--technical direction, cost and schedule control, construction, contracting and contract administration--in the production and waste management area to limited program support--contracting contract administration, and cost control--in non-nuclear

energy development, biomedical and environmental research and physical research.

Richland has the lead for preparation of a generic environmental impact statement for the management of spent fuel and/or waste from the LWR fuel cycle. RL is also conducting a major program to assess the feasibility of basalt as a geologic storage medium for commercial spent fuels and/or high level waste. RL has been assigned program management responsibility for the activities of the Office of Nuclear Waste Isolation (ONWI) in the conduct of the National Waste Terminal Storage Program. ONWI is operated by the Battelle Memorial Institute and is located in Columbus, Ohio. RL has established an office in Columbus to support this activity.

The greatest degree of program diversity among RL contractors is found in the Pacific Northwest Laboratory (PNL). PNL research now includes biology, ecology, radiological sciences, water and land resources, atmospheric sciences, physics, computer technology, electronics, mathematics, engineering metallurgy, and material sciences, with significant program work being conducted in solar, geothermal, fossil, wind, fusion, and energy conservation programs. Total operating program costs in fiscal 1978 were about \$76 million, with greater than 50 percent emphasis on non-nuclear energy technology development.

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

Nuclear Programs

Nuclear Programs are a principal part of Richland operations. Under management of United Nuclear Industries, Inc., the N reactor produces plutonium for national defense purposes, while supplying steam to the Washington Public Power Supply System (WPPSS) to run its 860 megawatt electric generating station.

The N reactor normally operates at 3,800 megawatt tons and is fueled with zirconium-clad uranium metal. Fuel is fabricated at Hanford by UNI. Upon removal from the reactor, the fuel currently is being stored in water-filled basins at the reactor and at one of the shutdown reactor sites on the Hanford Reservation.

Responsibility for chemical separations and nuclear waste management is the Atomics International Division of Rockwell International. The chemical reprocessing facility, PUREX, is currently shut down. Plutonium recovered from the irradiated fuel is transferred offsite to the weapons complex. The uranium from the irradiated fuel is also recovered and, as UO_3 , is returned to the feed materials chains. Atomics International is also responsible for management of the high level radioactive liquid wastes which have been generated during the past 30 years and may be generated in possible future PUREX reprocessing operations. The wastes are solidified through evaporation to form

a salt cake in the underground storage tanks. Research is underway to develop and evaluate alternative methods for ultimate disposal of the waste material. One alternative under study is conversion to a glass form and storage in deep geological formations. Investigations of the basalt formations underlying Hanford are underway.

The surplus facility and waste management program of United Nuclear Industries, Inc. is planning and implementing a program to provide long-term public and environmental protection against radiological and industrial hazards coupled with alternate restricted site use. The end-product of this program will be achieved by the removal or stabilization of the residual radioactive inventory contained in facilities excessed to government programs.

Fuels and Materials Examination Facility (FMEF)

Funds have been requested in the FY 1980 budget to Congress to expand the scope of the FMEF to include most of the functions now a part of the High Performance Fuels Laboratory.

This rescoped facility will be used for post-irradiation examination of FFTF components as well as consolidation of Hanford Engineering Development Laboratory (HEDL) fuel fabrication and analysis activities. The facility will have the capability for handling the FFTF test assemblies within a few weeks after removal from the reactor core, dismantling assemblies, destructive and non-destructive examination of full-size FFTF pins and assemblies, reconstitution of test assemblies, and development of proliferation-resistant fuel fabrication equipment and processes.

The FMEF will be located at the FFTF site (400 Area) on the Hanford reservation and will be composed of a large non-destructive examination cell, a decontamination cell, a destructive examination cell, fuel fabrication facilities, and support areas. The TEC is \$170 million. Construction is scheduled for completion in March of 1983 with operations to start in December of 1983.

The Richland Operations Office has been assigned the responsibility for management of the project. A Richland FMEF project office has been established for day-to-day DOE management and HEDL has been assigned responsibility for completion of the project.

Fusion Materials Irradiation Test (FMIT) Facility

The purpose of the proposed Fusion Materials Irradiation Test Facility (formerly known as the High Energy Neutron Source) will be to provide the capability to generate test data on the behavior of materials under fusion reactor irradiation conditions. The major objectives of this project are to determine the effects of high-energy neutrons on the mechanical properties of materials, basic bulk irradiation effects, and surface effects.

DOE's N Reactor, operated by United Nuclear Industries, Inc. (right center) produces steam which is conveyed by pipeline to the nearby generating plant (left center) which is owned and operated by Washington Public Power Supply System. The plant generates 860 MWe.

The FMIT facility will be located in the principal laboratory area (300 Area) of the Hanford site. The Title I design of the FMIT facility proposes two main structures: A linear accelerator building, a test building housing irradiation testing and service cells, and liquid lithium equipment.

The FMIT facility is currently budgeted as a FY 1979 construction project with an approximate cost of \$85 million scheduled for completion in April 1983. The Richland Operations Office has been assigned the responsibility for management of the project. As in the case of FMEF, a Richland FMIT project office handles day-to-day DOE management. HEDL has been assigned responsibility for technical management, coordination, planning, design, and construction.

Solar Energy R&D - Solar Electric Regional Assessment

Assessment of the availability of critical materials for solar application are underway at Hanford. Evaluations are being made of sources of supply, potential substitutes, recycle impact and environmental constraints. Other factors relating to the commercialization of solar energy technologies are being considered. Among these are: geological limitations, geographic distribution, government regulation, processing limitations, economic and financial constraints. Solar energy technology material requirements, current and projected, will be identified and schedules will be prepared.

Solar Electric Regional Assessment

Evaluations under the Solar Electric Regional Assessment program will identify demonstration opportunities and the outlook for more advanced systems, central and dispersed. Of particular interest are the economic, institutional and social opportunities and problems associated with large-scale use of solar power systems. User needs and regional perspectives will be considered in the study on a region-by-region basis starting in the southeastern and northeastern states.

The National Environmental Research Park at Hanford

The 570-square mile Hanford site has been designated a National Environmental Research Park. The designation makes the site available to scientists from universities, research institutions and other state and Federal agencies to perform energy-related ecological and environmental research in a protected outdoor laboratory setting. It is expected that funding for such research will come from sources other than DOE.

The broad objectives of the research park program include: (1) Developing methods to quantitatively and continuously monitor the environmental impact of man's activities; (2) developing methods to establish or predict the environmental response to proposed and ongoing activities especially concerning energy developments; and (3) demonstrating

the impact of various activities on the environment and evaluate methods to minimize adverse impacts.

At Hanford, research of this nature has been performed for many years by DOE's Pacific Northwest Laboratory (PNL) operated by Battelle Northwest. PNL also operates the Arid Lands Ecology (ALE) reserve which was established in 1967. The ALE reserve consists of 120 square miles of relatively pristine desert steppe terrain. ALE predates the research park program both in concept and in philosophy. ALE is now an integral part of the Hanford environmental program providing a significant scientific control for studies in the western semi-arid region.

Proposals for research will be submitted to the Richland Operations Office where joint reviews with PNL will assess scientific merit, technical feasibility, and compatibility with other DOE programs on-site. The Richland Operations Office is responsible for final approval of any research at the Hanford site.

SIGNIFICANT ACCOMPLISHMENTS

The past few years have seen major accomplishments at Hanford and in the Pacific Northwest. For example, Richland Operations Office and its contractors have:

- o Diversified Hanford's programs and missions from a predominance of defense-oriented activities to one predominant in research, development and demonstration of energy technologies.
- o Enhanced the management of high-level radioactive wastes.
 - o Completed seven new double-shelled tanks, with 13 more under construction.
 - o Instituted more effective monitoring procedures, controls and instrumentation, including a computer-automated surveillance system.
 - o Evaporated to a solid the backlog of high-level wastes liquid.
- o Completed and issued a comprehensive Environmental Impact Statement covering all Hanford radioactive waste management activities.
- o Prepared and issued a Technical Alternatives Document on long-term management of Hanford defense wastes.

- o Made significant contributions in the national program for the management of spent fuel and radioactive wastes from commercial nuclear power plants.
- o Prepared the comprehensive Technical Alternatives Document covering all commercial wastes.
- o Prepared the draft Generic Environmental Impact Statement on the management of commercial radioactive wastes.
- o Demonstrated vitrification of high-level radioactive wastes.
- o Initiated an intensive program to determine the capability of Pasco Basin basalts to serve as a geologic repository site for high-level nuclear wastes.
- o Significantly improved N-Reactor operating efficiency for scheduled operating periods from about 42 to over 90 percent availability.
- o Since 1966, provided byproduct N-Reactor steam for the Washington Public Power Supply System generation of more than 41 billion kilowatt hours of electrical energy for distribution through the Bonneville Power Administration's power grid.
- o Established the Hanford National Environmental Research Park.

(THIS PAGE INTENTIONALLY LEFT BLANK)

San Francisco Operations Office

EXECUTIVE SUMMARY

San Francisco Operations Office

LOCATION: Oakland, California

STATISTICS (FY 78)

NUMBER OF SATELLITE/PROJECT OFFICES:	8
NUMBER OF GOVERNMENT EMPLOYEES:	282
NUMBER OF CONTRACTOR EMPLOYEES:	12,923
ANNUAL OPERATING BUDGET:	\$800 million
CAPITAL COSTS:	\$161 million
TOTAL \$ OF REIMBURSABLE PROJECTS:	\$39 million
NUMBER OF CONTRACTS:	1,322

MAJOR PROGRAM AND PROJECTS

- o Solar Central Power Systems Program
- o 10 Megawatt Solar Central Receiver Power Plant
- o Geothermal Demonstration Power Plant
- o Geothermal Loan Guaranty Program
- o Mirror Fusion Test Facility
- o NOVA Project
- o Positron-Electron Project
- o National Defense Programs
- o Breeder Reactor Component Testing

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Lawrence Livermore Laboratory	University of California
Lawrence Berkeley Laboratory	University of California
Stanford Linear Accelerator Center	Stanford University
Energy Technology Engineering Center	Rockwell International

SAN FRANCISCO OPERATIONS OFFICE

BACKGROUND AND MISSION

The San Francisco Operations Office (SAN) is responsible for the management, coordination and support of programs and projects involving all energy technologies, national defense and basic research.

MANAGEMENT PHILOSOPHY

The style of management in operation at SAN is the matrix management team approach. SAN uses this approach to improve and expedite the workflow process. This approach is designed to bring together individuals with various kinds of information and expertise applicable to a given project, program, or issue. Collectively, team members can contribute more to getting the job done in a shorter time and with less duplication of effort than would be possible without the matrix team approach.

SAN's Geothermal Team is an example of this approach. This permanent group consists of the group members of the SAN's Geothermal Division and assigned representatives of the Office of the Regional Representative, Region IX; Procurement and Finance Divisions, Budget Branch and Chief Counsel's Office. In addition, support staff are identified, within other functional organizations, such as Engineering and Patents, and called upon as necessary. The team meets on a regular basis to review contract and program status, define problems in program execution, and monitor contractors' performance.

PROGRAM WORKLOAD

SAN currently is responsible for an annual operating budget of over \$800 million and administers some 1,322 contracts. This is an increase since FY 1975 from 305 contracts and a budget of \$679 million. The total estimated cost of DOE construction projects underway and planned under SAN's management is about \$1 billion. Interfaces with contractors cover a broad range of commercial (large industrial, small business, and individual entrepreneur), non-profit and academic organizations.

The extent of SAN's involvement with its contractors generally depends upon the needs of headquarters' program directors and the particular research and development phase of the activity underway. Some tasks, like basic research in the physical sciences, require little in the way of direct field involvement beyond the basic support mechanisms of assuring that funds are available, contracts are in place, and operations are conducted in a manner protecting the public interest. Others, like DOE/private industry energy demonstration projects, call

into play complex contracting and patent arrangements, project management plans and detailed cost/schedule control mechanisms.

Of SAN's major contractors, Lawrence Livermore Laboratory (LLL) is involved in all phases of research and development, from the basic sciences through technology demonstration and national defense programs. Activities of Lawrence Berkeley Laboratory (LBL) and the Stanford Linear Accelerator Center (SLAC) fall primarily into the research end of the spectrum. General Electric Corporation, General Atomic Company and the Energy Technology Engineering Center (ETEC) engage in technology and engineering development activities. Three smaller radiobiology laboratories operated by the University of California (UC) perform various biomedical research efforts.

In addition to national defense work, LLL also conducts research into long-term energy alternatives, including laser fusion and other advanced energy systems, and in fossil, solar, geothermal and, more recently, conservation. Research into biological and environmental impacts of nuclear and non-nuclear effluents complements LLL's other programs and brings a systems approach to evaluating energy sources.

Another of SAN's major contracts (about \$100 million) is with LBL. LBL devotes more than one-half of its research and development efforts to nuclear chemistry, high energy physics, biomedical and materials science. Research is also conducted in: the basic biological processes of plants and animals; the detection of environmental pollutants and their effects on living systems; conservation; and the currently under-utilized technologies of solar and geothermal.

SLAC is the third of SAN's major contractors. Operating on a \$42 million contract, SLAC specializes in theoretical and experimental high energy physics and operates several major pieces of specialized equipment, including the two-mile long linear accelerator and a positron-electron colliding beam storage ring. The position of SLAC as one of the world's leading facilities for the conduct of high energy particle research will further be enhanced when the Positron-Electron Project (PEP) becomes operational in 1980.

General Electric Corporation contracts with SAN involve work in Liquid Metal Fast Breeder Reactor (LMFBR) activities as well as light water reactor safety technology. The operating costs for FY 1979 are \$15 million. Recent efforts have focused on developing general principles, methods and procedures for breeder risk assignment.

The General Atomic Company (GA) operating contracts for FY 1979 total \$60 million. Major GA programs are the High-Temperature Gas Reactor (HTGR) Direct Cycle, Gas-Cooled Fast Reactor (GCFR) and Controlled Thermonuclear Research (Doublet III).

As noted above, three small radiobiology laboratories are also operated by the University of California under contract to SAN. The laboratory

10 MWe Central Solar Receiver
Pilot Plant Project
Barstow, California

of Nuclear Medicine and Radiation Biology at UCLA, the largest of the three, has contributed to the study of energy-related biomedical and environmental problems for more than 30 years. The laboratory for Energy-Related Health Research on the UC-Davis campus is associated with the School of Veterinary Medicine and focuses on nuclear effect studies on living systems. Finally, the Laboratory of Radiobiology operates as an organized research unit of the School of Medicine, UC-San Francisco. Its program is directed toward understanding the genetic, developmental, and physiological effects of energy-related environmental contaminants.

MAJOR PROGRAM AND PROJECTS

SAN's major energy program and project activities fall primarily under the Assistant Secretary for Energy Technology. Those programs and projects directed by other DOE offices include: the Geothermal Loan Guaranty Program, under the Assistant Secretary for Resource Applications; the Solar Heating and Cooling Program, under the Assistant Secretary for Conservation and Solar Applications; the Positron-Electron Project, directed by the Office of Energy Research; and lastly, National Defense Programs and the NOVA Project, which are both under the Assistant Secretary for Defense Programs.

Solar Central Power Systems Program

SAN has been assigned program responsibility for the development of large-scale central solar thermal electrical solar generation technology. This program is directed toward developing and demonstrating the technical and economic feasibility and environmental acceptability of solar energy power systems for the utility industry. In addition to the baseline water/steam central receiver approach (10 Megawatt Pilot Plant), the program explores alternative working fluids and transport media (air, gases, liquid metals, etc.), conversion cycles (Brayton cycles, combined cycles) and configuration (e.g., central and distributed linear focus systems; solar/non-solar hybrid systems).

10 Megawatt (MWe) Solar Central Receiver Power Plant

A 10 MWe pilot plant, scheduled for initial operation in 1981, will be the Nation's first electric generating station powered directly by solar energy. DOE is providing the solar portion of the plant. The conventional steam turbine generating equipment and electrical distribution network will be provided by the utility team, Southern California Edison and the Los Angeles Department of Water and Power. The California Energy Commission is also a participant and is responsible for assuring institutional technology transfer. The pilot plant will utilize the central receiver concept. Sunlight will be reflected off a group of tracking mirrors to a tower mounted receiver/boiler that will produce steam to generate electricity.

Field management of this project, with a total estimated cost in excess of \$100 million, has been assigned to SAN. SAN has developed the management plan for the project and is responsible for the day-to-day planning, direction, execution, and control of the project within the overall program requirements. A dedicated Project Office has been established by SAN and collocated with the utility consortium in the Los Angeles area.

Geothermal Demonstration Power Plant (GDPP)

SAN has been assigned decentralized project responsibility for the construction of GDPP, a major milestone in the development of geothermal energy. The 50 MWe geothermal electricity plant is a joint project between SAN, the Public Service Company of New Mexico (PNM), and Union Oil Company. The plant will supply enough power to meet the needs of a city about the size of Santa Fe.

Total project costs are estimated at \$100 million. Construction of the plant is scheduled in 1979 and slated for completion in 1982. PNM will build GDPP and Union Oil will drill the wells and install the pipeline system which will provide steam to the plant.

The completed project will have a potential for producing at least 400 MWe of electricity over a 30-year period.

PNM and Union Oil will also attempt to extend the geothermal reservoir's lifetime by reinjecting hot water underground after separating it from the steam. This process will be used to drive the electric generating turbines at GDPP.

This project is being managed by SAN personnel located at GDPP Project Office in Albuquerque, New Mexico.

Geothermal Loan Guaranty Program

The Geothermal Loan Guaranty Program (GLGP) aims to accelerate commercial development of geothermal energy by minimizing the financial risk to lending institutions by guaranteeing repayment of loans for up to 75 percent of total project costs. The program is also geared to foster normal lender-borrower relationships.

SAN has nationwide responsibility for processing all geothermal loan guaranty applications and has established a GLGP division which processes the applications and submits recommendations to headquarters. Processing of applications includes financial, legal, patent, management, marketing, technical, resource, and power conversion reviews, some of which are performed by outside contractors. In addition, SAN calls on other DOE facilities for assistance. The Oak Ridge National Laboratory, for instance, conducts environmental reviews on non-federal lands, and the Idaho National Engineering Laboratory conducts technical reviews for the utilization process.

As of early 1979, SAN is processing four applications totaling in excess of \$100 million. In addition, three guaranties have been executed for projects with a total project cost of \$24 million of which \$14 million is federally guaranteed. The GLGP, the only active loan guaranty program within DOE and SAN, has developed a management plan which may serve as a prototype for future loan guaranty programs in other technology areas.

Magnetic Fusion Program and Mirror Fusion Test Facility (MFTF)

SAN has been assigned cost and schedule responsibility for magnetic fusion energy programs at the Lawrence Livermore Laboratory and the General Atomic Company. In addition, SAN has been assigned field management responsibility and has established an onsite project office for MFTF at the Lawrence Livermore Laboratory (LLL).

Construction of MFTF represents a milestone in the Magnetic Fusion Energy Program as a major next step beyond the success achieved by the 2X IIB magnetic mirror device currently in operation at LLL. The MFTF experiments will provide timely physics and engineering data, as well as operating experience, for use in the concurrent design and construction of the first experimental mirror reactor. Total cost of the project is estimated at \$94.2 million and the facility is scheduled to be completed in 1981.

SAN has developed the management plan in coordination with LLL for the MFTF Project and has undertaken responsibility for management, administration planning, cost control, direction, and performance of all line-item project activities.

NOVA Project

SAN has lead responsibility to construct the NOVA Project, a large laser to demonstrate the scientific feasibility of producing future power through Inertial Confinement Fusion (ICF). The project entails building a mirror image of the existing High Energy Laser Facility (SHIVA) at LLL.

Preliminary design for the project was initiated in January 1978. Construction for the building addition is scheduled to start in March of 1979. Installation of the laser should be complete by 1982. Conversion of the SHIVA laser to the NOVA configuration will be complete in 1984. The total estimated cost for the project is \$195 million.

Positron-Electron Project

This project is located at the Stanford Linear Accelerator Center, Stanford, California, and when completed will be the most advanced facility of its kind in the world for the study of high energy physics.

SAN has been assigned project management responsibility which involves overseeing the design and construction of a large positron-electron colliding beam storage ring about a half-mile in circumference, the associated underground housing, the experimental halls, and the supporting utilities. The project is estimated to cost \$78 million and will be completed in 1980.

National Defense Program

In addition to its energy responsibilities for civilian applications, SAN takes an active part in the Nation's nuclear weapons research, development, testing, production and surveillance. Within SAN's total budget authority, approximately \$184 million is directed toward national defense activities. DOE defense programs include the nuclear weapons activities and related classification, safeguards and security, arms control and intelligence, special nuclear materials production, and inertial confinement (laser) fusion activities. These DOE defense programs activities are pursued almost exclusively at a few Government-owned, contractor-operated laboratories and production facilities which, together with a few DOE field offices, are called the weapons complex.

SAN's role in the weapons complex is to manage defense program activities through contract administration and program management support. This includes reviewing the contractor's resource requirements for assigned programs, implementing and supervising classification, safety and security policies and procedures, managing capital construction projects, and supervising institutional plans and the placement of defense and energy work.

SAN's principal defense contractor is LLL. LLL is one of three national laboratories having a primary mission of nuclear weapons design and development.

In keeping with SAN's matrix management, SAN has a Defense Programs Team from administrative and project divisions to coordinate and effect SAN's activities in support of national defense programs. This matrix team ensures contract administration effectively supports program objectives. The team provides an overview of all LLL program activities from an institutional perspective to assure the compatibility of energy programs objectives, needs, and activities with those of the Defense Programs.

Breeder Reactor Component Testing

The Breeder Reactor Program seeks to bridge the gap between technology development and commercial application by developing components and testing instrumentation for breeder reactor plants. The program serves not only as a proving ground, but also links design with experience to provide a source of engineering counsel in liquid metal technology.

The 1979 budget for the Breeder Reactor Program is \$20 million. The program is managed by the Energy Technology Engineering Center located northwest of Los Angeles at Rockwell International.

Equal Employment Opportunity (EEO)

In an effort to further the development of EEO, SAN has appointed an EEO Council whose primary function is promoting and monitoring the SAN EEO Plan. The EEO Council provides a forum where affirmative action items are discussed and where specific actions impacting the total EEO Program may be developed and assessed.

The EEO Council is composed of:

EEO Counselors who make inquiries and conduct interviews with aggrieved employees and their supervisors and attempt to informally secure resolution of these problems;

The Federal Women's Program Coordinator who assists the Manager to assure effective use of human resources within SAN by increasing the number of qualified women in upward mobility programs, career ladders and management positions;

The Hispanic Employment Coordinator who assists the Manager to increase the number of qualified Hispanics into the management of SAN, and;

The Director of the Personnel Division who assures that SAN maintains its high standards of EEO.

THE SAN/REGIONAL REPRESENTATIVE INTERFACE

The Office of the Regional Representative (ORR) in San Francisco has responsibility for maintaining the Department's interaction with the general public, other governmental organizations, business, labor and consumer groups with interests in Federal energy policy and programs in Region IX. Region IX consists of Arizona, California, Hawaii, Nevada, and the Pacific Island areas.

SAN and ORR provide mutual support to each other in several ways including ORR membership on appropriate SAN matrix teams, particularly when the project has high visibility or potential political or social implications.

SIGNIFICANT ACCOMPLISHMENTS

- o Designation as lead field office for the management of the Solar Central Power Systems Program and the Ocean Thermal Test Facility (OTEC-1).

- o Designation of SAN as the lead field office for project management of the Geothermal Demonstration Power Plant.
- o As of December 1978, SAN has been designated the lead field office for solar energy research and development for the following program elements: controls, solar-assisted heat pump, and active solar cooling.
- o SAN and the Office of the Regional Representative (ORR) for Region IX established a Management Assistance Agreement to provide mutual support to each other; ORR staff are now represented on the SAN matrix teams.
- o Worked with the Office of the Assistant Secretary for Energy Technology to develop a pilot Program Planning and Execution Process which addresses preplanning concerns, existing and potential issues in the field, and field-developed program and project tradeoffs.
- o SAN has begun to off-load work in areas such as procurement, audit, property management and management services. In this manner, we have been able to accept and manage significant workload increases with nominal increases in resources.
- o SAN established a Manpower Requirements Model which helps determine costs and people requirements resulting from the acceptance of new work assignments.

(THIS PAGE INTENTIONALLY LEFT BLANK)

Savannah River Operations Office

EXECUTIVE SUMMARY

Savannah River Operations OfficeLOCATION: Aiken, South CarolinaSTATISTICS (FY 78)

NUMBER OF AREA OFFICES:	0
NUMBER OF GOVERNMENT EMPLOYEES:	206
NUMBER OF CONTRACTOR EMPLOYEES:	7,557
ANNUAL OPERATING BUDGET:	\$284 million
CONSTRUCTION BUDGET:	\$344 million
NUMBER OF CONTRACTS:	325
SIZE OF RESERVATION:	192,323 acres

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o Nuclear Materials Production
- o Production of Heat Sources
- o Heavy Water Production
- o Weapons Components, Loading and Recycle
- o Interim and Long Term Nuclear Waste Management
- o National Uranium Resource Evaluation
- o Participation in Consolidated Fuel Cycle Program
- o Environmental Research
- o Storage and Reprocessing of Domestic and Foreign Test Reactor Fuels
- o Forest Management
- o Lead Office for National Program Long-Term High-Level Waste Management
- o Lead Office for National Program to Manage Storage of Power Reactor Spent Fuel

LABORATORIES AND PLANTS ADMINISTERED

<u>Facility Name</u>	<u>Contractor</u>
Savannah River Plant	E. I. duPont de Nemours & Co.
Savannah River Laboratory	E. I. duPont de Nemours & Co.
Savannah River Ecology Laboratory	University of Georgia
Savannah River Forest Station	Federally operated by U. S. Forest Service

SAVANNAH RIVER OPERATIONS OFFICE

BACKGROUND AND MISSION

Savannah River Operations Office (SR), located near Aiken, South Carolina, is one of the key installations in the special nuclear materials production and research program under DOE. The mission of Savannah River includes energy research and development; production of plutonium, tritium, and other nuclear materials primarily for national defense; and related environmental research activities. The prime operating contractor is E. I. duPont de Nemours and Company.

Over 25 years of intense, highly technical, energy-related project and program management uniquely qualify the Savannah River Operations Office to share in meeting the Nation's long-term energy goals. The program and project base includes: operation of a research and development organization (Savannah River Laboratory); design, construction, operation, and maintenance of a multi-billion-dollar industrial facility represented in the Savannah River Plant; the program for the full range evaluation of alternative fuel cycle techniques which reflects the Administration's policy on nuclear fuel recycle; high-level radioactive waste management; nuclear reactor operation and safety; chemical reprocessing technology; and studies of the environmental effects of nuclear and industrial operations. (See site map.)

Supporting these missions, the Savannah River Operations Office staff totals 206 of which 140 are professionals. Total contractor employment at the Savannah River Plant (SRP) site, including Savannah River Laboratory, duPont Operations and Construction, the Savannah River Ecology Laboratory, Savannah River Forest Station, and sub-contractors exceeds 7,500.

MANAGEMENT PHILOSOPHY

SR employs a typical line/staff organization structure. The overriding management objective of the SR staff is to assure the achievement of plant production goals in the safest, most efficient possible manner. The safety record at Savannah River ranks among the finest in DOE.

PROGRAM WORKLOAD

The fiscal 1978 operating budget at Savannah River was approximately \$284 million. About \$192 million of this total was devoted to special nuclear materials and heavy water production. An additional \$1.9 million supported work for other Federal agencies.

SAVANNAH RIVER PLANT
SITE MAP

REV. 8-29-1975 SCALE IN MILES

In addition to contracts with E. I. duPont de Nemours and Company, the University of Georgia's Institute of Ecology, and the Savannah River Forest Station, Savannah River administers 325 contracts with universities, hospitals, government agencies, and industry. Included are special research support agreements, loan agreements for californium-252, mutual aid agreements, and agreements covering the lease and reprocessing of heavy water.

Savannah River also conducts an extensive public affairs program and maintains relationships with the news media, state and local governments, and community leaders. Programs to encourage awareness among the general public regarding current and future projects at SR include: a consumer representation program, speakers' bureau, news media contact and notification, general site tours for high school science students, and in-depth tours for organizations, news media representatives and special interest groups. The primary reason behind such a public affairs effort is to provide opportunities for citizen participation in DOE's energy programs.

MAJOR PROGRAM ASSIGNMENTS

Nuclear Materials Production

The principal mission of the Savannah River complex is isotope production, fuel and target fabrication, and chemical separation. The products of the Savannah River facilities are of vital importance to the Nation's reactor research and development (R&D) program, to the weapons program, and for many other requirements. For example, isotopes produced here are used in the radioisotope thermoelectric generators supporting the space program. The production facilities are supported by Savannah River Laboratory, which is also operated by duPont, performing studies in process development, planning, nuclear safety, industrial safety, and environmental effects.

Waste Management

As a necessary consequence of operations, production facilities at Savannah River generate liquid, solid, and gaseous radioactive wastes. The objective of the Savannah River Waste Management Program is to handle these wastes in a manner so that they will neither endanger the health and safety of employees or the public, nor have an adverse impact on man's environment.

Research and development and conceptual design studies are aimed at the conversion of SRP high-level liquid and solid defense wastes to stable non-leachable solid forms such as glass or concrete. These forms will be suitable for long-term storage in a Federal Repository.

In addition, SR is the lead field office for the national high-level waste management program. Major program objectives are: (1) To conduct

research and development required to remove high-level waste (HLW) from tanks and bins for transfer to a waste processing facility; process the waste into form(s) for final disposal and package and ship the waste to a disposal site(s); (2) to construct and operate a lead facility for processing defense HLW; (3) to conduct materials characterization activities on processed HLW forms; and (4) to coordinate total United States efforts toward effective (HLW) long-term management, and to carry out appropriate international activities.

Spent Fuel Storage Program

In September 1978, the management responsibility for the Spent Fuel Storage Program was assigned to SR. The scope of the assignment includes ensuring that no reactor shuts down because of a lack of space to store spent fuel and that no delays are experienced in receiving and storing foreign spent fuel in this country once a decision to do so has been made.

The objective of the program is based upon the proposed DOE spent nuclear fuel policy announced on October 18, 1977.

Put into effect, this spent fuel policy will give relief to utilities, both domestic and foreign, by providing a plan for spent fuel disposition. This new policy is a logical extension of the established Federal responsibility for permanent disposal of high-level wastes, given the current indefinite deferral of reprocessing.

National Uranium Resource Evaluation

As part of the program to evaluate domestic uranium resources, SR is conducting a hydrogeochemical reconnaissance of 25 states in the eastern United States and 7 states in the West. Basic data reports will be issued on 116 high priority quadrangles by mid-1980. Development studies began in 1975, and reconnaissance surveys began in 1976.

U. S. Forest Service

In addition to managing and enhancing the extensive forest areas on the 300-square-mile SRP site, the Savannah River Forest Station is also conducting a variety of research studies, including one on the relationship between southern fusiform rust fungus and tree growth, defining habitat conditions for certain species of wildlife, and reclaiming disturbed areas. Of particular importance to energy conservation, the Forest Station is conducting experiments to increase the production of resins in pine trees. Greater resin yields could release petrochemicals in production processes for direct energy use.

Timber sales to industry, coordinated by the Forest Station, return close to \$1 million annually to the government.

Environmental Activities

The Savannah River Operations Office is committed to protecting the environment and supports a comprehensive program of environmental research. In 1972, the entire 192,000-acre plant site was designated as the Nation's first National Environmental Research Park.

A program of environmental monitoring by an outside group was begun at the plant site even before operations started. Data collected provide a baseline against which subsequent environmental effects are measured. Extensive monitoring has continued at the Savannah River Plant to maintain a constant watch on the environment.

Environmental research at the Savannah River Ecology Laboratory (SREL) supplements the more process-oriented studies of the Savannah River Laboratory. SREL is operated for DOE by the University of Georgia's Institute of Ecology. Many different aquatic and terrestrial habitats on the plant site have been protected and set aside for environmental studies. The areas affected by plant operations, as well as old town sites, also provide research opportunities. Major areas of research are: (1) Problems connected with thermal effects on aquatic and swamp ecosystems; (2) studies of mineral cycling (especially of heavy metals) in ecological systems (3) studies of basic and theoretical ecology; and (4) the radioecology of transuranic elements.

Other activities managed by SR which are directly applicable to resolving problems associated with a wide range of energy alternatives include:

- o Fossil Energy: studies of trace elements resulting from coal ash in aquatic and terrestrial eco-systems, studies to determine best uses for coal ash, tests of new techniques for revegetating disturbed lands, and analyzing data on offshore water movements as a basis for predictive models useful for both offshore oil drilling as well as for floating nuclear power plants.
- o Solar Energy: paraquat stimulation of pine resin production and experimental solar-powered environmental monitors.
- o Fusion Energy: experience in tritium production and handling, and cycling of tritium in biological systems.
- o Conservation: Energy recovery from low temperature waste heat and stimulation of biological activity.

SIGNIFICANT ACCOMPLISHMENTS

- o Sole producer of plutonium-238 in the United States.
- o Sole producer of heavy water in the United States and the center of U. S. heavy water reactor technology.
- o Largest producer of plutonium-239 in the United States.
- o First National Environmental Research Park.
- o Sole source of tritium in the United States.
- o DOE's only integrated contractor (E. I. duPont de Nemours and Company) capable of handling R&D, design, engineering, construction and operation of facilities.
- o DOE site for market evaluation and large-scale production of californium-252.
- o Only operating production scale fuel reprocessing facilities in the United States.

GRAND JUNCTION OFFICE

BACKGROUND AND MISSION

The Grand Junction Office (GJO) was established as the Colorado Raw Materials Office of the Atomic Energy Commission (AEC) in December 1947. The main functions of the office were to purchase ore and concentrate and to search for domestic uranium. This search was successful beyond all expectations.

In 1948, 102 tons of U_3O_8 were purchased by the Federal Government for \$1.5 million. By 1960, purchases by the Atomic Energy Commission (AEC) had grown to 17,637 tons U_3O_8 and the cost to \$305 million.

In 1952, there were only six uranium processing mills in operation, including five privately-owned mills and one Government-owned mill. By late 1961, a total of 27 privately-owned mills were processing about 22,000 tons of uranium ore per day. Each of these mills had a unit price contract individually negotiated at the Grand Junction Office. The last of the procurement contracts terminated in 1970 as industry assumed complete responsibility for uranium exploration, mining, and milling. GJO's staffing dropped to a low of 65 employees in 1974 compared to its peak of 522 employees in 1956. The mid-1970's energy crisis, however, brought renewed interest in the search for uranium, and GJO launched the National Uranium Resource Evaluation (NURE) program. NURE is a part of the GJO Uranium Resource Assessment program to make increasingly reliable estimates of the nation's uranium resources and to determine areas favorable to uranium deposits.

GJO's prime operating contractor for the program is Bendix Field Engineering Corporation.

GJO also makes estimates of uranium ore reserves, potential resources, and production capability; develops and evaluates improved uranium exploration assessment and production technology; administers leasing of mineral lands under DOE control; and carries out activities relating to environmental effects of uranium mining and milling operations, including corrective programs.

The Grand Junction Office is located on a 48.6 acre tract of land along the Gunnison River, south of the City of Grand Junction. The area is fenced for physical security of facilities. There are 38 buildings of various kinds being used for a variety of purposes. Plant and equipment are valued at about \$8.0 million.

The staffs of GJO and Bendix Field Engineering Corporation are primarily geoscience oriented and are fully committed to the early accomplishment of the NURE program. GJO staffing currently is 88, of which a high percentage is professionally trained: Ph.D. 4; M.A./M.S. 22; B.A./B.S. 40. The Bendix staff at Grand Junction totals 484, which

includes the following distribution by academic degree: Ph.D. 40; M.A./M.S. 62; B.A./B.S. 149. With adequate augmentation of staff, GJO is available to conduct expanded raw materials evaluation and other programs as may be assigned.

MANAGEMENT PHILOSOPHY

The organization of the Grand Junction Office is as depicted on the organization chart (see appendix B), which represents a typical line and staff arrangement of the major operational and administrative units.

The main office at Grand Junction is the place where management, administrative, and support personnel are housed. However, in support of the uranium assessment and elements of the NURE Program, field offices are located at Spokane, Washington; Reno, Nevada; Casper, Wyoming; Atlanta, Georgia; Anchorage, Alaska; Albuquerque, New Mexico; Austin, Texas; Pittsburgh, Pennsylvania; and Grand Junction. Supporting functions, such as analytical, electronic, and mineralogy laboratories are at Grand Junction, as are computer facilities, printing plant, library, and drafting facilities, and the administrative offices.

PROGRAM WORKLOAD

GJO's FY 1978 operating budget was \$51.3 million, and it administered about 165 contracts mainly through Bendix Field Engineering Corporation.

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

National Uranium Resources Evaluation

The NURE program has been under way since 1974. As noted above, the major objective of the program is to provide reliable estimates of the Nation's uranium resources. A necessary preliminary to this is the evaluation of the relative favorability (for occurrence of uranium) of all areas of the Nation.

The aerial radiometric survey of the U. S. is being conducted by geophysical service companies which use sensitive gamma-spectrometry techniques to measure low concentrations of uranium, thorium, and potassium. The purpose of the surveys, flown on flight lines averaging 5 kilometers apart, is to gather data for a broad-scale assessment of low-level radioactivity of discrete geologic units. Radioelement signatures related to uranium concentrations in specific rock types in a variety of districts with different geologic environments may be used to infer favorability in similar but unexplored areas.

Hydrogeochemical and stream sediment reconnaissance will identify new provinces favorable for occurrence of uranium deposits. Sediment

samples from permanent and ephemeral stream beds and water samples from streams, lakes, springs and wells are collected in designated locations throughout the U. S. following specific procedures, and then are analyzed for uranium and associated elements.

Geologic drilling is being done to develop subsurface geologic information on the favorability of specific geologic environments where such information is lacking. DOE drilling is not for exploration purposes, such as that done by industry, but rather to provide geologic information that will improve the information base for estimation of uranium resources.

Geologic studies and investigations are fundamental to the NURE program and favorability must be related to the geological environment to determine their relative significance. Geologic investigations are being conducted to identify formations and environments favorable for uranium occurrences, to develop favorability guides useful in exploration and to provide a basic framework for assessing uranium resources. Occurrences of uranium in different geologic environments are being studied as potential indicators of resources in presently unevaluated settings.

Geostatistical investigations are being conducted on improving methods to estimate reserves and assess potential resources. These include subjective probability studies of uranium resources, adapting ore reserves methodology for copper to uranium, state-of-the-art study or resource appraisal methodology, geostatistical methods applicable to the calculation of ore reserves in roll-type uranium deposits, geostatistical techniques for analyzing airborne gamma-spectrometry data, and a study of uranium grade distributions in domestic uranium deposits that have been mined.

Geophysical technology application activities include: establishment of a second dynamic test range for overflight testing of airborne radiometric surveying systems; investigation of the mechanism of radon propagation in the atmosphere; optical fiber logging cable development; helium measurement, helium isotope ratio measurements, helium-argon ratio measurement, all as possible indicators of subsurface uranium deposits; and continued development of borehole logging systems for the direct measurement of uranium in situ.

Ore Reserve and Potential Resource Programs

GJO's Ore Reserve Program results in independent estimates for individual deposits throughout the nation that are focused on detailed sample information made available to the Grand Junction Office voluntarily by uranium companies. Reserve estimates are made on a continuing basis and are reported annually both in public announcements and the report entitled "Statistical Data of the Uranium Industry," issued by GJO. In addition to reserve estimates, in-place uranium mineral inventories showing distribution of uranium by grade increments are compiled.

An industry Grumman S-2 Aircraft is shown parked on DOE's Aerial Radiometric Calibration Facility at the Grand Junction, Colorado, Airport. The plane's equipment is being calibrated over five concrete pads containing known quantities of potassium, thorium, and uranium.

Based on the results of the NURE and the ore reserve programs and additional data provided by the exploration companies, GJO estimates the potential or undiscovered uranium resources of the country. The estimates are made in three categories to indicate varying degrees of reliability. The estimates, which take into account expected economic conditions, are updated and released yearly.

Supply Analysis Program

The Supply Analysis program includes developing and administering programs for analyzing and reporting on the relationship between uranium resources supply, and nuclear energy requirements; developing procedures and methods for estimating the domestic uranium production capability; and preparing mine, mill and exploration cost data for the ore reserve and NURE programs.

Uranium Leasing Program

The Uranium Leasing Program includes 43 tracts of DOE controlled uranium-bearing land, totaling some 25,000 acres, located in southwest Colorado (38 tracts), Utah (4), and New Mexico (1). These 43 tracts have been leased to private companies and individuals for exploration and mining purposes. The leases are for 10-year periods with options to renew, and all contain royalty provisions. The program includes: reviewing exploration and mining plans for each tract, primarily to ensure compliance with environmental regulations of other Federal agencies; on-site reviews of operations for efficiency and safety purposes as well as compliance with approved plans; and maintaining records of production activities, verifying sampling, assaying, and other procedures to assure lease terms are adhered to and royalty payments are proper. An earlier leasing program during the period 1948-1962 generated \$5.9 million in royalty to the AEC. The current program, which commenced in 1974, already has provided royalties totaling \$21.6 million through December 1978.

Remedial Action Program

The Remedial Action Program is a cooperative Federal-State program administered by DOE and conducted by the Colorado State Health Department. The program was authorized by Congress in 1972 to limit exposure of individuals to radiation from the use of uranium mill tailings for construction purposes in the area of Grand Junction, Colorado. The State of Colorado conducts this program and contracts directly for most of the work to be done. Through 1977 remedial action, usually removal of tailings, had been accomplished on about 300 structures. Another 300 may still require remedial action during the next few years at a total estimated program cost of \$12.6 million (\$9.5 million Federal and \$3.1 million State).

Inactive Uranium Millsites and Tailings Piles Program

The Inactive Uranium Millsites and Tailings Piles Program is being conducted by DOE in cooperation with the Environmental Protection Agency and the various western states in which these sites are located.

Engineering assessments of possible methods and costs of cleaning up or stabilizing the sites have been prepared for DOE by Ford, Bacon & Davis Utah, Inc., Salt Lake City. The engineering assessments were the second phase of a study begun in 1974 and were the basis of cost estimates used by DOE in legislation proposed to Congress for authorizing remedial action at some 22 locations in eight western states.

SIGNIFICANT ACCOMPLISHMENTS

- o Organization and initiation of quadrangle evaluation studies, which is a systematic and uniform approach to evaluating the uranium resources of the U.S.
- o Industry calibrated 2,428 borehole probes at DOE facilities in 1978. This calibration is essential for standardization and normalization of industry furnished data used by DOE in ore reserves calculations.
- o Airborne radiometric survey systems covered 22,292 flight line miles in 1978 in the conterminous U.S. and Alaska.
- o Issued 468 reports in 1978.
- o Lease tract royalty during 1978 totaled \$9.1 million.
- o An estimate of uranium production capability and supply was made for the 30-year period, 1977-2006, utilizing resources available at a cost of \$30 per pound or less U₃O₈ in concentrate.

Pittsburgh Naval Reactors Office (PNR)

PNR administers the operations of the Bettis Atomic Power Laboratory and Shippingport Reactor Test Facility. PNR is located at the Bettis Site in western Pennsylvania, approximately 10 miles from Pittsburgh. It consists of 88 administrative and engineering DOE personnel.

Schenectady Naval Reactors Office (SNR)

SNR administers the operation of the Knolls Atomic Power Laboratory (KAPL) which is operated for DOE by the General Electric Co. SNR is located at the KAPL site in Niskayuna, Schenectady County, N.Y. It consists of 72 administrative and engineering DOE personnel.

4

CLINCH RIVER BREEDER REACTOR PLANT PROJECT OFFICE

BACKGROUND AND MISSION

The overall objective of the Clinch River Breeder Reactor Plant (CRBRP), as authorized by Public Law 91-273, as amended, is to design, license, build and test the Nation's first large-scale liquid sodium-cooled breeder reactor power plant and operate the plant as part of a utility system.

The Administration has now proposed the cancellation of CRBRP construction and component construction, licensing and commercialization efforts except for systems design and selected components. Implementation of the proposed redirection is pending final resolution by the Administration and Congress. Pending this resolution, project activities are continuing on a prudent and reasonable basis.

The former U.S. Atomic Energy Commission (AEC) was authorized by Public Law 91-273, in 1970, to undertake the design, construction and operation of a liquid metal fast breeder reactor demonstration plant. In 1972, the AEC entered into a negotiated agreement with Commonwealth Edison Company (CE) and the Tennessee Valley Authority (TVA) to implement the authorization. In March 1972, two not-for-profit organizations were formed to implement the CE-TVA proposal. The Project Management Corporation (PMC) provided centralized management of the reactor project and the ensuing demonstration program. The Breeder Reactor Corporation (BRC) was organized for liaison between the project participants and the utility industry.

Subsequent contracts were entered into with Westinghouse performing a lead reactor manufacturer function and directing the activities of two reactor manufacturers: General Electric (GE) and Atomics International (AI). Burns and Roe was awarded the architect-engineer function, and TVA entered into an agreement to operate the plant. Stone and Webster Engineering Corporation (SWEC) has been awarded the construction contract.

The project was under the dual managership of the AEC and PMC from 1972 through 1974 when, in view of a larger funding ratio by the Federal Government, it was decided that Government should have a larger management role in the undertaking. This occurred shortly after the Energy Research and Development Administration (ERDA) was formed and assumed AEC's role in the project. Public Law 94-187 amended the basic legislation to allow a single integrated management unit to be known as the CRBRP Project Office (PO).

MANAGEMENT PHILOSOPHY

The CRBRP Project Office, located in Oak Ridge, Tennessee, operating under the direction of the project director, is responsible for the overall management of the CRBRP Project including the direction of all project activities to accomplish the design, manufacturing, licensing, construction, testing, and operation on a utility network of a liquid metal fast breeder reactor demonstration plant.

The Project Director directs and coordinates all activities of the CRBRP project, including overall project direction, contract administration, technical guidance, acquisition of resources, evaluation of performance of project participants, and continual assessment of project costs and schedules to assure accomplishment of approved project objectives.

The Project Office is comprised of an integrated staff of the Department of Energy (DOE), PMC, and utility industry employees, in accordance with law, statutory criteria, Congressional commitments, contracts and pertinent federal regulations, organized to accomplish the project's mission. The major functional responsibilities of the Project Office organization include: engineering and design, plant licensing and public safety, construction, operations, procurement, quality assurance, project control, financial management, legal affairs, labor relations, and public information.

The Project Director has been delegated authority consistent with that normally exercised by Operations Office managers in carrying out his responsibility for activities required under contract for construction and operation of the CRBRP and other research and development work.

The Project Office obtains support from the Oak Ridge Operations Office (OR), in the interest of overall economy and efficiency of DOE affairs, as arranged between the Project Director and the Manager of OR. This support is principally in the areas of personnel management, communication, and office building maintenance service. The Project Director and the Manager, OR, coordinate closely on local community and industrial relations matters.

PROGRAM WORKLOAD

The CRBRPPO administers six prime DOE contracts and four major sub-contracts for a total of about \$667,300,000. The FY 1978 execution plan was reduced from \$232 million to \$179 million budget outlay as a result of the Administration's proposal to terminate the project.

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

The CRBRP project serves as the vehicle for the cooperative government-industry effort to design, construct, and operate the Nation's first large-scale liquid metal fast breeder demonstration plant.

The principal objectives of the CRBRP project are:

1. To attempt to successfully demonstrate the liquid metal fast breeder reactor.
2. To help (a) confirm and demonstrate the potential value and environmental desirability of the concept as a practical and economic future option for generating electric power (the impact of the demonstration plant on the environment will be given consideration throughout the design and planning phase of the project and will be integrated into design and planning decisions); (b) confirm the value of this concept for conserving important nonrenewable natural resources; (c) develop for the benefit of government, industry, and the public, important technological and economic data; (d) provide a broad base of experience and information important for commercial and industrial application of the breeder reactor concept; and (e) verify certain key characteristics and capabilities of breeder power plants for operation on utility systems such as licensability and safety, operability, reliability, availability, maintainability, flexibility, and prospect for economy.
3. To utilize to the maximum extent practicable the technology developed or being developed in DOE's programs recognizing that this project is an indispensable part of DOE's overall long-range breeder reactor research and development program and will be essential to the success of the liquid metal fast breeder reactor demonstration plant.

SIGNIFICANT ACCOMPLISHMENTS

- o Prior to October 1, 1977, the site was chosen and major plant system concepts were selected. The site geology survey was completed. Major system design descriptions and key equipment specifications were completed. Orders were placed for critical long-lead materials, and quotes were requested on major plant components. Some \$400 million of hardware is under fabrication and is about 40 percent completed.

- o Although licensing and construction and some procurement actions have been deferred, design work is being aggressively pursued. As of September 30, 1978, reactor manufacturer design was 62.9 percent complete, architect-engineer design was 64.3 percent complete, and applied base research and development which is borne by the project was 77.4 percent complete.
- o As of September 31, 1978, the project accrued cost was \$590.8 million.

FAST FLUX TEST FACILITY PROJECT OFFICE

BACKGROUND AND MISSION

The Fast Flux Test Facility Project Office (FFTFPO) was established on June 1, 1974, at Richland, Washington. Its principal mission at that time was to manage and direct the completion of design, construction, and startup of the Fast Flux Test Facility (FFTF). The Project Office was also tasked as contracting office for the prime contract with the Westinghouse Hanford Company under which the FFTF project is managed, along with all other reactor development work at the Hanford Engineering Development Laboratory (HEDL).

The FFTF--at a capital cost of \$540 million--is a sodium-cooled fast flux reactor designed specifically for irradiation testing of reactor fuels and materials. It also provides information and base technology in plant systems, component design and fabrication, prototype testing, construction, and acceptance testing. It is a key element in the Nation's breeder reactor program and, as a test reactor, is the largest of its kind in the world.

Development work at HEDL is dedicated to the development and testing of fuels and materials for use in reactor power plants. The Laboratory provides exceptional expertise and facilities in support of this area of engineering development and has recently been designated as the Technical Management Center for the national fuels and materials program.

PROGRAM WORKLOAD

FFTFPO, with a total staff of 65, administers and provides technical direction for contractor work with an annual total budget of approximately \$200 million.

PROGRAM AND PROJECT ASSIGNMENTS

Construction of the FFTF Project, now nearly complete, was started in 1970. Hot functional testing is in progress, and initial startup of the reactor is scheduled for late 1979.

Other major activities include:

- o Management of the reactor fuels and materials program at HEDL in support of the national program objective to achieve the development of a safe, economically viable and proliferation-resistant breeder reactor power plant fuel system. This requires coordinate staff work with the Nuclear Energy Programs Office, Department of Energy, Headquarters, to establish guidance and

Twelve large heat exchangers surround the Fast Flux Test Facility's dome-shaped reactor containment building. This 400 Megawatt-thermal sodium-cooled test reactor is 7 miles north of Richland, Washington, in the Hanford Reservation. Westinghouse Hanford Company is prime contractor to DOE for FFTF design, construction and operation.

direction of the national fuels and materials program and field management of the \$50 million per year laboratory development effort.

- o Management of design and construction of supporting projects, including the \$30 million Fuel Storage Facility (FSF), the \$16.7 million Maintenance and Storage Facility (MASF), and a \$12 million Security Improvements Project. The FSF and MASF will be located at the FFTF site, while the security project will provide an advanced security system at both the FFTF site and the 300 Area fuel development laboratories.
- o Management of specific breeder reactor research and development work directly supporting the FFTF project.
- o Management of general breeder reactor research and development work in the areas of safety, engineering components, physics, and reactor analysis including contract management of the Conceptual Design Studies for a large sodium-cooled breeder reactor plant.
- o Management of design of equipment to be utilized in the support of the expanded fuel handling and process system for the Fuels and Material Examination Facility (FMEF) as modified to incorporate the High Performance Fuel Laboratory (HPFL) system.

SIGNIFICANT ACCOMPLISHMENTS

- o Established effective management systems for cost and schedule control of the FFTF project and related FFTF activities, utilizing a modified Performance Measurement System (PMS). Based upon successful use at FFTFPO, PMS is being extended to other research search and technology programs.
- o The FFTF project is within cost and on schedule. The FFTF design and main construction contractor work is complete. Instituted overall planning and development necessary to implement the FFTF irradiation test activities consistent with overall breeder reactor program objectives.
- o Prioritized HEDL activities to support the breeder reactor program consistent with achieving FFTF startup on schedule.

- o Established an award fee arrangement for FFTF Project work and a separate award fee for the remaining research and development work at HEDL. Developed innovative incentive contract for FFTF construction.
- o In accordance with DOE policy to decentralize major activity implementation, HEDL was established as the Technical Management Center for the national reactor fuels and materials program. Management techniques that were successful for FFTF are being utilized.

SECTION IV
RESEARCH AND DEVELOPMENT FACILITIES

MULTIPROGRAM LABORATORIES
PROGRAM-DEDICATED FACILITIES

Introduction

Programs carried out in these facilities range from the most fundamental research programs in the physical and life sciences to most advanced goal-oriented design and development plans in nuclear and alternative energy technologies and nuclear weapons. The laboratories have demonstrated their ability to undertake technical management of large projects.

The institutional strength of DOE laboratories is based primarily on the excellence of their technical staffs and their ability to marshall all of the resources of the laboratory to solve specific problems. An unusually high percentage of the staffs have advanced degrees and many years of professional experience.

Another central feature of the institutional strength of DOE's laboratories is the excellence of their physical facilities. The laboratories are equipped to perform experiments covering most aspects of the physical and life sciences. Much of the specialized instrumentation has been developed by the individual researchers and, in many instances, is one-of-a-kind equipment. Large engineering facilities are available to many of the laboratories. The research and engineering staffs at each of the major laboratories have at their disposal highly competent machine and electronics shops and computer centers. Environmental and ecological studies have benefitted from setting aside protected environmental research areas at selected DOE sites.

The system of management practices and controls is built on a foundation of program budgeting in which funding levels are in terms of major functional categories. Frequently, laboratory management formulates and executes specific projects within broadly defined program areas. It provides extensive formal and informal input for program planning, including specific budgetary proposals developed on a laboratory-wide basis which are submitted annually through the appropriate DOE field office.

Summaries for these laboratories by employee occupational fields, by academic degree and by operating budgets/capital investment are given in appendix A.

To relate the laboratories to program activities, two additional appendices have been provided. Appendix E shows the mission areas in which each laboratory is involved, while appendix F lists facilities by program ranked by the extent of their participation in the program.

MULTIPROGRAM LABORATORIES

The backbone of DOE's scientific/technology base is the 12 multiprogram laboratories:

Ames Laboratory, Ames, Iowa
Argonne National Laboratory, Argonne, Illinois
Brookhaven National Laboratory, Upton, Long Island, New York
Hanford Engineering Development Laboratory, Richland, Washington
Idaho National Engineering Laboratory, Idaho Falls, Idaho
Lawrence Berkeley Laboratory, Berkeley, California
Lawrence Livermore Laboratory, Livermore, California
Los Alamos Scientific Laboratory, Los Alamos, New Mexico
Oak Ridge National Laboratory, Oak Ridge, Tennessee
Pacific Northwest Laboratory, Richland, Washington
Sandia Laboratories, Albuquerque, New Mexico
Savannah River Laboratory, Aiken, South Carolina

The 12 laboratories are grouped into two types: those 9 that are unrestricted in their availability to serve all of DOE's programs; those 3 that are limited in their availability. The 9 unrestricted laboratories are Ames Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Hanford Engineering Development Laboratory, Idaho National Engineering Laboratory, Lawrence Berkeley Laboratory, Oak Ridge National Laboratory and Pacific Northwest Laboratory and Savannah River Laboratory. The 3 limited use laboratories are the weapons laboratories--Lawrence Livermore, Los Alamos, and Sandia.

The Director of Energy Research and the Assistant Secretaries for Energy Technology and Defense Programs manage the multiprogram laboratories assigned to them with an agency-level Institutional Planning Process which includes: policy guidance on laboratory utilization and direction; 5-year Institutional Plans; general purpose facilities; and lead mission assignments.

The Institutional Plans containing 5-year projections of dollar and manpower are developed for these laboratories. These plans encompass total laboratory activity and represent DOE's projected overall plans for the use of the laboratories over a 5-year period including broad missions to be assigned and resources required to achieve those missions. The Field and Laboratory Coordination Council, which is chaired by the Under Secretary, overviews all the activities in the field and reviews the laboratory Institutional Plans each year.

EXECUTIVE SUMMARY

Ames Laboratory

LOCATION: Ames, Iowa

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$11.6 Million
STAFFING:	450
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$29.3 Million
NUMBER OF ACRES:	Not Government Property
NUMBER OF BUILDINGS:	15
FLOOR SPACE:	325,532 sq. ft.

OPERATING CONTRACTOR:

Iowa State University

RESPONSIBLE OPERATIONS OFFICE:

Chicago

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Materials Sciences (44%)	Math Sciences (1%)
Chemical Sciences (21%)	Magnetic Fusion Energy (1%)
Environment (6%)	Materials for Space Technology
High Energy Physics (5%)	(Fission) (2%)
Fossil Energy (6%)	Nuclear Physics (1%)
Nuclear Sciences (4%)	Solar (1%)
Institutional Relations (2%)	Work for Other DOE Laboratories
	and Federal Agencies (6%)

MAJOR FACILITIES:^{2/}

None

^{1/} Percentages reflect total staff (FTE) devoted to that activity including indirect.

^{2/} \$5 million acquisition cost.

AMES LABORATORY

Ames, Iowa

INTRODUCTION

The Ames Laboratory is a multiprogram government-owned, contractor-operated laboratory of the United States Department of Energy. Iowa State University is the operating contractor through its Energy and Mineral Resources Research Institute (EMRRI) and the laboratory is physically located on the university campus. Many of the laboratory's scientific group leaders are also members of the university faculty, and a substantial fraction of the basic research is performed by university graduate students holding research assistantships in the laboratory. Since the laboratory's inception in 1947, 963 Ph.D. degrees and 793 M.S. degrees have been awarded to students who based their theses on such research. Responsibility for the laboratory's now strong and expanding applied research and technology programs is shared by those holding joint university/laboratory appointments and the laboratory's full-time professional staff, with the latter also primarily responsible for providing scientific support services.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D.	91.	Engineers	39
M.S.	43	Computer Scientists	
B.S.	<u>136</u>	and Mathematicians	6
		Physical Scientists	197
		Life Scientists	3
		Technicians	46
		Other	<u>159</u>
Total	270	Total	450

CURRENT MISSION AND PROGRAM ACTIVITIES

The laboratory's multiprogram activities range from the most fundamental research in the physical sciences to goal-oriented programs in the energy and environmental sciences. The major program is in the materials sciences and centers on the preparation, purification, chemical characterization, and structure identification of new materials, followed by evaluation and interpretation of their chemical, physical and mechanical properties. Present efforts emphasize preparation of refractory metals and their alloys, refractory oxides, materials for solar applications, superconducting materials including composites, catalytic and hydrogen storage materials, and the evaluation and interpretation of optical properties of solids, the behavior of materials in hostile environments, superconductivity, and catalytic reactions.

A strong program in chemical analysis, emphasizing analytical optical and mass spectroscopies, was developed largely to support the materials program. It continues to serve this role, but has also been the nucleus for a growing program in environmental sciences especially aimed at the detection, identification, and quantitative determination of pollutants resulting from energy production and conversion processes.

Other programs in chemistry and chemical engineering are devoted to the identification of reaction pathways in very fast reactions, especially photochemical reactions and their theoretical interpretation; to establishing the structural chemistry of coal (including its variability with source); to the chemistry of hydrogen storage and catalyst; to the properties and potential of fly ash; and to process development and control.

A DOE fossil energy program is in progress, developing in large part from work started under the State-funded Iowa Coal project. Objectives include the development and evaluation of advanced methods of coal beneficiation and the development of materials resistant to coal conversion technology environments.

Activities in the Solar Energy Division include an extensive engineering effort in support of the DOE Solar Commercial Demonstration Program and the Hotel/Motel Hot Water Initiative.

The Experimental Nuclear Sciences Group, utilizing major facilities at Brookhaven National Laboratory, establishes the energy levels and states of short-lived isotopes produced by nuclear fission. These studies influence importantly the design of fission power reactors. This Group will soon launch an extensive program in heavy ion physics at the BEVALAC at Lawrence Berkeley Laboratory (LBL). A Theoretical Nuclear Physics Group, strongly supportive of the experimental program and deeply involved in the heavy ion work, remains in Ames.

The High Energy Physics Group functions largely as an accelerator user group, with recent experiments conducted at Fermi National Accelerator Laboratory and the Stanford Linear Accelerator Center. Program emphasis is forefront studies of strong interactions, particularly multi-particle hadronic final states. A substantial theoretical effort is maintained in Ames.

PROGRAM FUNDING

The fiscal 1978 DOE operating budget for the Ames Laboratory was \$11.6 million, plus \$732,000 in work for other Federal agencies. Plant and capital equipment investment on September 30, 1978, was \$29.3 million. Current employment is 642.

Programs	FY 1978
	Operating Funds (In Millions)
Basic Energy Sciences	\$ 8.4
Environmental Resource & Development	1.1
High Energy Physics	0.6
Fossil Energy Development	0.8
Solar	0.2
Fission	0.2
Nuclear Physics	0.1
Institutional Relations	0.1
Magnetic Fusion Energy	0.1
Total DOE	\$11.6

SIGNIFICANT ACCOMPLISHMENTS

- o Development of efficient reduction and purification processes for uranium, thorium, all of the rare earths, yttrium, vanadium, zirconium, and hafnium, all of which have been adopted by industry and are presently in use. Essentially all of the uranium used in the Western World has been prepared by processes developed at Ames.
- o Development of the plasma atomic emission spectroscopy method for multi-element analysis. The method is very fast, requires minute amounts of sample, permits simultaneous determination of up to 48 elements, and for most of these elements is more sensitive than any other method. Commercial instruments based on this development have been introduced; four U.S. companies and four foreign companies are now marketing such instruments.

A new family of high-performance superconducting materials have been fabricated at the Ames Laboratory using a chill casting process. Techniques have been developed to grow very long, very thin dendrites of niobium in a copper matrix as shown in the Scanning Electron Microscope pictured below. After these composites are drawn into wire and the niobium filaments are converted to Nb_3Sn , the wire will carry millions of amperes of electric current per square centimeter with no power loss.

The Ames Laboratory has pioneered the development of the inductively coupled plasma-atomic emission spectroscopic technique and applied it to the ultratrace determination of a wide variety of metallic pollutants in water and in air, pollutants that are derived mostly from energy generation sources. This analytical technique makes it possible to perform simultaneous, multi-element determinations of up to 40 trace metals in sample volumes of less than one-tenth milliliter.

- o Development of the basic science for sampling, isolating, and quantitating the trace organic compounds in water. The isolation techniques have increased detection power approximately a thousandfold for most compounds of environmental interest. The methodology is being widely adopted in the Environmental Protection Agency and water works laboratories, and a cooperative program with the American Water Association has been initiated to investigate the possibility of using the isolation method for water purification.
- o Invention of a new wet oxidation method for reducing the sulfur content of coal which promises to be technically simpler and more economical than any existing beneficiation process of comparable effectiveness.
- o Development of ductile, composite, superconducting wire with extraordinary current-carrying capability.
- o Development of processes for the recovery of alumina from coal fly ash.
- o Development of methods for improved control of the complex chemical equilibrium governing the separation of plutonium from uranium in fuel processing.

EXECUTIVE SUMMARY

Argonne National Laboratory^{1/}

LOCATION: Argonne, Illinois and Idaho National Engineering Laboratory,
Idaho

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$191.1 million
STAFFING:	5,166
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$521.5 million
NUMBER OF ACRES:	1,704
NUMBER OF BUILDINGS:	186
FLOOR SPACE:	3.8 million sq. ft.

OPERATING CONTRACTOR:

University of Chicago and Argonne Universities Association

RESPONSIBLE OPERATIONS OFFICE:

Chicago

PRINCIPAL PROGRAM ACTIVITIES:^{2/}

Reactor Development (39%)	Biomedical and Environmental
Basic Energy Sciences and	Research (10%)
Nuclear Physics (14%)	Work for Nuclear
High Energy Physics (9%)	Regulatory (4%)
Energy and Environmental	Work for Other Agencies (6%)
Technology (18%)	

MAJOR FACILITIES:^{3/}ANL-East

Zero Gradient Synchrotron
JANUS Reactor
CP-5 Research Reactor
Center for Human Radiobiology
Zero Power Reactors (ZPR-6
and ZPR-9)
Alpha-Gamma Hot Cells
Liquid Metal/Water Components
Testing Facilities
Fast Neutron Generator Facility

ANL-West

EBR-II (Experimental Breeder
Reactor)
TREAT (Transient Reactor Test
Facility)
Hot Fuel Examination Facilities
ZPPR (Zero Power Plutonium
Reactor)
Sodium Loop Safety Facility

^{1/} Includes Argonne-West in Idaho.

^{2/} Percentages reflect total staff (full-time equivalent) devoted to that activity including indirect.

^{3/} \$5 million or more.

ARGONNE NATIONAL LABORATORY

Argonne, Illinois and Idaho National Engineering Laboratory, Idaho

INTRODUCTION

Argonne National Laboratory (ANL) carries out broad programs of research and technology development in the physical, biomedical and environmental sciences and serves as a major center for energy research and development. Located on a 1700 acre site 27 miles southwest of Chicago, Illinois, it is operated under a tripartite contract among the Department of Energy (DOE); the University of Chicago; and the Argonne Universities Association (AUA), a consortium of 30 midwest universities. The University of Chicago operates the laboratory for DOE in accordance with policies establish jointly with AUA.

In addition to the Illinois site, Argonne maintains a second site (Argonne West) at the Idaho National Engineering Laboratory (INEL) 40 miles west of Idaho Falls, Idaho, where much of the laboratory's reactor development program is carried out.

PERSONNEL

On December 31, 1978, the ANL staff was composed of the following:

Highest Degree Attained		Number	Occupation		Number
Ph.D.		911	Engineers		843
M.S.		458	Computer Scientists/		
B.S.		667	Mathematicians		93
			Life Scientists		222
			Physical Scientists		699
			Technicians		703
			Other		2,606
	Total	2,036		Total	5,166

In addition, nearly 800 visiting scientists, faculty, and students hold temporary research appointments at Argonne.

CURRENT MISSION AND PROGRAM ACTIVITIES

Reactor Development

Development of the liquid metal fast breeder reactor (LMFBR) is the focus of the largest single program effort at ANL and comprises a number of coordinated efforts. The Experimental Breeder Reactor, EBR-II, is a mainstay of the Nation's LMFBR program as the reactor continues after 15 years to produce some 20 megawatts of electricity and to serve as a primary irradiation test facility for fuel element components and materials.

Argonne has the major responsibility for basic safety analysis and reactor physics studies in the LMFBR program and, in this connection operates and carries out experiments in a number of major LMFBR test facilities, including the Sodium Loop Safety Facility, the TREAT reactor for safety tests, the Zero Power Plutonium Reactor (ZPPR) for physics data on large, plutonium-fueled configurations, the ZPR-6 and ZPR-9 for smaller scale physics studies, and the fast neutron generator facility. The laboratory has also been assigned responsibility for management of DOE's breeder reactor components development to help assure the availability of power plant components and operates and conducts experiments in their liquid metal/water components testing facilities.

More recent assignments are responsibility to provide the United States input on Breeder Reactors (Group 5) to the International Fuel Cycle Evaluation and lead laboratory for the reduced enrichment research and test reactor program. Pyrochemical and dry-processing methods are being pursued as a technique to reduce the risk of nuclear weapons proliferation.

Energy and Environmental Technology

The mission of Energy and Environmental Technology is to develop environmentally acceptable processes for better utilization of our fossil energy and renewable energy resources. The fossil energy program centers on improved methods for the direct combustion of coal along with the development of the base technology required for a variety of coal conversion processes. Base technology support is supplied to the fossil energy program in the areas of instrumentation, materials, and in-plant components.

The open-cycle magnetohydrodynamics (MHD) program is developing key components such as superconducting magnets, generators, and electrodes. ANL is also assisting DOE in a cooperative MHD program with the USSR. A 50,000 Gauss superconducting magnet was delivered to the Soviet Union in 1977 for use in collaborative US/USSR MHD experiments.

ANL is actively involved in the development of technologies and methods for reducing energy consumption. Argonne is playing a key role in the community systems and urban waste programs, in an effort to carry these through proof-of-concept demonstrations in the early 1980's.

The Experimental Breeder Reactor II (EBR-II) is housed within the dome at the left; the Hot Fuel Examination Facility-South, formerly the Fuel Cycle Facility in which EBR-II fuel was reprocessed, is at the center. The building at the right is the newly completed Hot Fuel Examination Facility-North, which will be the primary disassembly and examination facility for irradiated Liquid Metal Fast Breeder Reactor fuels.

The 4MV Dynamitron prior to modification for use as the pre-accelerator for the Heavy-Ion Fusion Experimental Program. This concept is one of the leading advanced driver candidates for inertial confinement fusion.

Superconducting Heavy-Ion Energy Booster being constructed at the Argonne FN Tandem. It is anticipated that this superconducting Linac will be the main accelerator component of the proposed Argonne Tandem Linac Accelerator System (ATLAS), a unique user-oriented national facility which will provide precision beams of heavy ions for nuclear structure research.

The development of novel techniques for energy storage is under way at the laboratory with active programs in high and ambient temperature batteries, fuel cells and related technologies with vehicle propulsion and load leveling applications.

ANL has broad interest in the development of solar, fusion, and other renewable energy sources. Argonne is actively involved in the fusion technologies of both magnetic confinement and inertial confinement. The new ion beam approach to fusion devices shows excellent potential. Principal solar energy development activities involve nontracking solar concentrators and, in support of OTEC, heat exchanger tests and management of the biofouling, corrosion and materials program.

Biomedical and Environmental Research

Argonne has major responsibilities in biomedical and environmental studies. Significant effort has been devoted to determining the effects of radiation on living organisms, particularly effects due to internally deposited radionuclides. An important facility at Argonne is the Center for Human Radiobiology, established in 1969, which is responsible for the long-term study of those persons in the United States who are known to have ingested radium. The techniques used in these studies are now being applied to the investigation of the effects of pollutants produced by other energy sources such as fossil fuels, particularly coal.

There is much activity at Argonne in the area of transport and assessment of industrial pollutants, strip-mine land reclamation, and determination of the effects of power plants on the ecosystems of the Great Lakes.

Basic Sciences

A large fraction of the laboratory's resources are committed to basic research in the physical and biological sciences and to interaction with the universities in such fields as physics, chemistry, biology, mathematics, materials sciences, and molecular sciences. These fundamental studies are centered around the Laboratory's energy missions.

An array of nuclear physics tools, such as tandem electrostatic generators and dynamitrons, has been acquired over the years by the laboratory and continue to be used for nuclear structure and other studies and in particular for heavy ion research. A major new effort is the development of a pulsed neutron source and its applications in problems of the solid state and other branches of physics.

The Zero Gradient Synchrotron (ZGS), a 12.5 billion electron volts (GeV) proton accelerator for experiments in particle physics, produces the only high energy polarized proton beam in the world. This facility is one of the three major high energy proton accelerators in the United States and is used by a very large community of university and national

laboratory physicists. It is the only high energy accelerator with the demonstrated capability of accelerating polarized protons and its present use is dedicated to this capability.

PROGRAM FUNDING

ANL's operating budget in fiscal 1978 was \$205.8 million, of which about \$14.7 million was for non-DOE work, primarily for other Federal agencies. As of December 1978, the total number of laboratory employees was about 5,166. There were also about 800 visiting scientists, faculty, and students on temporary research appointments. The major programs in 1978 were the following:

Program	FY 1978 Operating Funds (millions)
<u>DOE</u>	
Basic Energy Sciences and Nuclear Physics	\$ 27.9
Energy and Environmental Technology	37.8
High Energy Physics	18.1
Reactor Development	80.9
Biomedical and Environmental Research	20.6
Other DOE	<u>5.8</u>
Total	\$191.1
<u>Other Sources*</u>	
Nuclear Regulatory Commission	\$ 7.2
Other Federal Agencies	3.4
Non-Federal Funding	<u>4.1</u>
Total	\$ 14.7

* These funds are primarily for environmentally-related work and studies related to the production and storage of energy.

The authorized investment in plant and equipment at ANL (including Argonne-West) in 1978 was \$521.5 million.

MAJOR FACILITIES

Listed below are some of the more unique and significant facilities. In addition, Argonne also has other general purpose and specialized research equipment, as well as appropriate support facilities.

Argonne, Illinois

- o A 12.5-GeV proton accelerator, the Zero Gradient Synchrotron (ZGS), and associated experimental facilities.
- o CP-5, a 5-MW heavy water research reactor; JANUS, a reactor devoted to biological studies; and two zero-power reactors, ZPR-6 and ZPR-9, for studies of the physics characteristics of fast reactors.
- o A 9-million electron volt (MeV) Tandem Van de Graaff, two large dynamitrons, a 60-inch cyclotron, and other smaller high-voltage accelerators.
- o Extensive animal facilities and five research vessels for studies on the Great Lakes.
- o Extensive facilities for materials research and development, including a large alpha-gamma hot cell, plutonium glovebox facilities, a class-10 clean room, a new high voltage electron microscope, and a pulsed neutron source (ZING-P') driven by a 500-MeV proton synchrotron.

Argonne-West

- o EBR-II, a 62.5 MW experimental fast breeder reactor. The only breeder reactor operating in the United States today, it is used for fuels and materials development and for fast reactor safety studies.
- o Hot Fuel Examination Facilities (HFEF), two large shielded facilities used to examine and analyze highly radioactive reactor fuels and materials in the LMFBR program.
- o Transient Reactor Test Facility (TREAT), used in various safety-related tests in the LMFBR safety program.
- o Zero Power Plutonium Reactor (ZPPR), a critical facility used to obtain physics and safety data for design of large plutonium-fueled LMFBR power reactors.
- o Sodium Loop Safety Facility, used to investigate the consequences of various postulated LMFBR core accidents.

SIGNIFICANT ACCOMPLISHMENTS

- o Development of many of the nuclear power reactor types in use today--pressurized water, boiling water, and liquid metal fast

breeder reactor. Construction and operation of the first reactors to generate usable amounts of electricity, prove the feasibility of the breeding principle, operate with a plutonium core, and operate with a closed fuel reprocessing cycle.

- o Development and construction of large superconducting magnets for use in high energy physics research, magnetohydrodynamics and energy production applications; development of open-cycle and two-phase liquid-metal magnetohydrodynamic generators.
- o Many significant advances in the physical sciences, most notably the development of the shell theory of the nucleus for which a Nobel Prize was awarded.
- o Pioneering work in the areas of cancer diagnosis and therapy through research on the causative factors of radiation and, more recently, chemotherapy through the use of liposome-encapsulation techniques; establishment of a national Center for Human Radiobiology for the study of effects of bone-seeking radio-nuclides deposited within the human body.
- o Development of high efficiency lithium-metal sulfide batteries for vehicle propulsion and peak-load leveling for utilities. The design and construction of solar collectors capable of concentrating the sun's rays by factors of 3 to 10 times without tracking the sun.

EXECUTIVE SUMMARY

Brookhaven National Laboratory

LOCATION: Upton, Long Island, New York

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$93.7 million
STAFFING:	3,460
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$391.7 million
NUMBER OF ACRES:	5,625
NUMBER OF BUILDINGS:	232
FLOOR SPACE:	2.9 million sq. ft.

OPERATING CONTRACTOR:

Associated Universities, Inc.

RESPONSIBLE OPERATIONS OFFICE:

Chicago

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

High Energy Physics (30%)
Basic Energy Sciences (19%)
Environmental R&D (11%)
Life Sciences Research and Nuclear Medicine (8%)
Nuclear Physics (4%)
Magnetic Fusion Energy (2%)
Electric Energy Systems (2%)
Support Activities (3%)
Energy Storage Systems (1%)
Coal (1%)
Solar Energy Development (1%)
Other DOE (5%)

Nuclear Regulatory Commission (8%)
Work for Others (5%)

MAJOR FACILITIES:^{2/}

Alternating Gradient Synchrotron
High Flux Beam Reactor
Double Tandem Van de Graaff
Computer Center
Under construction - ISABELLE and National Synchrotron Light Source

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

^{2/} \$5 million or more.

This is a photograph of a series of superconducting magnets for ISABELLE. They are positioned within a tunnel section simulating their use in the Colliding Beam Facility.

BROOKHAVEN NATIONAL LABORATORY

Upton, Long Island, New York

INTRODUCTION

Brookhaven National Laboratory (BNL), operated by Associated Universities, Inc., occupies a 5,625 acre tract of land near the geographic center of Long Island about 60 miles east of New York City. The research program explores the fundamental constituents of matter, their properties, and their interactions; studies the physical, chemical, and biological effects of radiation and of chemical substances involved in the production and use of energy; uses a variety of special facilities and scientific devices in advancing knowledge in the basic energy sciences; and conducts research and development to solve problems of national interest in energy systems.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D./M.D.	690	Engineers	281
M.S.	241	Mathematicians	79
B.S.	<u>431</u>	Physical Scientists	494
		Life Scientists	146
Total	1,362	Social Scientists	18
		Technicians	668
		Others	<u>1,774</u>
		Total	<u>3,460</u>

CURRENT MISSION AND PROGRAM ACTIVITIES

Physical Sciences

The current goal of the High Energy Physics program is to maintain the high scientific productivity at the Alternating Gradient Synchrotron (AGS) in the study of weak forces, the nature of charmed particles, and the structure of nucleons. In addition, BNL is developing superconducting magnets needed for future accelerators, and is currently designing ISABELLE, a proton-proton colliding-beam accelerator with center-of-mass collision energy of 400 billion electron volts (GeV).

The basic energy sciences continue to exploit the special facilities at BNL. Present missions are low energy physics; solid state physics

including superconductivity and defects in solids; and a broad range of basic and applied chemistry research including the structure of organic complexes, hydride chemistry, radiation and photochemistry, and improvement of techniques for measuring environmental pollution levels. Under construction is a national synchrotron light source that will add new dimensions to research using high-intensity ultraviolet and X-ray radiation.

Life Sciences

Environment and health studies cover work to determine the effects of energy production systems on a wide spectrum of organisms, including man, and on the environment. Emphasis in the life sciences on the genetic, somatic, and molecular effects of radiation has been broadened to include new efforts in carcinogenic, mutagenic, and teratogenic effects of pollutants derived from energy production. Biological structures are analyzed by various advanced biochemical and physical techniques, and the ability of the organism to cope with some environmentally-induced insults by active repair mechanisms is studied. The carcinogenic and mutagenic activity of noxious agents is studied by a means of a wide variety of in vitro and in vivo techniques. Major new initiatives in toxicology of the lung, the main route for most pollutants, include the construction of an inhalation toxicology facility for the study of noxious effluents. Programs in coastal oceanography, meteorology, and atmospheric sciences, as well as land and fresh water environmental sciences fall in this category.

Energy Development

Current technology-base missions are in analysis and support, and in energy technologies. Principal activities in analysis and support are in individual centers: the National Center for Analysis of Energy Systems (NCAES), which includes economic analysis and several programs of environmental importance, the National Nuclear Data Center (NNDC); and the Technical Support Organization (TSO), which assists DOE and NRC in their missions of preventing diversion of special nuclear materials.

In the category of energy technologies, there are major missions in several areas of energy conservation and fusion, and moderate efforts in solar and fossil energy. The conservation program includes development of an a.c. superconducting transmission line, research and program management of space conditioning, control systems, and insulation for residential and commercial buildings. The fusion program includes systems engineering, magnetic systems, and plasma heating with neutral beams. The initiation of fusion by beams of heavy ions on pellet targets has been under study. Rapid expansion of this program is projected.

PROGRAM FUNDING

The total DOE operating cost for fiscal 1978 was \$93.7 million. Authorized investment in plant and equipment was \$391.7 million. The funding for DOE and Nuclear Regulatory Commission (NRC), Department of State, and work for others in fiscal 1978 was:

Programs	FY 1978 (In Millions)
Fossil Energy	\$ 1.1
Advanced Energy Systems	63.9
Conservation	4.7
Nuclear Energy Development	1.2
National Security	1.8
Environment & Research	18.2
Program Support	2.8
Total DOE	\$ 93.7
Nuclear Regulatory Commission	\$ 11.6
Department of State	2.1
Work for Others	6.5
Total BNL	\$113.9

MAJOR FACILITIES

The major facilities are the 33-GeV Alternating Gradient Synchrotron (AGS), the High Flux Beam Reactor (HFBR), and the Tandem Van de Graaff Facility. These facilities are used primarily in the High Energy Physics and the Basic Energy Science programs. Under construction are ISABELLE and the National Synchrotron Light Source.

Complementing these facilities are several smaller accelerators, mass spectrometers, electron microscopes, a scanning transmission electron microscope (STEM) with a resolution of 2Å, a research hospital, towers for meteorological studies, buoy systems for coastal zone oceanography, and various metallurgical and cryogenic facilities.

The Central Scientific Computing Facility (CSCF) provides direct access and remote terminal capability for a CDC Cyber 70/76 and two CD 6600 computers.

SIGNIFICANT ACCOMPLISHMENTS

- o All modern high energy accelerators are designed on the "strong focusing" concept discovered at BNL; and numerous fundamental

particles were discovered here, the best known being the recently found J/Psi particle.

- o In the basic energy sciences, neutron diffraction and inelastic scattering have established the structure and atomic motions in magnetic compounds, noble gas compounds, ferroelectrics, and many other important substances. New classes of metallic hydrides were discovered, several of which have properties that make them valuable in energy storage and fusion engineering.
- o Advances in the biomedical sciences include the development of a very sensitive plant system, tradescantia, to monitor and study effects of environmental agents at extremely low exposure rates; and a novel fish system to determine the carcinogenic potential of toxic agents. In vivo determination by facilities unique to BNL, of body elements such as calcium, phosphorus, chlorine, sodium, and potassium has been extended to determinations of trace metals (such as cadmium) found to be fossil-fuel pollutants.
- o Environmental Sciences studies using SF₆ tracer techniques have permitted the study of plume dispersion from coal- and oil-fired powerplants up to distances of 400 miles. The possible sources of floating trash and pollutants washed up in large quantities on Long Island beaches in June 1976 were analyzed using a numerical model, at the request of the National Oceanic and Atmospheric Administration.
- o BNL was the lead institution in developing the radiation sources now used industrially and in the "milked" isotope systems, especially technetium-99m now used extensively in nuclear medicine.

EXECUTIVE SUMMARY

Hanford Engineering Development Laboratory

LOCATION: Richland, Washington

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$ 154.8 million
STAFFING:	3,187
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$ 606.1 million
NUMBER OF ACRES:	700
NUMBER OF BUILDINGS:	60
FLOOR SPACE:	1 million sq. ft.

OPERATING CONTRACTOR:

Westinghouse Hanford Company

RESPONSIBLE OPERATIONS OFFICE:

Fast Flux Test Facility Project Office (FFTFPO) and Richland^{1/}

PRINCIPAL PROGRAM ACTIVITIES:^{2/}

Breeder Reactor (94%) Magnetic Fusion Development and Technology (2%)
 Fuel Cycle R&D (1%) Nuclear Research and Applications (1%)

HEDL has no flow-through dollars for research or development
 (A&E services and hardware procurement only).

MAJOR FACILITIES:^{3/}

Fast Flux Test Facility
 High Temperature Sodium Facility

^{1/} FFTFPO - Prime contract administration and FFTF Program
 Richland - Other programs and delegated support services

^{2/} Percentages represent total staff (full-time equivalent) devoted to
 that activity, including indirect.

^{3/} \$5 million or more

HANFORD ENGINEERING DEVELOPMENT LABORATORY

Richland, Washington

INTRODUCTION

In early 1970, the former Atomic Energy Commission (a predecessor of the Department of Energy-DOE) selected Westinghouse Electric Corporation to establish and operate at Hanford an organization geared principally to the engineering development of the Fast Flux Test Facility (FFTF), which will serve as the primary test bed for fast breeder reactor fuels, materials, and components.

The Hanford Engineering Development Laboratory (HEDL) has been assigned national leadership for design, construction, and operation of the FFTF and its associated support facilities to test fuels and materials performance and gain systems experience in support of DOE breeder reactor technology and fuel development programs. The laboratory has also recently been assigned technical manager for the integrated Reactor Fuels and Materials Development Program. Responsibilities include review, assessment, and coordination of all existing and proposed fuels and materials development programs.

The HEDL complex consists of 92 buildings totaling nearly 1,000,000 square feet of laboratory and office space. These facilities provide for a broad range of research, engineering, and test capabilities. The HEDL complex is part of the 570-square-mile Hanford Reservation in southeastern Washington state.

Through experience on the FFTF Program, HEDL has gained the capability to manage complex, highly technical energy programs through: (a) integrating activities of many diverse laboratories and industrial firms to achieve project objectives in a unified and timely manner, and (b) conducting broad, coordinated development and testing efforts to provide the necessary technological support. These capabilities are particularly important for the development and verification of new nuclear reactor or energy related technologies.

Assembly of a Fuels Open Test Assembly to be used in the Fast Flux Test Facility.

PERSONNEL

The current HEDL staff includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	123	Management	367
M.S.	304	Engineering & Scientific	749
B.S.	798	Administrative	341
Total	1,225	Technicians	405
		Secretaries & Clerks	534
		Crafts and Services	504
		Total	2,900

CURRENT MISSION AND PROGRAM ACTIVITIES

The mission of the Hanford Engineering Development Laboratory is to conduct engineering development work in furtherance of breeder reactor technology, supporting the Program Director for Nuclear Energy.

Major program activities are listed below.

Fast Flux Test Facility

HEDL's primary responsibility is design, construction, startup and operation of the Fast Flux Test Facility (FFTF).

The FFTF is a 400-megawatt-thermal, sodium-cooled reactor. Its capital cost is \$540 million. Sodium fill was initiated in July 1978 and criticality will be reached by August 1979. The reactor is designed specifically for irradiation testing of breeder fuels, materials, and components. Thus the FFTF is the key U.S. facility for the demonstration and improvement of mixed oxide fuel performance, other advanced and alternate breeder fuels. Special test locations will allow fuel testing up to and including failure. The FFTF's fast-flux reactor environment will enable testing of large quantities of fuel specimens, cladding and subassemblies, structural and control materials (controlled/characterized conditions).

Breeder Technology

HEDL will, as technical manager for the DOE-integrated Reactor Fuels and Materials Development Program, review, assess and provide recommendations on all existing and proposed programs, as well as technical

The 250-ton, 63-foot-high Closed Loop Ex-Vessel Machine assembled inside the FFTF reactor containment building.

Final assembly of FFTF 217-pin driver fuel bundle, showing the loading of the individual rows of pins onto the lower grid and nozzle.

coordination and overview to meet the DOE objective of providing a nuclear power option.

The program requires chemical and metallurgical research, selection and development of various forms of fissile and fertile materials, and cladding, structural, absorber, and coolant materials leading to an optimized fuel system. Fabrication and process development are included as are design and development of laboratory equipment and facilities necessary to carry out the development program. Implementation of foreign exchange agreements within the area of fuels and materials technology is also an included task.

Fast breeder work at HEDL is specifically geared toward building a solid base for the breeder reactor--requiring an integration of technology with industrial manufacturing capabilities and utility confidence. The purpose is to provide full technical development and understanding of breeder reactor technology.

Fast Reactor Safety

HEDL has significant responsibilities in the DOE program to establish the necessary technology and methods to support fast reactor safety assessment and licensing. This work is closely related to HEDL's activities on the FFTF and in the fuels and materials and sodium technology programs. The HEDL safety activities are organized in accordance with the DOE format and safety lines of assurance (LOA). Key activities include transient safety testing and analysis of fuels, core dynamics analysis, containment response technology, containment air-cleaning development, safety fuels planning for FFTF irradiation, and support of safety documentation programs.

Waste Management

HEDL's role in the waste management program is to apply the laboratory's engineering development and construction management expertise to demonstrate pilot-scale transuranic (TRU) waste processing technology. This program evaluates the application of acid digestion to nuclear wastes. The program will result in the development, construction, and demonstration of the safe operation of a chemical oxidation system for management of DOE waste currently being generated, as well as workoff of backlog.

A Radioactive Acid Digestion Test Unit (RADTU) has been built to process DOE combustible transuranic waste and to demonstrate the total processing of combustible waste materials, including recovery of plutonium and uranium and immobilization of residue from the process. Demonstration of the integrated process operation is scheduled for the beginning of 1981 and conversion of RADTU to a production facility is expected in early 1982.

Fusion

HEDL is responsible for construction and operation of the Fusion Materials Irradiation Test Facility (FMIT). Its purpose will be to provide the capability to generate test data on the behavior of materials under fusion reactor irradiation conditions. The major objectives of this project are to determine the effects of high energy neutrons on the mechanical properties of materials, basic bulk irradiation effects, and surface effects. Assignment at HEDL as lead laboratory for this program has been proposed by the DOE FFTF Project Office (PO).

The FMIT facility will be located in the principal laboratory area (300 Area) of the Hanford site. The design of the FMIT facility specifies four main structures: a linear accelerator, two irradiation test cells, an interconnecting beam transport tunnel, and a support building housing liquid lithium equipment. The TEC is \$83 million. It will be operational in 1983.

NASAP

HEDL has recently been assigned responsibility for management of the DOE Non-Proliferation Alternative Systems Assessment Program (NASAP) Alternative Fuel Cycle Evaluation Program, an effort which involves the Argonne National Laboratory, Oak Ridge National Laboratory, the Savannah River Laboratory, and HEDL. The program will include identification of R&D requirements, proliferation resistance, and economic assessments for alternative fuel fabrication and reprocessing operations. Data and results will be provided to NASAP and the International Fuel Cycle Evaluation Program (INFCE).

Quality Assurance

Particular emphasis has been placed on the establishment and verification of quality assurance (QA) during construction and component procurement and is continuing for startup, operation, and maintenance of the FFTF and its associated irradiation test programs.

In addition to the HEDL Quality Assurance organization, DOE has established a Nuclear Quality Assurance Program which will assist DOE in planning and coordinating quality assurance activities of common interest and benefit to DOE and contractor offices, such as national standards development, audits and training in QA disciplines.

New Facilities (In addition to FMIT listed above)

Fuels and Materials Examination Facility (FMEF) - This facility will be used for post-irradiation examination of FFTF components as well as consolidation of HEDL fuel fabrication and analysis activities. The facility will have the capability for handling the FFTF test assemblies within a few weeks after removal from the reactor core, dismantling assemblies, destructive and nondestructive examination of full-size FFTF

pins and assemblies, reconstitution of test assemblies, and development of proliferation-resistant fuel fabrication equipment and processes.

The FMEF will be located at the FFTF site (400 Area) on the Hanford Reservation and will be composed of a large non-destructive examination cell, a decontamination cell, a destructive examination cell, and support areas. The TEC is \$170 million. It will be operational in 1983.

Maintenance and Storage Facility (MASF) - This facility will provide sodium removal, decontamination, repair, and storage capabilities for other 400 Area facilities. The TEC is \$7 million. It will be operational in 1983.

Fuel Storage Facility (FSF) - This facility, a DOE-administered project, provides storage for 5 years' accumulation of discharged fuel from FFTF operation, including fuel examined at FMEF.

The FSF, to be located at the FFTF site (400 Area), has 466 storage positions, with decay heat removal via a sodium-filled vessel cooled by redundant NaK natural convection loops and natural draft heat exchangers.

PROGRAM FUNDING

In fiscal 1978, HEDL's operating budget, \$156.2 million, was largely funded by the Reactor Research and Technology Division. The major programs in fiscal 1978 are as follows:

Program	FY 1978 Operating Funds (In Millions)
Breeder Reactor	\$121.2
Nuclear Research & Application	.8
Fuel Cycle R&D	2.5
Special Materials Production	.2
Environmental Research	.7
Magnetic Fusion R&D	3.8
LWR	.4
Inventories	18.7
Work for Other DOE Contractors and Laboratories	6.5
Total DOE	\$154.8
Nuclear Regulatory Commission	1.4
Total	\$156.2

The authorized investment in plant and equipment through fiscal 1978 was \$606.1 million.

MAJOR FACILITIES

The main laboratory complex (300 Area) provides for a broad range of research and development, engineering and test capabilities. The extensive materials technology programs require laboratories equipped with electron microprobes, scanning electron microscopes, mass spectrometers, emission spectrographs, and a one-million-volt electron microscope, the largest instrument of its kind in the United States used exclusively for studies of irradiation damage to metals. The laboratory's non-destructive test capabilities are enhanced by a 250-kilowatt experimental test reactor (TRIGA).

FFTF

The Fast Flux Test Facility is a liquid metal-cooled, fast flux reactor plant which will be used to test fuels and materials to gain operating experience for future breeder reactor programs. The FFTF will provide the testing capability to satisfy the diverse needs of breeder reactor program base technology development. The FFTF will be used to test prototypic and advanced fuel, fuel pins, fuel assemblies, fuel cladding, and core duct materials in a controlled, instrumented, fast flux environment. The facility will provide information on the performance of components and systems necessary for large sodium-cooled fast reactors. Experience with operation and maintenance procedures developed for FFTF will benefit future plant design, construction and operation.

The FFTF site (400 Area) is located 6 miles north of the main laboratory. The 135-foot diameter FFTF reactor containment building rises 120 feet above ground level and extends 67 feet beneath the surface with an array of concrete cells and piping galleries for the test reactor systems. In addition to the main reactor structure, the FFTF plant includes the dump heat exchangers, sodium pump towers, service buildings and auxiliary buildings for control and monitoring equipment and offices.

HTSF

The High Temperature Sodium Facility (HTSF) provides a unique capability for the assembly and verification of full-scale breeder reactor components and prototypes. The HTSF has been primarily for testing fuel-handling in both sodium and air prior to their installation in the FFTF.

Assembly and test of full-size FFTF/BRP components are possible in the 90-foot-high, one-of-a-kind High Temperature Sodium Facility which features a 40,000-gallon vessel used to test FFTF components in liquid sodium at temperatures up to 1100°F.

In late FY 1978, the Composite Reactor Components Test Activity (CRCTA), located within the HTSF, was deactivated. The remaining HTSF facilities--such as the core mechanical mockup, the component disassembly station, and the assembly and test pit--will be maintained in support of

FFTF acceptance testing and startup. The Alkali Metal Cleaning Facility will be relocated to the Maintenance and Storage Facility (MASF).

The physical plant contains more than 106,000 square feet and consists of a High Bay, two office wings, and an interconnecting service area. The three-story office wings, serving as headquarters for Hanford Engineering Development Laboratory, provide space for approximately 375 employees.

Nuclear Fuel Facilities

Facilities are available to analyze nuclear fuel, examine irradiated fuel, and improve the processes involved in fuel fabrication.

Sodium Loops

During FY 1978, all sodium test loops in the 300 Area were deactivated except the Prototype Applications Loop (PAL). In accordance with direction from DOE, these facilities are on standby with provision for startup within 60 days.

SIGNIFICANT ACCOMPLISHMENTS

HEDL has demonstrated major expertise in the planning, coordination, and management of complex, high technology design, development, and construction projects. HEDL's management of the design and construction of the Fast Flux Test Facility (FFTF) has involved more than 300 materials and equipment suppliers across the country and a peak construction force of approximately 2,000 people. Similar management activities are being performed by the Laboratory for the Fuels and Materials Examination Facility (FMEF), the Maintenance and Storage Facility (MASF), and the Fusion Materials Irradiation Test (FMIT) facility.

HEDL is also a pioneer for DOE in the development and implementation of integrated cost and schedule management control systems for construction project and technology programs management, and in using earned value performance measurement monitoring.

The past few years have been ones of major accomplishments at HEDL and have included:

- o Completion of FFTF construction and sodium fill of the FFTF primary Heat Transport Systems in 1978.
- o Completion of the fuel assemblies and other replaceable core components for the first FFTF fuel core in 1976. This constituted the largest mixed-oxide fuel core ever assembled for a United States reactor.

- o Completion of the Final Safety Analysis Report (FSAR) for the FFTF in 1976. The seven volumes include descriptions and evaluation of the reactor and coolant systems, structural design, radiation protection, nuclear materials handling, quality assurance, and planned operating procedures.
- o Development, construction, and operation of a number of key engineering facilities for the investigation and verification of the different systems and operating parameters for sodium-cooled reactors. In this regard, a number of design features of the FFTF have been verified through experimental investigations.
- o Development and demonstration of breeder reactor fuel technology including fuel-pin fabrication techniques and procedures. A significant portion of this program has been integral in-pile testing to demonstrate the existence of adequate fabrication technology and achievement of satisfactory performance under all operating and transient conditions.
- o Selection, in conjunction with other laboratories associated with the advanced alloy development program, of six prime candidates for advanced fuel systems from a field of 29 commercial and 34 advanced alloys tested.
- o Development, in conjunction with industry, of significant first-of-a-kind breeder reactor engineering designs, equipment, analytical techniques and quality assurance practices.

EXECUTIVE SUMMARY

Idaho National Engineering Laboratory

LOCATION: Idaho Falls, Idaho

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$144.4 million
STAFFING:	9,365
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$536.1 million
NUMBER OF ACRES:	572,000
NUMBER OF BUILDINGS:	269
FLOOR SPACE:	1.7 million sq. ft.

OPERATING CONTRACTOR:

EG&G Idaho, Inc., and Allied Chemical Corporation

RESPONSIBLE OPERATIONS OFFICE:

Idaho

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Breeder Reactor (13%)
Naval Reactor Development (9%)
Reactor Safety Facilities (15%)
Special Materials and Waste Management (18%)
Geothermal (2%)
Work for Others (30%)

MAJOR FACILITIES:^{2/}

EBR-II - Experimental Breeder Reactor
LOFT - Loss of Fluid Test Facility
ICPP - Idaho Chemical Processing Plant (includes FAST and ROVER)
ATR - Advanced Test Reactor
ETR - Engineering Test Reactor
PBF - Power Burst Facility
HFEF - Hot Fuel Examination Facility

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity, including indirect..

^{2/} \$5 million or more

MAJOR FACILITIES Continued

CDIF - Component Development and Integration Facility (Butte, Montana)
TREAT - Transient Reactor Test Facility
ZPPR - Zero Power Plutonium Reactor
S1W - Submarine Prototype
A1W - Large Ship Reactor
ECF - Expanded Core Facilities
S5G - Natural Circulation Reactor
NWCF - New Waste Calcining Facility
- Raft River Geothermal Site

IDAHO NATIONAL ENGINEERING LABORATORY

IDAHO NATIONAL ENGINEERING LABORATORY

Idaho Falls, Idaho

INTRODUCTION

The principal site of the Idaho National Engineering Laboratory (INEL) is an 893-square mile region in the Snake River Plains of southeastern Idaho. It was established in 1949 to provide an isolated station where various kinds of nuclear reactors and support facilities could be built and tested. Three of the Nation's major commercial power reactor concepts--pressurized water reactor, boiling water reactor, and liquid metal-cooled fast breeder reactor--were first prototyped at INEL. Of the 62 reactors constructed, 17 are still operable, the others having been phased out upon completion of their research mission.

INEL's present assignment in nuclear energy include water reactor safety, materials and fuels reprocessing, waste management, and liquid metal-cooled fast breeder reactor research and development. A program for developing geothermal energy is also under way at two locations--one about 100 miles south of the INEL test site in the Raft River Valley and one near Boise, Idaho.

INEL is operated for the Department of Energy (DOE) by EG&G Idaho, Inc., and Allied Chemical Corporation (ACC). Two other contractors, Argonne National Laboratory and Westinghouse Electric Corporation, also conduct energy research and development functions for DOE at the INEL.

INEL currently provides project management support to DOE in the areas of industrial energy conservation and nonelectrical applications of geothermal energy by reviewing industrial proposals, monitoring technical programs, and participating in program planning.

INEL is assisting in the managing of the low-head hydro program for DOE. In this capacity, INEL has prepared a national program plan defining low-head hydro objectives and a plan for accomplishments and is in the process of implementing the plan for DOE. INEL has proposed regional offices to expedite projects throughout the United States. There are a large number of potential sites for low-head hydro principally in the northeast and western states, and considering current high energy costs, the stimulus to the rapid development of low-head hydro is significant. INEL is also preparing requests for proposals to institute low-head hydro projects, and an international workshop has been conducted to disseminate information on the advantages of low-head hydro systems. As projects are initiated, INEL will monitor technical progress for DOE.

Engineering Test Reactor at the Idaho National Engineering Laboratory

PERSONNEL

Approximately two out of every five employees of EG&G and ACC at the INEL sites hold engineering and science degrees; these can be broken down into the following categories:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	135	Engineers	302
M.S.	517	Computer Scientists/ Mathematicians	21
B.S.	<u>1,026</u>	Physical Scientists	55
Total	1,678	Technicians	356
		Other	<u>1,477</u>
		Total	2,211

CURRENT MISSION AND PROGRAM ACTIVITIES

INEL has been the principal center for reactor safety testing since 1954. Three major test facilities--the Power Burst Facility (PBF), the Loss-of-Fluid-Test (LOFT), and Semiscale--are continuing and expanding the scope of previous reactor safety studies.

The objective of testing in the PBF is to determine the response of a Pressurized Water Reactor (PWR) fuel-cladding system to off-normal reactor conditions. The spectrum of off-normal conditions considered will cover the range extending from the normal operating conditions to those conditions predicted to result in cladding and fuel melting.

LOFT is a nuclear reactor test facility designed to simulate as effectively as possible all the important effects that might take place during a postulated loss-of-coolant accident in a large pressurized water reactor.

Semiscale is a non-nuclear facility in which nuclear heating is simulated by an electrically heated core of heater rods having dimension and heat flux characteristics similar to the fuel rods in a nuclear core. The program provides integral test data for the development and verification of analytical models for describing events in a PWR during a postulated loss-of-coolant accident. It also provides data for the LOFT program.

Reactor Fuels Reprocessing

The Idaho Chemical Processing Plant (ICPP) recovers valuable unburned uranium from fuel elements discharged from government-owned reactors.

The highly radioactive by-product liquids are stored until cool and then piped to the Waste Calcining Facility (WCF) where they are converted into granular solids. The WCF is the first plant-scale facility (since 1963) for reducing highly radioactive waste solutions to a safer, solid form requiring only one-tenth as much storage space as the liquids. The solid wastes are stored in large stainless steel bins inside underground concrete vaults; eventually they will be transferred to a permanent repository. Advanced conceptual design was started in 1974 on a replacement for the WCF--a New Waste Calcining Facility (NWCF). The NWCF will incorporate design improvements, such as remote handling of high maintenance items and have an increased production capacity.

Geothermal Research and Development

A program is underway on the feasibility of using medium-temperature (300°F) geothermal water to economically generate electricity. Three exploratory wells drilled in southcentral Idaho's Raft River Valley have defined a sizable hot water resource in the desired temperature range. Studies are being conducted on methods for locating and evaluating geothermal resources and on using this natural hot water to heat buildings, process food, and so forth.

Breeder Reactor Research

Four reactors are currently being operated in the Argonne National Laboratory-West area in support of the breeder program: EBR-II for irradiation testing of fuels and materials for the fast breeder program; Zero Power Plutonium Reactor (ZPPR), for obtaining reactor physics data; the TREAT reactor and the Engineering Test Reactor for safety research testing.

Waste Management

The purpose of the long-term waste management program is to ensure the availability of technology for the management of high-level wastes. Major emphasis is on calcine solids handling and storage, removal of actinides from various types of wastes, development of waste forms for ultimate storage, and the studies necessary to support selection of a given waste management option. INEL also has programs for demonstrating safe and efficient techniques for handling low- to intermediate-level beta-gamma and transuranic wastes.

Conservation

INEL has been established by DOE as a program office to serve as the focal point for evaluating unsolicited proposals from industry for conservation projects. This office will conduct program management activities and will plan and conduct research, development, and demonstration programs--particularly emphasizing programs important to the

The LOFT Reactor Assembly is transported from a nearby fabrication shop to its containment building on a special four-track railroad.

industries of the northwest region, as well as cooperating with the industries, educational institutions, and community organizations within the region.

Gas Reactor Safety Program

GRIST-2 will consist of an in-pile test loop to be installed in the TREAT reactor at INEL. Operation of the test loop will support the Gas-Cooled Fast Breeder Reactor (GCFR) safety program by providing a means of transient testing of GCFR fuels. The GRIST-2 will provide the capability for experimental verification of analytical models of GCFR fuels in order to verify predictions of safety margins and for experimental exploration of the consequences of loss-of-flow, loss-of-pressure, and reactivity insertion transients. Current efforts include: performing system engineering studies to develop a loop concept; performing physics studies to support the loop design; performing safety analyses of worst-case accidents; performing an environmental assessment; and developing cost and schedule data.

Naval Propulsion Reactors

The Naval Reactors Facility serves as a training station for nuclear Navy crews. Its significant accomplishments include the feasibility testing of the world's first nuclear submarine engine and subsequent prototype operation of the first nuclear engines for large surface ships.

Radiological and Environmental Science Laboratory

DOE's Radiological and Environmental Science Laboratory at INEL carries on a year-around program for studying and monitoring the underground water supply and the air. The data obtained from this work provide the evidence that substantiates the safety of INEL operations for site employees and the public as well. Working in conjunction with, but independent of DOE employees, are a number of highly trained atmospheric, geology, and hydrology experts employed by the U.S. Geological Survey and the National Oceanic and Atmospheric Administration.

National Environmental Research Park

INEL has been designated a National Environmental Research Park, where scientists throughout the Nation can study changes caused by man's activities and develop information to assist in land use decisions. Objectives include preserving and cataloging the area as a regional reference of a cool-temperate desert scrub environment.

PROGRAM FUNDING

INEL operating costs for EG&G, ACC, and other ID direct contracts in fiscal 1978 are estimated as \$195.5 million. The cost by program is shown below:

Program	(In millions)
Fossil Energy Coal	\$ 17.6
Gas	.1
Solar	.3
Geothermal Energy Development	13.9
Basic Energy Sciences	.5
Nuclear Physics	.1
Conservation	1.5
Breeder Reactor	13.3
Nuclear Research and Applications	.6
LOFT	24.0
International Spent Fuel Storage	.3
Low-Head Hydro Electric	4.7
Nuclear Materials Security and Safeguards	1.2
Environmental Research Safety	1.0
Fuel Cycle R&D	2.1
Special Materials Production	31.1
Naval Reactor Development	23.1
Other (KN)	9.0
	<hr/>
Total DOE	\$144.4
Work For Others (Nuclear Regulatory Commission)	51.1
	<hr/>
Total INEL	\$195.5

The authorized investment in plant and capital equipment at the end of fiscal 1978 was \$536.1 million.

MAJOR FACILITIES

Test facilities include the Advanced Test Reactor (ATR) and the Engineering Test Reactor (ETR), which have capabilities for high flux irradiation testing of fuels and materials. Other major test reactors are the Power Burst Facility (PBF) and the Loss-of-Fluid Test (LOFT) facility. Non-nuclear facilities for safety tests include a semiscale model of a pressurized-water reactor.

A high- and low-level radiation measurement laboratory provides complete radiation detection capability. Also available are instrument development and testing laboratories; extensive hot-cell facilities; and materials testing facilities for both unirradiated and irradiated materials. The Idaho Chemical Processing Plant and Waste Calcining Facility are designed to recover a wide variety of irradiated nuclear fuels, including unused enriched uranium in the form of granular oxide, and to solidify the fission-product waste streams to granular solids for retrievable onsite storage. Auxiliary facilities include extensive chemical laboratory units, modern facilities for a wide variety of chemical analyses, and developmental engineering laboratories.

The following major facilities are in process.

Project	Total Estimated	Scheduled Completion
MHD Component Development and Testing Facility (Butte, Montana)	\$ 37.0 million	FY 1979
Fluorinel Dissolution Process and Fuel Receipt and Storage	175.0 million	FY 1981
New Waste Calcining Facility	81.0 million	FY 1980
Raft River Thermal Loop Facility	8.5 million	FY 1980
Rover Fuel Processing Facilities	7.8 million	FY 1978
Radioactive Liquid Waste System Improvements	5.8 million	FY 1979
Personnel Protection and Support Facilities	10.5 million	FY 1980
Fifth Set of Calcined Storage Bins	12.5 million	FY 1981

SIGNIFICANT ACCOMPLISHMENTS

Major contributions have been made to the Light Water Reactor Programs, the Naval Reactors Program, the Liquid Metal Fast Breeder Program, the Aircraft Nuclear Propulsion and Army Reactor Program, and the Organic Reactor Program. These accomplishments have involved:

- o Component and subsystem development
- o Power plant demonstration

- o Light-water reactor safety
- o Materials investigation and development
- o Instrumentation development
- o Analytical code development
- o Physics and engineering

Major accomplishments in the field of chemistry include:

- o Pioneering many fuel reprocessing operations
- o The world's first high-level radioactive waste solidification process
- o Major reductions of radioactivity in plant effluents
- o Fluidized bed technology for solidification and combustion operations
- o Control of nuclear safety through use of soluble neutron poisons
- o Adaptation of fluid-bed calcination process for purification of saline waters
- o Hundreds of new chemical analysis methods
- o Simplified process schemes suitable for remote operation
- o Techniques for safe, direct maintenance of contaminated equipment

EXECUTIVE SUMMARY

Lawrence Berkeley Laboratory

LOCATION: Berkeley, California

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$74.5 million
STAFFING:	3,370
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$185 million
NUMBER OF ACRES:	Not government property
NUMBER OF BUILDINGS:	58
FLOOR SPACE:	1.1 million sq. ft.

OPERATING CONTRACTOR:

University of California

RESPONSIBLE OPERATIONS OFFICE:

San Francisco

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Energy Technology: Fossil, Solar, Geothermal
 Magnetic Fusion, Fission, and Biomass Energy (15%)
 Energy Research: Basic Energy Sciences, High Energy
 Physics, and Nuclear Physics (50%)
 Environment and Health: Biological, Biomedical and
 Environmental Research and Applications (12%)
 Energy Conservation (4%)
 Work for Others (17%)

MAJOR FACILITIES:

Alloy Preparation & Characterization Facilities
 Animal Colony & Tissue Culture Facilities
 Bevalac
 Large-Scale Central Computer System
 88" Cyclotron

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

MAJOR FACILITIES (Continued)

Electron Microscope Facility
Mechanical & Electronics Fabrication Facilities
Medical Research & Clinical Facility
SuperHILAC
Surface Science & Catalysis Research Laboratories
184" Synchrocyclotron
National Resource for Computation in Chemistry

LAWRENCE BERKELEY LABORATORY

Berkeley, California.

INTRODUCTION

The Lawrence Berkeley Laboratory (LBL), established in 1931, consists of a group of over 50 buildings on a 120-acre site in the hills above the University of California (UC) at Berkeley. The laboratory is an outgrowth of Ernest O. Lawrence's work in developing the cyclotron, which began in 1929 with the construction of the first successful models. Pioneering work with the successive generations of accelerators led to major discoveries in high energy physics, nuclear chemistry, and nuclear medicine. During their first decade, the LBL staff produced the first deuteron and proton beams and discovered over 200 new radioisotopes, including carbon-14, iodine-131, iron-59, and sodium-24. They made the first artificial element, technitium; the first and second transuranium elements, neptunium and plutonium; and began to use the new radioisotopes for medical diagnosis and therapy.

The laboratory today has nine research divisions:

- o Accelerator and Fusion Research--performs the design, construction, and operation of accelerators, and conducts research to advance accelerator design
- o Biology and Medicine--conducts a program in biological science with emphasis on nuclear medicine
- o Chemical Biodynamics--emphasizes research on fundamental biological processes in plants and animals
- o Energy and Environment--conducts R&D on energy supply Technologies, efficient use of energy, and impacts energy production and use.
- o Earth Sciences Division--conducts research in geothermal exploration, reservoir engineering, and energy conversion; nuclear waste isolation; enhanced oil recovery; thermal energy storage; uranium resource assessment; and the fundamental geosciences.
- o Materials and Molecular Research--pursues a broad range of fundamental studies of materials and reactions, with a special interest in the problems of advanced energy systems
- o Nuclear Science--involved in research in nuclear science, chemical and atomic physics, heavy element chemistry, and geochemistry

- o Physics, Computer Science, and Mathematics--responsible for the high energy physics program and part of the work in medium energy physics and nuclear science
- o National Resources for Computation in Chemistry--conducts research in computer-assisted computational chemistry and provides computer services to nationwide researchers. Supported jointly with the National Science Foundation.

The multidisciplinary aspect of LBL is highly developed, with much interaction between divisions: programs in plasma physics and accelerator development have resulted in the development of engineering design of neutral beam injectors for major national projects in magnetic fusion energy; techniques derived from biomedicine and nuclear science are being applied to environmental problems; knowledge obtained in photosynthesis research is applied to environmental problems; and knowledge obtained in photosynthesis research is applied to solar energy conversion.

Over the decades, the laboratory has had extensive experience in program planning, budget preparation, and management of large-scale research projects and large technical construction projects. Major programmatic goals and objectives are developed by the key scientific staff; these are then reduced by the engineering and administrative staff to a series of secondary goals and objectives to produce the necessary substructure for each program.

PERSONNEL

Although its own staff is the main support for LBL activities, the laboratory has gained a special character and capability because of its interaction with the University of California at Berkeley; LBL and UC have enjoyed a close and productive relationship for over 45 years. Sixty-seven faculty members in the physical, biological, and engineering sciences now hold joint appointments at LBL; and each year a few hundred graduate students from a variety of fields take part in many of the laboratory's research projects. In addition, LBL attracts large numbers of applicants for its short-term post-doctoral research positions. The LBL staff of about 3,370 includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	517	Biochemists	20
M.S.	278	Biologists	14
B.S.	619	Biophysicists	40
Total	1,414	Chemists	160
		Computer Scientists	135
		Engineers	327
		Mathematicians	17
		Medicine	14
		Metallurgists	21
		Physiologists	10
		Physicists	258
		Total	1,016

CURRENT MISSION AND PROGRAM ACTIVITIES

Basic Energy Sciences

LBL is the principal U.S. laboratory in the field of heavy ion research due to its unusual constellation of accelerators and to the commitment of its research staff. Its major heavy-ion accelerator is the Bevalac which accelerates nuclei of elements from helium to iron to relativistic energies. The Bevalac is operated as a national center for exploration of a new field of research--nuclear reactions from relativistic heavy ions, including the possible formation of nuclear matter of abnormally high density. A rich program is also under way at the Bevalac in radiation biology, including testing of the medical diagnostic and treatment potential of heavy ions.

LBL nuclear scientists have been involved in the synthesis and identification of all of the 14 known transuranium elements, and most recently with element 106. Several of these elements--notably plutonium (as fuel), and americium and curium (as by-products)--will play a central role in the use of nuclear fission energy; and an interdisciplinary program on actinide element chemistry, involving laboratory and campus scientists, includes work directed toward the solution of the serious waste disposal and poisoning problems associated with the use of these elements in nuclear reactors.

LBL is the birthplace of modern high energy physics. Research in this field, together with the design, construction, and operation of accelerators, still constitutes a large component of LBL's mix of activities. A vigorous program of experimentation is being conducted at the Stanford Linear Accelerator Center (SLAC) and at the Fermi National Accelerator

Test Stand Vacuum System designed at Lawrence Berkeley Laboratory for the Neutral Beam Development Facility to be located at the Princeton Plasma Physics Laboratory. Neutral beams produce the high energy Deuterium Ions necessary for controlled thermonuclear reactions.

Laboratory (Fermilab). Recently, the collaboration with SLAC resulted in discoveries of fundamental importance: the existence of two heretofore unsuspected particles [called $\psi(3195)$ and $\psi(3695)$]. The investigation into the nature of these particles will be a major element in LBL's future high energy physics program.

Another major field of emphasis is the application of materials and molecular science to the problems of advanced energy systems. Programs under way include fundamental studies of metals, alloys, ceramics, ferroelectric materials, catalysts, superconductors, and new types of high energy compounds. Work also is being done on the experimental and theoretical characterization of the kinetics of reactions--in a wide range of environments from high-temperature plasma and stratospheric conditions to aqueous solutions, and from fission and fusion reactor conditions to very low-temperature solvents. In general, these programs are directed toward understanding the factors that control the properties of materials and to using this knowledge to search for new materials, new techniques for studying the properties of materials, and novel applications of materials to satisfy the severe design criteria posed by advanced energy processes.

Energy Technologies

Drawing on the expertise of its own staff and on the unusual range of talent in the geological science departments at the Berkeley campus, LBL is engaged in a program aimed at better utilization of the heat resources lying beneath the surface of the earth. This diverse program includes basic and applied sciences as well as engineering. Major emphasis is now in two areas: (1) The development of methodology for resource exploration and assessment, with supporting research on basic geological materials and processes; and (2) A geothermal energy program designed to develop a technological base for use of the energy within high-temperature low-salinity hydrothermal reservoirs.

A major part of the magnetic fusion energy (MFE) program at LBL is devoted to the development and fabrication of intense neutral beam sources for use in experimental devices at other national laboratories (e.g., for TFTR at Princeton and the Doublet III for General Atomic). Also under way are basic experimental and theoretical studies of plasma physics, and the study of plasma production, confinement, and heating in the TORMAC toroidal magnetic cusp configuration.

The solar energy program includes activities in two major areas. The first, thermal conversion, includes projects directed toward the development of technology for the heating and cooling of buildings and the development of low-temperature heat engines. The second involves research and development activities related to quantum-conversion processes, which include photovoltaic conversion, photochemical conversion, and production and conversion of biomass.

Development of energy conservation technology as well as energy conservation policy and impacts are also being undertaken.

Biomedical and Environmental Research

Among the aims of the LBL environmental science program is the determination of the effects of pollutants associated with energy production and utilization on human health and on the environment. Scientists at LBL are engaged in a range of environmentally-related biological, chemical, physical, technological, and socio-economic studies, which include research at the molecular, cellular, and organismic level on the effects of radiation and other pollutants; and exploration of land, freshwater, marine, and atmospheric environments to develop an understanding of the distribution, movement, and uptake of environmental agents. One major LBL program involves the characterization of atmospheric particulate matter and a study of the chemical transformations of pollutants in the combustion process.

The LBL health program is directed toward testing and developing heavy ion beams for use in the diagnosis and treatment of human diseases and toward fundamental studies to develop new diagnostic and therapeutic uses of radionuclides.

Technology Utilization

In its strong areas of technology development and applied research, LBL is increasing its contacts with industry, utilities, and state governments in order to be in a position to address effectively their scientific, technical, and institutional problems related to the assimilation of new energy-related technologies. For example, the laboratory is now engaged in the design, construction, and testing of prototype neutral beam injectors for two major national projects in the development of magnetic-confinement fusion reactors. A close working relationship will be established with the industrial organizations that will manufacture the injectors.

PROGRAM FUNDING

LBL's fiscal 1978 operating budget was \$104 million, of which \$74.5 million was for DOE work. Operating costs for work related to other Federal agencies and to Lawrence Livermore Laboratory programs, and work done for others, make up the remaining \$29.5 million.

The major operating programs are as follows:

Program	(\$ Million)
<u>DOE</u>	
Nuclear Physics	\$ 15.1
Basic Energy Sciences	12.1
Environmental and Life Sciences Research	12.0
High Energy Physics	10.2
Magnetic Fusion Research and Development	8.4
Geothermal Energy Development	6.2
Conservation Research and Development	5.5
Solar Energy Development	1.3
Inertial Confinement Fusion	0.9
Policy and Management	0.6
Fossil Energy Development	0.5
Fuels from Biomass	0.4
Energy Information Validation	0.4
Heating and Cooling Demonstration	0.3
Advanced Isotope Separation	0.2
Total	\$ 74.5
Other Federal Agencies	\$ 9.2
Livermore Programs	4.6
Work for Others	15.7
Total	\$104.0

MAJOR FACILITIES

LBL designed, constructed, and now operates three heavy-ion accelerators which together comprise an international center for heavy ion research in both nuclear science and biomedicine:

- o The SuperHILAC, a heavy ion linear accelerator, which accelerates nuclei of all elements to xenon or heavier to 8.5 million electron volts (MeV) per nucleon. It operates as a national facility.
- o The 88-Inch Cyclotron, a low energy accelerator, that produces polarized proton beams and heavy ion beams for nuclear studies and radioisotope production.
- o Bevalac, an accelerator combination of the SuperHILAC as an injector for the Bevatron, produces high energy, high-intensity,

heavy-ion beams for medical, cosmic ray, and nuclear chemistry research. Because it is the only source in the United States of such particles, it is operated as a national facility.

The collaboration with SLAC has resulted in the design of a major new research facility called PEP (Positron-Electron-Project colliding beam storage ring). The construction of this facility at SLAC, scheduled for 1980, will open the door to a vast new area of research and promises to advance significantly our understanding of the basic composition of the nucleon and the forces between elementary particles.

Donner Scanning Pavilion is a unique center on the UC campus where LBL scientists are developing diagnostic procedures, testing new instruments, studying physiological problems, developing new radiopharmaceuticals, and training physicians in the techniques of nuclear medicine. The Pavilion is equipped with a positron camera, a 16-inch scintillation camera, a Mark II whole body scanner, atomographic scanner, and other imaging instruments.

Facilities are established at both the Bevalac and the 184-Inch Cyclotron in which referred patients with certain pituitary diseases and cancers are treated with beams of accelerated particles. A specially designed patient positioner, ISAH, rotates the patient by computer to irradiate just the diseased tissue.

To LBL's present 650-RV high resolution electron microscopy capability will soon be added a 1.5 MeV machine, to be made available as a national resource for high resolution electron microscopy.

SIGNIFICANT ACCOMPLISHMENTS

- o Design and construction of several generations of accelerators, bubble chambers, and automated particle data reduction equipment.
- o Development of X-ray fluorescence and neutron activation techniques and their associated electronics for the analysis of ultra-trace elements.
- o Discovery of many elementary particles and resonances, transuranium elements, and radioisotopes.
- o Development of the scintillation camera and other imaging devices.
- o Treatment of over 200 patients for acromegaly, Cushing's disease, breast cancer, and certain malignant diseases of the eye.

The SuperHILAC, a heavy-ion linear accelerator, accelerates nuclei of all elements to xenon or heavier to 8.5 million electronvolts per nucleon.

- o Elucidation of details of the photosynthetic process.
- o Development of the ability to design and produce materials with any desired combinations of properties (e.g., steels that are both strong and ductile).
- o Development and fabrication of intense neutral beam sources for use in fusion energy devices.

EXECUTIVE SUMMARY

Lawrence Livermore Laboratory

LOCATION: Livermore, California

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$262.5 million
STAFFING:	7,014
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$400.0 million
NUMBER OF ACRES:	631.1
NUMBER OF BUILDINGS:	244
FLOOR SPACE:	3.1 million sq. ft.

OPERATING CONTRACTOR:

University of California

RESPONSIBLE OPERATIONS OFFICE:

San Francisco

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

National Defense (50.6%)
Laser Fusion (11.4%)
Laser Isotope Separation (3.5%)
Magnetic Fusion Energy (9.9%)
Energy and Resource (5.7%)
Biomedical and Environmental (4.7%)
Basic Energy Science (.9%)
Other DOE (3.4%)
Department of Defense (5.2%)
Nuclear Regulatory Commission (2.1%)
Other Agencies (2.6%)

MAJOR FACILITIES:^{2/}

Argus Laser Facility
Shiva Laser Facility
Nova Laser Facility (in progress)
100 MeV Accelerator Facility
National Defense Supported Livermore Computer Center

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

^{2/} Defined as > \$5 million acquisition cost.

MAJOR FACILITIES (Continued)

Gaseous and Metallurgical Facility (Plutonium and Tritium)
Magnetic Fusion Energy Facility
High Explosive Processing and Test Facility
14 MeV Rotating Target Neutron Source (in progress)
Mirror Fusion Test Facility (MFTF) (in progress)
Tandem Mirror Experiment (TMX) (in progress)
National Magnetic Fusion Energy Computation Center (new building in progress)
High Explosive Flash Radiography Facility (in progress)

LAWRENCE LIVERMORE LABORATORY

Livermore, California

INTRODUCTION

The Lawrence Livermore Laboratory (LLL), founded in 1952, is operated by the University of California. The main facility is located near Livermore, California, some 40 miles east of San Francisco. There is a high explosives test facility 15 miles east of Livermore, and a small staff is maintained at the Nevada Test Site to field nuclear weapons tests. Livermore is a mission-oriented research and development laboratory devoted to the achievement of specific technical goals in the national interest. Major current missions are to: Assist in maintaining an adequate national defense, primarily through nuclear weapons design; develop new technologies to expand the energy resource base; and Provide biological and environmental data that help guide the recovery and use of energy in environmentally acceptable ways.

LLL brings to the energy field two traditions: First, methods of large-scale, broad-ranging interdisciplinary research and development (R&D), with a flexible, matrix organization geared to prompt response to new challenges; second, the essential weapons laboratory requirement for a complete technical system, capable of developing a new idea from its conception to completion of prototype hardware.

There are two main organizational structures. One is a supporting departmental structure, consisting of a core of basic disciplines in physics, chemistry, computations, and engineering, as well as technicians, machine shops, etc. The second structure consists of programs, each of which is aimed at achieving specific goals--nuclear weapons, laser fusion, fossil energy development, etc. When a new program or project is assigned, the program director can use resources from the discipline pools to quickly form an experienced interdisciplinary program team to pursue the objective, with continuing technical services from the supporting departmental resources.

As a part of this R&D capability, the laboratory maintains supporting administrative expertise in contracting for services, purchasing special equipment, etc. There is a major commitment to commercialization of technologies and to technology transfer in general. Close interactions with industry are inherent in coal gasification, oil shale, geothermal and other technologies.

PERSONNEL

Scientific and Engineering Professionals

Highest Degree Attained	Number	Occupation	Number
Ph.D.	919	Physicists	772
M.S.	683	Chemists	298
B.S.	800	Mathematicians	35
(Non-degree)	55	Mathematical Programmers	269
Total	2,457	Metallurgists	36
		Life Scientists	82
		Engineers	965
		Total	2,457

The total staff of 7,014 consists of 2,457 scientists and engineers, 2,992 technicians, and 1,565 administrative personnel. Some 547 technicians and administrators have degrees at the bachelor level or higher.

The Livermore site of the University of California Department of Applied Science, Davis/Livermore, established in 1963, offers graduate study toward the Ph.D. and M.S. in Applied Science. About a third of the student body of 100 are LLL staff members. Some 25 LLL scientists and engineers hold academic positions and supervise thesis research in LLL Laboratories.

CURRENT MISSION AND PROGRAM ACTIVITIES

National Defense

Nuclear weapons design accounts for approximately half the laboratory's effort, and continues to be LLL's primary responsibility. The program addresses current weapon requirements of the Department of Defense, exploration of new nuclear explosive concepts, a broad R&D program, and the conduct of nuclear tests essential to exploration and design of nuclear explosives. At present, the laboratory is completing design of a warhead for an 8-inch and the 155 mm artillery shells, a new strategic air dropped bomb, and an improved warhead for the Lance tactical missile system. A continued heavy workload in weaponization to replace aging warheads is projected for several years.

Laser Fusion

This program, started in 1962, is aimed at producing energy by laser implosion of thermonuclear material. An important base of new technology in glass disc research lasers, pellet target design, and research

experience has been developed at LLL in the last several years. The 0.4 trillion watt (TW) Janus, the one-arm 1-TW Cyclops, and the 4-TW Argus have been developed and used for target irradiations. In 1975 the first direct evidence for unambiguous laser-induced thermonuclear fusion reactions was obtained, and in 1976 a record one billion fusion reactions were observed in experiments with the Argus. During 1978, in the initial experimental work with the Shiva laser, approximately 30 billion fusion reactions were observed.

The 20-30 trillion watt Shiva system began operations in 1977. In FY 1978 work to upgrade Shiva to the new expanded Nova system began. This project, aimed at demonstrating the feasibility of laser fusion in the early 1980's, will continue over a 5 to 6 year period.

Meanwhile, progress is being made toward development of gas lasers having the characteristics needed for eventual laser fusion power plants.

Laser Isotope Separation

Since 1973, LLL has been exploring methods of separating isotopes with lasers. In 1975, uranium enrichment on a macroscopic scale (milligram quantities) was achieved, using lasers to selectively ionize U-235 selectively for subsequent separation by electrical methods. Work has continued on development of lasers and spectroscopy.

Magnetic Fusion Energy (MFE)

In exploring the production of thermonuclear energy by the confinement of superhot hydrogen gases in a magnetic field, the laboratory is responsible for one of the major approaches--the mirror machine. As a future commercial power generator, the mirror offers the potentials of high power density and relatively small size--comparable to conventional fossil facilities.

In the last several years the 2XII-B experiment has been the main focus of this program. A major neutral beam technology for injecting a higher density of fuel has been developed, as well as a method for streaming low-energy ions through the plasma to reduce instabilities. Experiments in the last 2 years resulted in the achievement of plasma temperatures of 250 million degrees, higher than any other major MFE experiment, a quadrupling of fuel density, and a reduction in plasma instabilities.

These results have led to a \$94 million funding of the Mirror Fusion Test Facility (MFTF), with an initial commitment of \$14M in FY 1978. In this device the results of 2XII-B will be extended, and it is expected that remaining scientific questions about the mirror approach will be explored by the early 1980's.

View of the north bank of six of the 20 Shiva laser amplifier chains looking back from the end nearest the target room. The Shiva laser system will deliver more than 30 trillion watts of optical power in less than one billionth of a second to a tiny fusion target the size of a grain of sand. Shiva, the world's most powerful laser, is one in a series of high power laser systems built by the Lawrence Livermore Laboratory.

Construction has been completed on an experiment (TMX) to test a new concept for use of a mirror at each end of a tube containing reacting plasma. This tandem mirror might simplify and reduce cost in an ultimate mirror reactor.

The 2XII-B experiment is being converted to the Beta II Facility to study plasma confinement in field reversed and mirror configurations.

Energy and Resources

LLL is developing several concepts for economic recovery of a number of large, presently inaccessible resources and is providing technology for their efficient utilization: in situ processes for the recovery of oil from oil shale; in situ gasification of deep coal deposits to the west; methods to control the sealing and corrosion which has inhibited the commercialization of California's Imperial Valley Geothermal resource; and a number of transportation-related efforts including flywheel and advanced battery development for energy storage. All involve close interaction of laboratory experimentation and computer calculation to identify and demonstrate effective methods and processes. Field experiments are also conducted in the coal and geothermal projects.

In the coal program, the third of a series of small gasification experiments was carried out at Hoe Creek, Wyoming during the fall and winter of 1977. Over 2,000 tons of coal were gasified during 58 days of operation. Significant technical and environmental results were obtained.

In the oil shale project, experimental retorts and computer modeling are proving to be very useful in planning toward scale-up to commercial size, a task to be undertaken in the field by industry with Laboratory support.

In the geothermal program, the use of additives has been found to significantly reduce scale buildup. Methods to clarify and filter the geothermal fluid to condition it for reinjection after use show every indication of being feasible and economic. There is close involvement with industrial geothermal developers in the Salton Sea region.

A shallow solar pond technology has been developed in collaboration with industry in New Mexico, and modifications are now being studied to reduce the cost of this method of producing hot water for industrial and agricultural processing.

Energy conservation concepts being studied include the aluminum-air battery, a wind energy modeling project, and flywheel development.

In Nuclear Waste Isolation, LLL has designed and is leading the execution of an experiment in which about one dozen spent reactor fuel elements will be emplaced at a depth of 1,400 feet in a granite formation at the Nevada Test Site and the results monitored and evaluated.

Biomedical and Environmental

The Biomedical and Environmental program was established in 1963 specifically to study environmental consequences of the release of radioactivity. Although this work is continuing, the horizons of the program have expanded to include:

- o Study of the biological and environmental effects of energy-related effluents in the biosphere.
- o Application of such knowledge to broad assessments of national, regional, and local energy issues as they impinge on human health and welfare.

The biomedical work deals with the biophysics, genetics, and molecular biology of cellular toxicology. Chromosome aberrations, genetic mutation, reproductive biology, and cellular kinetics are the main emphases, with a heavy commitment to instrumentation development in biophysical cell studies.

In the environmental work, laboratory and field experiments, computer simulation, and information-gathering approaches are being made in marine biology, terrestrial ecology, and atmospheric sciences. The Imperial Valley Environmental Project on the environmental impacts of geothermal energy, led by LLL for the Department of Energy (DOE) and involving local government and industry, is an example of a major, integrated, environmental assessment of a new non-nuclear energy technology.

The capabilities developed in the 1950's and 1960's to study the potential release of radioactivity have been applied to new environmental problems. For example, LLL has developed the National Atmospheric Release Advisory Capability (ARAC), to provide DOE with real-time estimates of the effects of inadvertent atmospheric releases of radioactive material. Research undertaken for the Department of Transportation on the potential impact on atmospheric ozone of fleets of supersonic transports led to the establishment at the Laboratory of a Satellite Ozone Analysis Center in 1976.

The Liquid Energy Fuel (LEF) Safety Program is a new program within the Environmental Research activity. It focuses particularly on providing an ensemble of verified predictive tools which can estimate the effects on people and materials of possible large-scale ($> 10,000 \text{ m}^3$) liquefied natural gas (LNG) accidental spills.

PROGRAM FUNDING

Program	FY 1978 Operating Funds (In Millions)
<u>DOE</u>	
National Defense	\$143.4
Laser Fusion	40.4
Laser Isotope Separation	10.9
Magnetic Fusion Energy	34.4
Energy and Resource	17.9
Biomedical and Environmental	12.3
Basic Energy Science	2.1
Other DOE	<u>1.1</u>
Total DOE	\$262.5
<u>Other Federal Agencies</u>	
Department of Defense	\$ 15.7
Nuclear Regulatory Commission	8.5
Environmental Protection Agency	1.1
Department of Health, Education & Welfare	1.2
Department of Transportation	.8
National Science Foundation	.1
Others	<u>13.7</u>
Total	\$303.6

MAJOR FACILITIES

LLL has 3.1 million square feet of building space at the Livermore site. Total authorized investment in plant and capital equipment is \$400 million.

- o In Magnetic Fusion Energy (MFE), the 2XII-B operates with a 600 ampere neutral beam injection system; the \$94 million MFTF, its successor, is included in the fiscal 1978 budget. The TMX Facility is completed with experiments expected to begin soon. Construction of Beta II is underway. There is a Rotating Target Neutron Source (RTNS) to study MFE materials problems, and the \$5 million RTNS II Facility was completed in 1978. Construction has been completed on a High-Voltage Test Stand (HVTS) to test neutral beam sources for Mirror and Tokamak research. There are laboratories for research on direct and conversion of fusion energy, superconducting magnets, and neutral beam technology.

- o Laser fusion facilities include the 0.4 terrawatt Janus and the 4 TW Argus. The 20-30 TW Shiva has just been completed and work on the Shiva Nova laser system is underway. Shiva Nova will increase Shiva laser power available by a factor of 10. There are substantial facilities for research on laser technology, including gas lasers.
- o A 7000-acre chemical explosives test site for formulating, fabricating, and firing explosives, equipped with sophisticated diagnostic equipment, including X-ray and neutron radiography and high-speed photography for hydrodynamic research.
- o One of the largest research computer centers in the world, including one Cray I, two CDC Star 100's, four CDC 7600's, one CDC 6600, a Sigma 7/Sigma 3, peripheral operating gear, small control computers, and 1,000 remote access stations (600 of which have television display units) in the laboratory tied to the time-sharing Octopus system. In addition, the National Magnetic Fusion Energy Computer Center, with a CRAY I as well as CDC-7600 and CDC-6600, is on-line to all major U.S. MFE laboratories.
- o Extensive facilities for research and testing in rock mechanics, chemistry, chemical engineering, metallurgy, metrology, and other fields.
- o Extensive and diversified engineering and machine-shop facilities (including one of the leading precision machining capabilities) for designing, testing, fabricating, and assembling virtually any electronic or mechanical device.

SIGNIFICANT ACCOMPLISHMENTS

- o In national defense, a major contribution has been the miniaturization of warheads for strategic missiles. A breakthrough in 1958 produced initially the Polaris warhead design, and subsequently LLL developed the warheads for currently deployed strategic missiles, including Minuteman III and Poseidon.
- o In laser fusion, LLL developed basic theoretical concepts in 1961. In 1972-75 the excimer transfer laser and the rare gas oxide lasers, with potential application in laser fusion reactors, were developed. Direct evidence of unequivocal laser-induced thermonuclear reaction was obtained in 1975. In 1976 a milestone of one billion fusion reactions, by far the largest ever achieved, was produced with the Argus. During 1978, in the initial experiment with the Shiva Laser, a new milestone was reached with approximately 30 billion fusion reactions observed.

- o In MFE, LLL has been a major contributor to theoretical and experimental progress since the program began in 1952. In 1975 the 2XII-B demonstrated two concepts important to mirror technology--improved confinement at high plasma density and the potential for high beta (plasma/magnetic field pressure). In 1976 the 2XII-B beta experiments were extended, raising the important prospect that field reversal can be achieved, which would enhance the efficiency of a mirror reactor.
- o LLL has made important innovations in new computer languages, software concepts, and detailed programs for integrating varied computer equipment into a total system. Application of these computational techniques has promoted progress in nuclear weapons, laser fusion, in situ coal gasification, geothermal energy, pollution modeling, wind power, and other technologies.
- o Underground engineering and experimental capabilities, such as remote retrieval of data, pioneered for the weapons program and Plowshare, have been applied successfully in such technologies as geothermal energy and in situ coal gasification.

A large oil shale retort at Lawrence Livermore Laboratory is used to explore in situ methods of obtaining oil-like fuel from the nation's huge underground shale deposits in the Rocky Mountain region. In the photo, flammable gas from a retorting experiment is being flared, and high winds are driving the flame near the top of the photo.

EXECUTIVE SUMMARY

Los Alamos Scientific Laboratory

LOCATION: Los Alamos, New Mexico

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$253.3 million
STAFFING:	6,560
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$541.5 million
NUMBER OF ACRES:	27,000
NUMBER OF BUILDINGS:	618
FLOOR SPACE:	4.4 million sq. ft.

OPERATING CONTRACTOR:

University of California

RESPONSIBLE OPERATIONS OFFICE:

Albuquerque

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

- Weapons Activities (36%)
- LAMPF (8%)
- Laser Fusion (8%)
- Nuclear Energy (6%)
- Environmental R&D (6%)
- Advanced Isotope Separation (5%)
- Magnetic Fusion Energy (5%)
- Fossils Geothermal and Solar (3%)
- Nuclear Safeguards (3%)
- Other DOE (8%)
- Work for Others (12%)

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

MAJOR FACILITIES:

LAMPF - 800 MeV proton accelerator
PHERMEX - high intensity flash X-ray machine
National Security and Resources Study Center
Plutonium Processing Facility
Weapons Neutron Research Facility
Eight-Beam CO₂ Laser Facility
Central Computing Facility
Hot Dry Rock Geothermal Drill Site

LOS ALAMOS SCIENTIFIC LABORATORY

Los Alamos, New Mexico

INTRODUCTION

Los Alamos Scientific Laboratory (LASL), operated by the University of California, is a multiprogram facility encompassing 37 miles of Los Alamos County in New Mexico and located 200 miles north of Albuquerque. Established in 1943 as Site Y of the U.S. Army's Manhattan Engineer District, its role was that of designing, constructing, and (for one design) testing World War II atomic bombs, using uranium-235 from Oak Ridge and plutonium-239 from Hanford. In 1947, it was renamed Los Alamos Scientific Laboratory, and its mission was changed and broadened.

In the weapons area, LASL has retained responsibility for the development of nuclear warheads and works closely with industrial contractors to ensure effective technology transfer to optimize both weapons production and stockpile maintenance.

LASL's non-weapons work has in the past been concentrated on advanced nuclear reactor designs, including the development with industrial contractors of a nuclear powered rocket engine, on the physics of controlled thermonuclear reactions, and on nuclear science research. Recently, however, its work was again broadened in response to the needs of the Department of Energy (DOE) and the Nuclear Regulatory Commission (NRC). All six DOE program Assistant Secretaries now fund work at LASL, not only in traditional nuclear energy fields but also in conservation, environmental and safety areas, fossil energy, geothermal energy, and solar heating and cooling. LASL is a lead laboratory for development of major portions of the NRC's reactor safety computer codes. In addition, LASL works for several other federal agencies, including the Department of Agriculture, the Department of Defense, and the Department of Health, Education and Welfare.

LASL management emphasizes the basic role of disciplinary strengths as the foundation for flexible and appropriate responses to new technological challenges. Frequently, new laboratory groups or divisions are formed to carry out a project's work. Project-oriented units draw technical personnel from discipline-oriented divisions as necessary. When the project is concluded, the project-oriented group is disbanded and the personnel returned to their discipline-oriented division.

Steam spews forth from the Nation's first man-made geothermal reservoir, a part of the hot, dry rock program of the Los Alamos Scientific Laboratory. The steam was the last to be vented before a closed-loop system was implemented.

PERSONNEL

In 1978, the LASL staff included:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	1,254	Engineers	858
M.S.	569	Physicists	817
B.S.	673	Chemists	345
		Mathematicians/Computer Scientists	210
Total	2,496	Life Scientists	
		Geologists, Metallurgists,	93
		Others	283
		Technical Support	2,317
		Non-Technical Support,	1,637
		Miscellaneous and Administrative	
		Total	6,560

The above includes about 30 post-doctoral fellows for appointments up to 2 years in length. About 20 graduate students work at LASL on their doctors thesis programs, supported by their own universities.

CURRENT MISSION AND PROGRAM ACTIVITIES

LASL's mission is the application of science and technology to solve national problems both in nuclear weapons development programs and in energy supply and conservation projects.

Weapons

Nuclear weapons work constitutes about half of LASL's activities. The goals of this work are to be both innovative in development and responsive to national needs. The work can be categorized broadly as follows:

- o Developing nuclear warheads for current military requirements.
- o Designing and testing advanced technology concepts.
- o Maintaining an innovative weapons design program through continuing research programs, both theoretical and experimental, in relevant fields of science and technology, such as mathematics, nuclear physics, nuclear chemistry, high intensity radiography, high explosives development, metallurgy, computer science, and fluid dynamics.

To demonstrate the size of the tiny glass microballoons used in laser fusion experiments at the Los Alamos Scientific Laboratory, researchers photographed a microballoon suspended on a human hair in the eye of a conventional needle.

Nuclear Fission

In the field of nuclear fission energy, LASL's activities span the entire range of fuel cycle and include:

- o Surveying the Rocky Mountain states and Alaska for uranium as part of DOE's National Uranium Resource Evaluation. LASL plans to complete the stream water and sediment survey of its assigned area (33 % of the United States) by 1985.
- o Developing laser-induced isotopic separation of uranium and other elements to provide a less energy intensive separation process than the currently used gaseous diffusion method.
- o Participating in the development, fabrication, and testing of advanced fast reactor fuel elements.
- o Modeling reactor accident results for the Nuclear Regulatory Commission.
- o Designing instruments and procedures to detect the diversion of special nuclear materials in the nuclear fuel cycle including work being done in collaboration with the International Atomic Energy Agency.
- o Evaluating the biomedical consequences of nuclear energy production.
- o Developing effective nuclear waste disposal methods. LASL's efforts concentrate on innovative methods for transuranic wastes, including volume reduction by controlled incineration.

Nuclear Fusion

Activities in fusion energy include projects to develop:

- o Magnetically confined plasma devices, especially high beta devices (beta is the ratio of plasma particle pressure to the pressure exerted by the confining magnetic field). LASL is developing both toriodal reversed field Z-pinch devices, in which the magnetic field is produced by an electric current flowing along the main axis of a toroidal tube, and linear theta pinch devices, in which the magnetic field is generated by an electric current flowing in the azimuthal direction, as well as other devices. LASL is the only high beta major laboratory in the United States, although complementary research is being performed in Japan and in several European countries.
- o Laser-induced fusion. The LASL project is unique in its development and use of CO₂ gas lasers, which are capable of high

repetition rates at high power levels with high efficiency. Experiments with a 0.5 terawatt CO₂ laser system in 1977 produced more than 10⁵ thermonuclear neutrons. An eight-beam CO₂ machine named HELIOS exceeded its power design specifications in 1978, and is now producing 15 terrawatts. Pellet experiments with this machine began late in September 1978.

- o Safe handling techniques for large quantities of tritium. The Tritium Safety Test Assembly is being built at LASL as a national facility to study tritium handling techniques; it will be operational in 1981.

Non-nuclear Energy

LASL's high explosives expertise and its techniques for studying materials under conditions of extreme pressure are being used to investigate the stimulation of natural gas production in eastern oil shales and to optimize rubblization of western oil shales for tests of in situ petroleum production. The solar energy program concentrates on heating and cooling of buildings, which range from modular homes to a 70,000 square foot library and study center. A geothermal energy project is using an area of high heat flow in the earth's crust just 50 kilometers from Los Alamos to develop methods of heat extraction from hot dry rock; LASL's electronics division is participating in this experiment through developmental work on well-logging instrumentation that can function at temperatures over 200°C. Major efforts in electrical energy conservation involve development of a direct current superconducting power transmission line and a superconducting magnetic energy storage system.

Basic Energy Science

Research activities at LASL cover a range that extends from modeling heat flow deep within the earth's crust to observing gamma-ray bursts impinging on satellites far above the atmosphere. Major activities in each of three fields include the following:

- o Nuclear Physics. LASL operates the Clinton P. Anderson Meson Physics Facility for a users' group of more than 1000 individuals. The experimental program emphasizes the use of intense pion and muon beams to probe nuclear forces. LASL's success in building this high-current accelerator has resulted in funding by the National Cancer Institute to develop a compact, inexpensive pion generator that could be purchased by hospitals for cancer irradiation therapy.
- o Chemistry. A large theoretical and experimental photochemistry effort has been developed in support of the laser isotope separation program. The energy conservation by industry could be enormous if it becomes economically feasible to (selectively) induce commercially important chemical reactions by lasers.

- o Molecular and Cellular Biology. Instrumentation developed at LASL for studies on whole cells as well as chromosomes permits very rapid screening of cells for certain anomalies. This work should find application in studying the biological effects of pollutants from energy production.

Technology Utilization

Projects initiated at LASL that were later commercialized elsewhere include: advanced uranium mineral extraction technology, heat pipe commercialization, and nuclear or biological instrumentation development. Technology transfer also occurs directly from activities carried out at LASL for other purposes. For example, the side-coupled cavity design invented to accelerate protons in the LASL meson facility was used immediately by medical X-ray machine manufacturers because of its efficient use of energy. The total sales of commercial X-ray machines that use this LASL invention exceed \$100 million.

The techniques that LASL uses to encourage commercial applications of laboratory-developed ideas include: Participating in joint development projects with industrial firms or consortia; placing contracts in the private sector for the manufacture of LASL-designed equipment; holding workshops to inform industrial representatives of LASL developments; and providing industrial staff member appointments at LASL.

PROGRAM FUNDING

In fiscal 1978, LASL's operating budget was approximately \$288.1 million, about \$253.3 million of which came from DOE; the remainder (about \$34.8 million) comes mainly from other Federal agencies. Major programs are:

Programs	FY 1978 Operating Funds (In Millions)
<u>DOE</u>	
Weapons	\$114.3
Nuclear Energy	29.1
LAMPF-Medium Energy Physics	21.3
Laser Fusion	24.1
Magnetically Confined Fusion	15.5
Environment and Safety	13.1
Fossil, Geothermal, Solar Energy	10.4
Nuclear Safeguards	7.5
Other	<u>18.0</u>
Total	\$253.3

Programs	FY 1978 Operating Funds (In Millions)
Reimbursable Work	
DOE Contractors	\$10.5
Department of Defense	6.8
Nuclear Regulatory Commission	9.3
Other	8.2
Total	\$34.8

The authorized investment in plant and equipment through fiscal 1978 was \$541.5 million, including \$72.5 million in general maintenance facilities and utility systems operated for LASL by the Zia Company. This investment represents, in part, utilities valued at \$42.9 million and floor space totaling 4.4 million square feet, of which about 70 percent is dedicated to direct research and development activities.

MAJOR FACILITIES

The mission of the facilities program at LASL is to provide adequate laboratory, experimental, and support space together with reliable utility services to assure that LASL's programs can be conducted safely, in an environmentally acceptable manner, and with a minimum of facility-related interference. Examples of unique research and development facilities at LASL include:

- o An 800-MeV linear proton accelerator (LAMPF) operated as a major national facility for medium energy nuclear science research.
- o A Weapons Neutron Research facility that produces bursts of neutrons for weapons effects simulations and for solid state physics research.
- o A stable isotopes production facility that uses cryogenic distillation to produce kilogram quantities annually of non-radioactive isotopes used in biomedical, agricultural, and environmental research (nitrogen-15, oxygen-18 and ton quantities of nitrogen-14 depleted in nitrogen-15).
- o A short-pulse, 27-MeV X-ray machine for diagnosis of explosively activated hydrodynamic experiments.

- o A computer center with the following complement of large computers: one CRAY-1, four CDC 7600's, two CDC 6600's, two CDC Cyber 73's, and one IBM 370/148.
- o A 20-terawatt CO₂ gas laser facility for laser fusion studies.
- o An 8-megawatt nuclear reactor.
- o National Security Resources and Studies Center (solar heated and cooled).

Facilities currently under construction include:

- o High Energy Gas Laser Facility. \$62 million. Completion date: 1983. This high energy CO₂ laser facility is being constructed to provide laser beams to 200 terawatts for laser fusion studies. This power should produce fusion with thermonuclear energy output equal to or greater than the laser energy.
- o Tritium Systems Test Assembly: \$13.3 million. Completion date: 1981. To develop and demonstrate the tritium fuel cycle and environmental control systems for an experimental power reactor.

SIGNIFICANT ACCOMPLISHMENTS

- o Development of the first atomic weapons
- o Development of the first thermonuclear weapons
- o Development of Monte Carlo mathematical techniques for random processes
- o Development of tritium handling techniques
- o First liquefaction and property determinations of the rare isotope of helium-3
- o Synthesis of the superconducting material Nb₃Ge
- o Construction of an 800-MeV linear accelerator with a high intensity H⁺ beam, H⁻ beam, and a polarized H⁻ beam
- o First laboratory demonstration of controlled thermonuclear reactions
- o Development and application of the multiparameter fast-flow analyzer and cell separator for use in biological research and disease diagnosis

- o First observation of gamma-ray bursts in space
- o First use of CO₂ lasers to produce thermonuclear reactions
- o Invention of the Heat Pipe
- o Nuclear reactor for space propulsion
- o Developed first United States hot dry rock geothermal reservoir.

EXECUTIVE SUMMARY

Oak Ridge National Laboratory

LOCATION: Oak Ridge, Tennessee

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$202.4 million
STAFFING:	4,980
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$480.0 million
NUMBER OF BUILDINGS:	192
FLOOR SPACE:	2,625,000 sq. ft.

OPERATING CONTRACTOR:

Union Carbide Corporation, Nuclear Division

RESPONSIBLE OPERATIONS OFFICE:

Oak Ridge

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

- Nuclear Energy Development (25%)
- Basic Energy Sciences (17%)
- Biomedical & Environmental Research (14%)
- Magnetic Fusion Energy (10%)
- Fossil Energy Research (3%)
- Nuclear Physics (3%)
- Conservation (2%)
- Solar & Geothermal (1%)
- Miscellaneous DOE (8%)
- Work for Others
 - NRC (8%)
 - Other (8%)

MAJOR FACILITIES:

Construction in Progress

- Heavy Ion Research Facility
- Superconducting Magnet Test Facility

^{1/} Percentages represent total staff (full-time equivalent), including indirect staff, devoted to that activity.

MAJOR FACILITIES (Continued)

Completed Facilities

Isotopes Separation Facility
High-Flux Isotope Reactor
Electron Linear Accelerator
Transuranium Processing Plant
Oak Ridge Research Reactor
Oak Ridge Isochronous Cyclotron
High-Level Radiochemical Laboratory
Materials Processing Laboratory
Thorium Uranium Fuel Recycle Facility
High Radiation Level Examination Laboratory
Environmental Sciences Laboratory

OAK RIDGE NATIONAL LABORATORY

Oak Ridge, Tennessee

INTRODUCTION

Oak Ridge National Laboratory (ORNL) is a multiprogram institution whose principal goal is the development of safe, economic, and environmentally acceptable technologies for efficient production and use of energy. Laboratory activities cover a broad range of inter-related functions: basic research, technology development, applied research, pilot-plant operation, and large-scale advanced technology development. The program is dominated by four general areas that are roughly equal in size: fission energy development, biomedical and environmental research, basic energy sciences, and magnetic fusion. In addition, there are rapidly growing programs in fossil energy and conservation.

ORNL is one of three Department of Energy (DOE) Oak Ridge facilities operated by Union Carbide Corporation. It is located on a 38,000-acre Federal reservation in eastern Tennessee. The Federal reservation is adjacent to the city of Oak Ridge (population 29,000); Knoxville (population 180,000) is about 30 miles away. Knoxville is the home of the main campus of the University of Tennessee with about 27,000 students and the central administrative offices of the Tennessee Valley Authority.

The other two DOE installations in the Oak Ridge area are the Oak Ridge Y-12 plant, an engineering development and fabrication organization engaged primarily in national defense work, and the Oak Ridge Gaseous Diffusion Plant, one of the three United States plants for enriching uranium. Also, DOE's Program Management Office on the Gas Centrifuge Project is located in Oak Ridge and is staffed with personnel drawn from the three DOE facilities. Altogether, the facilities in the Oak Ridge area represent an investment in plant and equipment of over \$1.8 billion and a total employment of about 16,000 people.

Laboratory Management Organization

In order to direct its diverse multidisciplinary effort, ORNL has adopted a decentralized matrix organizational structure. The laboratory has 22 divisions which can each be clearly identified by a service function or an area of disciplinary expertise. There is also a cross cut structure organized along program lines such as coal technology, advanced fuel recycle, NRC reactor safety research, environmental policy analysis, and energy conservation. These programs involve multidisciplinary teams of physical and life scientists and engineers who are drawn for varying periods of time from the disciplinary divisions. In this way, there exists flexibility without the sacrifice of depth of knowledge which results from close involvement with disciplinary activities.

PERSONNEL

The ORNL technical staff represents a wide range of scientific and technological disciplines. Staff specialities, once limited to the physical and life sciences, mathematics, and engineering, now extend into the social sciences--economics in particular.

About 50 percent of the ORNL staff is technically trained, with the following breakdowns by degree and field of expertise:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	930	Engineers	980
M.S.	530	Computer Scientist/ Mathematicians	135
B.S. or equivalent	990	Life Scientists	295
		Physical Scientists	785
		Behavioral and Social Scientists	75
		Other Disciplines and Technicians	180
Total	2,450	Total	2,450

The laboratory population also includes 400 to 500 guest scientists, many of them representing foreign laboratories or research centers, who are at ORNL on assignments of a few months to a year or more. College and university visitors, under a variety of research participation and advanced study programs, number approximately 1,200 annually.

In addition to ORNL technical staff and guests, a centralized engineering staff of 1,275 and a centralized computer operations staff of 750 serve all three DOE Oak Ridge facilities.

CURRENT MISSION AND PROGRAM ACTIVITIES

ORNL's activities are largely directed toward the following: developing nuclear power as a safe, economic industry; demonstrating the technical feasibility of magnetic fusion; understanding and controlling the health and environmental effects of energy production and use; and basic science. In addition, ORNL conducts large and growing programs in coal processing and use and energy conservation, as well as modest programs in solar and geothermal energy.

Nuclear Energy Development

The laboratory's program includes technology development and reactor safety research as well as all phases of the nuclear fuel cycle. The reactor technology program for breeder reactors concentrates on the development and testing of materials for special service conditions, core and shielding design and physics studies, reactor instrumentation and experimental and analytical studies of system safety and performance. Related developments for the High Temperature Gas Reactor (HTGR) and for special projects and space applications include high temperature materials, fuels, and containment technology. Fuel cycle work involves management responsibility for the HTGR fuel recycle program, development of techniques and equipment for reprocessing of Light Water Reactor (LWR) and advanced-reactor fuels, development of refabrication technology for HTGR and LWR fuels, and techniques for the separation, stabilization, and eventual isolation and disposal of nuclear wastes.

A reactor safety program, conducted primarily for the Nuclear Regulatory Commission (NRC), concentrates on pressure vessel integrity, heat transfer under transient and accident conditions, and the behavior of structural materials and fission products under accident conditions. Current work on commercial light-water reactors is designed to increase reactor reliability and to define safe operating limits. Assistance to NRC also involves work on environmental impact statements and related environmental and social impact research, preparation of "As Low As Reasonably Achievable" guides and assessment methodologies for the release of radioactive materials, siting of nuclear energy centers, and safeguards.

Basic Energy Sciences

The development of new knowledge relevant to the Nation's energy goals, both in direct support of technology programs and in more fundamental areas of investigation, has been a major effort at ORNL. Included are large research and development programs on the mechanical, physical, and optical properties of materials related to energy conversion, utilization, transport, and storage. Research in engineering science is concerned with energy conversion processes. In the nuclear area, programs address radiation damage problems in fission and fusion reactors. The chemical and physical properties of coal and catalytic reactions important to coal are being studied under the chemical research program, and pertinent thermodynamic and kinetic data are measured. Properties and reactions of fusion blanket materials and thermochemical, photochemical, and biochemical means for the production of synthetic fuels are being investigated, together with development of chemical systems for energy storage. The high-temperature chemistry of geothermal solutions is also under study.

Research in the fields of nuclear and atomic physics and chemistry provides nuclear data for the support of fusion and fission reactor

programs and investigates the physics of plasmas, particle/surface interactions, and reactor-related materials. The laboratory is a leader in heavy-ion research. The new Holifield Heavy-Ion Research Facility, presently under construction at ORNL, will be the future center of DOE's heavy-ion science program.

Fusion Energy

ORNL's fusion-energy effort is aimed at making significant contributions to the development of toroidal fusion reactor systems. Primary efforts are concerned with basic research in plasma confinement, neutral-beam injection heating, development of large superconducting magnets, and fusion reactor concepts.

Biomedical and Environmental Sciences

Environmental research is conducted on the characterization, transport, and effects of effluents from various energy technologies; this information is synthesized into useful forms for assessment through advanced information processing techniques. The biomedical program focuses on the potential mutagenic, carcinogenic, and teratogenic hazards posed by the release of radiation and of chemicals from energy-producing processes, and on the development of rapid screening tests for health problems that may be caused by these emissions. Basic atomic and molecular studies of the interaction of radiation and chemicals with matter are pursued in order to better understand the effects on living systems.

The bioengineering program deals with bioconversion of wastes into useful products. An evaluation of the impacts of coal conversion technology integrates environmental and biomedical studies with the technological developments that have been made. As part of a DOE-wide effort, a new program has been initiated in environmental policy analysis, with principal responsibility for addressing issues on nuclear fuel cycles and coal conversion technology.

Fossil Energy

ORNL has a broad program aimed at better utilization of coal. Important features of this program are the development of advanced processes for converting coal to clean liquid and gaseous fuels, the exploration of clean coal-combustion processes using fluidized-bed boilers, and the development of a highly efficient thermal conversion process for central power stations. This work is supported by basic research on the physical and chemical properties of coal. The health and environmental effects associated with conversion plants and furnaces are studied to provide information to expedite engineering of adequate controls.

Researchers in Oak Ridge National Laboratory's Dry Magnetic Cleaning of Pulverized Coal Program are studying ways to remove the inorganic particles that contain sulfur from coal before the coal is burned. This piece of pulverized coal, approximately 20 microns long, shows submicron particles of iron pyrites, clay and shale.

Conservation

ORNL's applied conservation activities include modeling residential and commercial energy use, evaluating and modifying commercially available appliances to enhance efficiencies, developing processes for recovering energy from domestic sewage, and developing the Annual Cycle Energy System (ACES) for efficient heating and cooling of buildings. Other conservation efforts include analysis and testing of insulation materials for use as high-voltage insulators, and developing low-temperature thermal storage systems.

Geothermal Energy

A small, concentrated effort in geothermal energy involves environmental assessment, the development of low-temperature Rankine cycles, the improvement of heat transfer with non-aqueous low-boiling-point fluids, and the control of corrosion and scale formation by geothermal brines.

Solar Energy

The laboratory presently has a small effort directed toward long-term solar energy technologies, including bioconversion of wastes, improvement of photovoltaic materials, environmental assessment, and development of large heat exchangers for ocean-thermal gradient and other low-temperature heat source applications.

Social Science Research

In support of the growing need to understand the social and institutional components of accomplishing our national energy goals, ORNL has become increasingly involved in research on the social aspects of energy production and use. Such work includes development of predictive models for electricity demand, coal production, and migration patterns; analysis of social impacts of new energy facilities; and development of advanced computer techniques to be used in regional studies to correlate factors such as land topography, population, income, ecological parameters, and government services.

Commercialization and Technology Utilization

A diverse research facility such as ORNL can interface with industry in several ways including development of equipment that has commercial value, and through the involvement of private companies in the early stages of design and development of "big" technology.

ORNL attempts to establish working relationships with industry at the earliest possible development stage of new technology. An example of successful commercialization of ORNL research is the zonal gradient centrifuge, which is in wide use in clinical laboratories around the world. The laboratory also is closely involved with industry in the

Scientists at Oak Ridge National Laboratory have developed a device which reproduces the conditions that occur when fish or other organisms are pulled through a power plant along with the waters used to cool and condense steam and carry away excess heat. The "Power Plant Simulator" includes a 4,000-gallon tank, 144 small aquariums, and a closed loop of pipes and pumps supported by a 40-foot-high steel structure. Purpose of this research is to suggest changes in design of power plants to minimize harmful effects of entrainment.

- o Production of radioisotopes and development of techniques for their use that have wide application in industry, medicine, agriculture, and research, including isotope heat sources for use in space, remote meteorological stations, underseas transmitters, etc.
- o Development of ultracentrifuge techniques for producing pure vaccines, performance of rapid quantitative measurements of pollutants, and development of medical diagnostic systems that are now used commercially.
- o Development of the neutron activation analysis method, which permits precise analyses not possible by other techniques, and a basic-sensitive eddy-current technique that is in wide use industrially for nondestructive testing.
- o Development of special alloys such as a modified type 316 stainless steel that has markedly improved resistance to irradiation-induced swelling and creep and an iridium-based high temperature fuel cladding alloy for Voyager space probes.
- o Development and production of neutral beam injectors for the Princeton Large Torus Fusion Device and Poloidal Divertor Experiment.
- o Development and demonstration of a one-atom detection system.
- o Development of extensive techniques for testing of mutagenic and carcinogenic effects of chemical by-products of energy generation and technology.

development of large superconducting magnets, a potassium vapor topping cycle for power generation, and a fluidized-bed coal combustion facility. Examples of commercialization activities with small scale technology include the ACES concept, various modes of solar-assisted heating and cooling systems, and applications of end-use conservation.

PROGRAM FUNDING

For fiscal 1978, ORNL's operating budget was \$241.9 million; \$202.4 million of this was DOE funding; the remainder is primarily work for other Federal agencies, the largest single sponsor being the Nuclear Regulatory Commission (\$21.9M). Other major funding agencies include the National Institutes of Health (\$5.1M), the Environmental Protection Agency (\$2.1M), the National Science Foundation (\$1.3M), and the Department of Defense (\$1.3M). The following is a breakdown and summary of funding by program for fiscal 1978.

Program	Summary of FY 1978 Operating Costs (In Millions)
DOE	
Nuclear Energy Development	\$ 60.4
Advanced Energy Systems (including Basic Physical Sciences)	94.7
Environmental Research and Safeguards	29.9
Fossil	7.8
Conservation	7.7
Program Support (Energy Information Administration/Economic Regulatory Administration)	1.7
Total DOE	<u>\$202.4</u>
Work for Others	<u>39.5</u>
Total Operating	<u>\$241.9</u>

The authorized investment in plant and equipment in fiscal 1978 was \$480 million.

MAJOR FACILITIES

Special facilities at ORNL include the following:

- o Five nuclear reactors, including the High-Flux Isotope Reactor (HFIR), which produces the world's highest neutron flux, and

the Tower Shielding Facility, a reactor that can be suspended in the air for shielding studies.

- o Six particle accelerators including an advanced Electron Linear Accelerator (ORELA) and the Isochronous Cyclotron (ORIC), which has special capability for accelerating heavy ions.
- o A variety of chemical processing development facilities, including the Transuranium Processing Plant for separating californium and other heavy elements and the Thorium-Uranium Recycle Facility for remotely processing reactor fuels, and a pilot plant for processing irradiated nuclear fuels.
- o Two major fusion energy devices including one tokamak, ISX (Impurities Studies Experiment), and the ELMO Bumpy Torus, a mirror-type toroidal plasma confinement device.
- o An extensive and varied biological laboratory complex, including a Small Animal Facility that can house an experimental mouse population of about 330,000.
- o Holifield Heavy-Ion Research Facility, incorporating the laboratory's present heavy-ion accelerator ORIC, is scheduled for completion in 1979. The 25-million-volt tandem electrostatic accelerator that is the heart of the new facility will make possible studies of the behavior of nuclear matter over a large portion of the periodic table and of atomic structure over the full range of elements.
- o The Environmental Sciences Laboratory is the first in the nationwide DOE complex designed specifically for environmental-sciences research.

SIGNIFICANT ACCOMPLISHMENTS

- o Significant contributions to recycle technology for nuclear fuels, including selection and specification of a reference recycle fuel for HTGR, demonstration of successful dissolution and solvent extraction of high-burnup LWR fuel, and development of techniques for retention of radio-iodine during reprocessing operations.
- o Extensive contributions to the technology and safety of nuclear power plants including standards for manufacture of reactor components, data systems for information centers, development of diagnostic techniques to define reactor operating limits, development and operation of large experiments for simulating behavior of reactor components and systems, and correlation of experimental results with mathematical models.

Construction continues on the Holifield Heavy-Ion Research Facility located at the Oak Ridge National Laboratory. The photo shows the top of the 100-foot pressure vessel that will contain a 25 million-volt electrostatic accelerator. The tower facility will become the country's most advanced tool for studying interaction of heavy, charged particles of matter.

EXECUTIVE SUMMARY

Pacific Northwest Laboratory

LOCATION: Richland, Washington

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$96.9 million
STAFFING:	1,950
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$60.7 million
NUMBER OF BUILDINGS:	69
FLOOR SPACE:	500,000 sq. ft.

OPERATING CONTRACTOR:

Battelle Memorial Institute

RESPONSIBLE OPERATIONS OFFICE:

Richland

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Fuel Cycle Research and Development (35%)
 Environmental Research and Development (16%)
 Solar (4%)
 Basic Energy Sciences (3%)
 Defense (3%)
 Work for Others (30%)

MAJOR FACILITIES:

Life Sciences Laboratory
 Critical Mass Laboratory
 Meteorological Center
 Nuclear Hot Cells
 Environmental Laboratory
 Waste Management Laboratory
 National Environmental Research Park
 Engineering Development Laboratory
 Material Sciences Laboratory
 Aquatic Laboratory

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

PACIFIC NORTHWEST LABORATORY

Richland, Washington

INTRODUCTION

The Pacific Northwest Laboratory (PNL) is located near the city of Richland in south-central Washington. Research facilities are within or adjacent to the 570-square-mile government reservation known as the Hanford Project. PNL supports a broad range of the Department of Energy's (DOE's) programs and performs research and development (R&D) for other government agencies. Battelle Memorial Institute, which has operated PNL since 1965, also conducts private research and development activities for other sponsors in government and industry. Battelle's privately developed research complex and the government-owned laboratories and support facilities are operated as a consolidated laboratory.

PNL programs are truly interdisciplinary. Thus, resources from throughout the laboratory can contribute to any specific investigation; the PNL team approach is fundamental to project-style management of R&D programs. A senior council of Battelle executives manages the laboratory and monitors the activities of nine research departments. Top management offices are directly responsible for coordinating program assignments that require the services of many R&D components, and for committing the resources necessary for executing large projects on schedule.

Biomedical and environmental research is a significant area of activity. A wide range of studies on the fate and effects of industrial and energy-related materials is coordinated through a program office. PNL has also established a lead role in R&D related to the management of high-level nuclear waste and compressed air energy storage, a category of program-coordinated activity and funding.

The capability for managing research programs is evidenced by PNL's currently assigned responsibility for: management of DOE's Wind Characteristics Program; management and preparation of the Generic Environmental Impact Statement on Commercial Nuclear Waste Management; and management of the Fuels Refabrication and Development Program.

Battelle's tie to industry, maintained through private research under the laboratory's use permit, has proved valuable in programs of shared government-industry interest. A new \$15 million DOE-funded fuel development program for the nuclear industry links PNL to a private fuel manufacturer and a major utility. Another million-dollar DOE study, on the biological effects of ultra-high voltage fields, is being conducted in parallel with an industry-sponsored study of a similar type. PNL, through years of extensive funding, maintains a broad spectrum of environmental studies capabilities.

PERSONNEL

At the beginning of the fiscal year there were 2,195 people employed at the Pacific Northwest Laboratory. More than half, 1,350, are assigned to research departments and R&D program offices. More than 1,000 members of the PNL staff hold degrees from academic institutions.

Highest Degree Attained	Number
Ph.D.	276
M.S.	313
B.S.	495
A.A.	65
D.V.M.	6
J.D.	6
Total	1,161

CURRENT MISSION AND PROGRAM ACTIVITIES

The Pacific Northwest Laboratory is a multiprogram research and development site where science and engineering are applied to today's leading technical questions. PNL activities include research programs on advanced energy system concepts, proposed avenues for making present systems safer and more efficient, and the environmental consequences of man's energy-related developments.

Environmental and Biomedical Programs

Approaches to the reclamation of disturbed lands are being investigated for the best methods to treat strip-mine spoils in semiarid regions of the west. Developments to more effectively remove particulates from exhaust stack gases are being studied.

The PNL staff has been directly involved in preparation of environmental statements and the assessment of energy-related facilities and systems, and PNL has been engaged in a study of the self-contained energy park concept.

Research in the life sciences includes species-specific studies of the impact on freshwater and marine aquatic organisms resulting from energy-related activities. Examples include investigations of the effects of petroleum and oil-dispersal materials on the coastal ecosystem, and the effect on aquatic life of power plant operation and shutdown cycles, as cooling system effluents influence ambient water temperatures.

For more than 25 years the PNL staff has been engaged in radionuclide inhalation studies. One long-term animal research program on combined somatic effects of inhaled air pollutants involves atmospheres simulating those encountered by uranium miners. The long-term biological effects of exposures to plutonium, the transplutonium elements, and noble gases are also being investigated. Cancer studies include basic research at the cellular level and biomedical applications of radioisotopes. Work is also being done on soil retention and uptake by plants of heavy metals and heavy-metal complexes, and the movement and concentration of radionuclides through the ecosystem.

Specialized PNL capabilities include biometrics, biomathematics, and other advanced approaches to monitoring, modeling, and predicting sophisticated processes encountered in biological and environmental research. For example, computer models for entire river basin systems have been developed to enhance water quality planning; other models aid land use and site selection decisions.

PNL perfected techniques for airborne remote-sensing of surface temperature conditions over a number of years--an extension of environmental surveillance methods that has had site-specific application. Access to data from earth-orbiting satellites has opened a new vista, and PNL is developing a lead capability in geophysical and resource analysis interpretation of this imagery.

PNL is responsible for major work in the DOE Regional Assessment Program. The laboratory has been named to lead the national study of oil, natural gas, and oil shale use; other laboratories will assess different regions of the United States while PNL studies the Pacific Northwest and subsequently coordinates all of the studies in an integrated national assessment. PNL is also responsible for studying the impact of various coal-use scenarios in the Northwest. Battelle's Human Affairs Research Center in Seattle is also contributing research expertise to the Regional Assessment Program.

Nuclear Fuel Cycle

The entire nuclear fuel cycle is the subject of research, from analysis of commercial fuel design concepts to the ultimate disposal of long-lived radioactive wastes. Drawing upon extensive staff expertise in radiochemistry and waste solidification, PNL is at the forefront of technology related to final isolation of these materials from the biosphere. Work is in progress to verify methods for incorporating high-level wastes in a stable borosilicate glass matrix, as well as studies on transportation of radioactive materials. Liquid Metal Fast Breeder Reactor materials and fuels have been the subject of safety review and performance analysis.

Fossil Fuels

Fossil fuel programs range from a basic study of coal and chemistry to new methods for removing sulfur compounds from hot fuel gases and

developing electrode materials for magnetohydrodynamics systems. PNL scientists and engineers are also engaged in studies of safer and more economical mining methods and machinery.

Solar Energy

Solar energy investigations include development of improved collector panel insulation materials and regional assessments of the application of solar electric technologies, starting first in the southeastern and northeastern United States. PNL also has responsibility for management of DOE's program to identify individual sites with wind characteristics most favorable for wind energy systems.

Geothermal

PNL studies related to expanded use of geothermal energy include work on the chemistry of geothermal fluids, an effort to reduce or prevent corrosion problems and improve powerplant efficiency. Removal of hydrogen sulfide from geothermal steam and disposal of waste fluids from powerplants are other subjects of investigation, along with research on possible toxic effects of pollutants from geothermal sites and work leading toward operational standards to protect the environment. Staff members are also engaged in economic analyses of geothermal development and an assessment of low temperature resources in the State of Washington.

Conservation

Study of biological effects of high-strength (1200-kilovolts) electric fields on small animals helps explore potential problems related to highvoltage transmission systems and equipment.

Magnetic Fusion

A research program in support of magnetic fusion development is in place. Included are studies of candidate materials, and the safety and environmental implications of the fusion concept. The fission-fusion hybrid reactor is another advanced concept of the continuing study and is the subject of scientific exchange with the Soviet Union.

PROGRAM FUNDING

Fiscal 1978 funding of Government research and support activities at PNL under the operating contract with DOE will total more than \$100 million. This amount includes current authorized funding for DOE divisional programs and for services related to the prime operating contract and work for other contractors, plus future 1978 additional program authorizations.

In addition to this support of DOE programs, Battelle is conducting research and development programs for private and government sponsors

that will total an estimated \$12 million during the present fiscal year.

Fiscal 1978 authorized DOE funding included research and development activities for all programs:

Program	FY 1978 Operations (In Millions)
Fossil Energy	\$ 1.5
Solar Energy	4.7
Geothermal Energy	1.4
Magnetic Fusion	0.4
Basic energy Sciences	3.5
Conservation	2.7
Nuclear Energy Development	39.3
National Security	3.4
Environmental Research	18.1
Biomass	0.6
Policy Management	1.0
Total DOE Financial Plan	\$76.6
Other DOE Sites and Contractors	20.3
Total	\$96.9

DOE-administered authorized facilities and equipment at PNL are valued at \$60.7 million; Battelle's private developments represent an investment of about \$25 million (currently valued at more than \$40 million).

MAJOR FACILITIES

Government-owned space assigned to Battelle (69 buildings) totals about 500,000 square feet. Battelle-owned facilities in Richland provide 382,000 square feet; the Marine Research Laboratory at Sequim Bay on the Washington coast includes 14,000 square feet of space. Some PNL personnel are also housed in rented facilities that provide 159,870 square feet of office space.

Major PNL facilities include:

- o Two major life sciences laboratories, providing stringent environmental controls for laboratory investigations in experimental and clinical pathology, inhalation toxicology, microbiology and virology, biometrics, and pharmacology.
- o Aquatic laboratory facilities for studies of marine and freshwater ecosystems, and mobile aquatic labs for on-site investigations.

- o An extensive meteorological tower-grid system and extensive atmospheric sampling equipment, and two twin-engine aircraft equipped for sensitive trace-element release and atmospheric sampling instrumentation.
- o A laboratory for criticality experiments.
- o High-level radiochemistry laboratories.
- o Ultra-sensitive radiation counting facilities.
- o High-rate sputtering equipment.
- o Electropolishing decontamination facilities.
- o High-voltage electric field exposure facilities.
- o Micro-machining equipment.
- o PNL has access to extensive boiler and electrical switching facilities, pumping equipment, and large outdoor water basins equipped with wave-generating equipment in shutdown reactor facilities.
- o PNL also manages and conducts research on the Hanford National Environmental Research Park which includes the PNL-managed Arid Lands Ecology (ALE) reserve, a 120-square-mile site dedicated to basic ecological research.

SIGNIFICANT ACCOMPLISHMENTS

- o Compilation of the Technical Alternatives Document and related documents providing a thorough assessment of avenues available for managing high-level nuclear wastes.
- o Development of high-rate sputtering processes for flexible, automated fabrication of special materials.
- o Foremost DOE research laboratory on the biomedical effects of radioactive materials, including plutonium.
- o Nuclear criticality data to support design of production facilities and the LMFBR program through experiments in the Critical Mass Laboratory.
- o The Plutonium Utilization Program, the technical basis for potential commercial use of mixed oxide fuels.
- o Significant advances in acoustic emission technology and holography for nondestructive testing and inspection.

PERSONNEL

Total employment at Sandia in September 1978 was 7,478, including 3,971 engaged in technical work. Geographic distribution was 6,356 in Albuquerque, 1,008 in Livermore, and 114 in other locations.

The distribution of degrees among professional staff was as follows:

<u>Professional Staff</u>	<u>Ph.D</u>	<u>Masters</u>	<u>Bachelors</u>	<u>Total</u>
Technical	782	765	643	2,190
Other	31	259	660	950

An interchange between the laboratories and universities is achieved through visiting professors, adjunct professorships, and joint appointment programs. Continuing education of the laboratories' staff is achieved through the Doctoral-Support, One-Year-On-Campus, and Tuition-Refund Programs, and by noncredit in-house courses.

CURRENT MISSION AND PROGRAM ACTIVITIES

Defense Programs

Approximately 75 percent of Sandia's activities are defense programs for the Department of Energy (DOE). The primary missions are: to conduct research and exploratory development; to provide military options; and to design, develop, and assure the lifetime performance of the systems that, together with LASL or LLL nuclear explosives, will support United States national security policies and requirements.

Sandia has the lead role in design of electrical system safing; arming, fuzing, and firing systems; neutron generators; weapon cases; security, command and control devices; and new delivery concepts.

Advanced Development activities include exploration of new concepts and technologies that can improve effectiveness, utility, safety, survivability, control, and security of nuclear weapons. These activities are supported by research and long range development in materials, components, analytical, facility, and instrumentation technologies.

Production and surveillance activities encompass the remainder of the life cycle of a nuclear weapon following completion of its development. Sandia performs product engineering to prepare for production of new weapons, conducts stockpile Quality Evaluation programs, monitors stockpile quality, resolves field problems as they arise, supplies weapon modification material when required, and generates engineering instructions for weapon retirement.

EXECUTIVE SUMMARY

Sandia Laboratories

LOCATION: Albuquerque, New Mexico, and Livermore, California

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$336.2 million
STAFFING:	7,498
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$398.0 million
NUMBER OF ACRES:	2,990
NUMBER OF BUILDINGS:	362
FLOOR SPACE:	2.9 million sq. ft.

OPERATING CONTRACTOR:

Western Electric Company

RESPONSIBLE OPERATIONS OFFICE:

Albuquerque

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

- Defense Programs (74%)
- Energy Technology (12%)
- Conservation and Solar Applications (2%)
- Environment (2%)
- Energy Research (2%)
- Resource Applications (2%)
- Work for Others
 - DOD (7%)
 - NRC (4%)
 - Other (1%)

MAJOR FACILITIES:^{2/}

5 Megawatt Solar Central Power Test Facility
Annular Core Pulsed Reactor

^{1/} Percentages reflect total staff (full-time equivalent) dedicated to that activity including indirect.

^{2/} Major construction line items only; \$5 million or more.

SANDIA LABORATORIES

Albuquerque, New Mexico; Livermore, California; Tonopah, Nevada

INTRODUCTION

The forerunner of Sandia Laboratories was Los Alamos Scientific Laboratory's (LASL) Z Division which was moved to Albuquerque in the fall of 1945 to assemble a nuclear weapon stockpile and to develop new weapons. Named Sandia Laboratory (SL) in 1948, the laboratory was operated by the University of California until 1949 when, at the request of President Truman, the Bell System assumed direction and the contract was taken over by the Western Electric Company. Western Electric has continued to operate Sandia on a no-profit, no-fee basis since that time, under a contract that has been renewed at 5-year intervals. In 1956, Sandia established a laboratory at Livermore, California, to support the second nuclear laboratory, now called Lawrence Livermore Laboratory (LLL). Under the U.S. Energy Research and Development Administration (ERDA), Sandia was designated a multiprogram national laboratory.

Sandia's original mission included both development and manufacturing functions. Rapid evolution of nuclear technology and concurrent urgency to establish a nuclear stockpile soon led to the creation of a complex of industry-operated production facilities to which the manufacturing was transferred. Sandia's central mission thus became, as it remains, development of the non-nuclear portions of nuclear weapons.

Sandia has a project-centered management system, designed to meet performance, schedule, and cost requirements. In fulfilling its weapon development obligations, Sandia has evolved into an engineering laboratory possessing comprehensive technical capabilities and facilities and with a management structure experienced in directing large long-term research and development programs.

A few years ago Sandia, recognizing an inherent match of its technical capabilities to energy problems of national importance, applied its attributes and experience to the needs for new energy technology. Sandia is now responsible for major programs in fossil, solar, inertial confinement fusion, and fission energy. In addition, the Nuclear Regulatory Commission is sponsoring major projects in advanced reactor research and nuclear fuel cycle safety. On a smaller scale, Sandia is also conducting energy programs in geothermal, magnetic fusion, environment, conservation, and basic energy sciences.

For monitoring limited and comprehensive nuclear test ban treaties, Sandia is developing seismic installations to detect and locate subsurface bursts, and satellite-borne instrumentation to detect and locate bursts in the atmosphere and in space. The latter will also provide near real-time information in case of war.

Since the early 1970's, Sandia has functioned as a technical lead laboratory in developing and implementing safe and secure transportation systems and secure manufacturing and storage facilities for nuclear weapons. Nuclear materials security and safeguards are also addressed under a broad program to develop and demonstrate improved physical protection technology for application to nuclear facilities.

Sandia is responsible for technical direction of a DOE Particle Beam fusion program entailing: research, development, and evaluation of particle-beam accelerators; research on particle beam interactions with matter and implosion physics of targets; system studies to evaluate civilian and military applications; and application of the technology to simulation of nuclear weapon effects.

Energy Programs

Energy technology development is focused primarily on solar, fossil, and nuclear energy. Activities include the following:

o Fossil Energy

Coal: in situ gasification, liquefaction, coal combustion, diagnostic techniques for open-cycle gas turbine systems.

Oil: enhanced recovery, shale oil production, drilling, offshore technology.

Gas: enhanced recovery, gas from oil shale.

Multisector: combustion research and technology.

o Solar Energy - central power applications and central receiver technology, dispersed (on-site) solar power systems, irrigation, environmental studies, resource measurements, photovoltaics, vertical axis wind turbine, energy storage.

o Geothermal Energy - drilling technology, and logging instrumentation and tool development.

o Magnetic Fusion - materials, plasma-surface effects, atomic physics.

o Fission Energy - spent fuel shipping cask, light water reactor safety, space applications, beneficial use of radioactive waste.

o Nuclear Waste Management - Waste Isolation Pilot Plant, Terminal Waste Storage Program.

PROTO II Electron Beam Accelerator at Sandia Laboratories subjects BB-size fuel pellets to power pulses of 8 trillion watts. PROTO II is one of a succession of increasingly powerful accelerators being developed in our Inertial Confinement Fusion Program.

- o Environment - radioactive waste disposal in deep ocean floor, transportation of nuclear materials, environmental policy analysis, atmospheric pollution.
- o Energy Research - Combustion Research Facility, combustion diagnostics research, fundamental combustion processes, geosciences, materials science, heavy ion nuclear physics.
- o Nuclear Regulatory Commission - research to support safety assessment and licensing of nuclear facilities, standards development, nuclear material safety and safeguards.

PROGRAM FUNDING

The operating budget for fiscal 1978 was \$398.9 million; \$336.2 million of the funding came directly from DOE; and the remaining \$62.7 million was from other Federal agencies, primarily the Department of Defense and the Nuclear Regulatory Commission. The number of full-time employees at the end of 1978 was 7,478.

Activity	Operating Budget FY 78 (In Millions)
DOE	
Defense Programs	\$272.2
Energy Technology	52.4
Conservation and Solar Applications	3.5
Environment	5.0
Energy Research	2.4
Resource Applications	0.7
Total DOE	\$336.2
Other Federal Agencies	
Department of Defense	\$ 38.7
Nuclear Regulatory Commission	15.4
Other	8.6
Total Other Federal Agencies	\$ 62.7

The original cost of the investment in plant and equipment was \$398 million.

Photo sequence is typical of those taken by the Sandia Laboratories' personnel using tracking instrumentation at the Tonopah (Nevada) Test Range. Photos show deployment, descent, and impact of parachute-retarded laydown bombs.

Forest of mirrors face the 200-foot-high tower at the Department of Energy's Solar Thermal Test Facility at Sandia Laboratories. Each of the 222 heliostat arrays contain 25 four-foot-square mirrors. Solar receivers to be tested at the facility will be mounted atop the tower.

MAJOR FACILITIES

Because of specialized demands, most of Sandia's equipment and facilities were either designed or modified by the laboratories. Major facilities include:

- o Intense relativistic electron-beam accelerators used in nuclear weapon effects studies, pulsed fusion research, laser excitation, and acceleration of ions to ultrahigh energies.
- o Van de Graaff and Cockroft-Walton accelerators used in surface physics research and microelectronics development.
- o Pulse reactors used in radiation effects studies on weapon materials, components, and systems, and in breeder reactor safety studies.
- o A neodymium-glass laser used in advanced physics research.
- o Testing facilities to provide capabilities for environment and radiation simulation, aerodynamic and material characterization, non-destructive testing and quality-assurance evaluation, and field assessments of components, weapons, and delivery modes.
- o Scientific computation facilities including one CDC-7600, one CYBR-76, and four CDC-6600 computers, with batch processing and interactive graphics capabilities and an off-line computer output microfilm system.
- o Facilities dedicated to design, fabrication, and process development include computers to aid in design; a complete machine shop; a specialized glass-fabrication shop; a ceramics fabrication laboratory; and a combustion laboratory, including equipment for laser-based Raman spectroscopy.
- o A primary standards laboratory for measurement standards.
- o A laboratory for studying hybrid microcircuitry and semiconductor processing techniques.

The following new facilities have been approved for construction:

	Total Estimated Cost (In Millions)	Completion
E-Beam Fusion Facility	\$14.2	FY 79
Nuclear Safeguards and Security Laboratory	8.3	FY 79
Combustion Research Facility	9.4	FY 80

SIGNIFICANT ACCOMPLISHMENTS

- o Sandia's primary accomplishment is the existence of the national weapon stockpile, which contains weapons that are safe, reliable, long-lived, and operationally ready.
- o Making weapons fail-safe under accident conditions was achieved by developing electrical systems that will respond predictably in imprecisely defined accident environments.
- o Instrumentation was provided for an in situ coal gasification experiment in which pressure, temperature, and gas composition data were acquired. The feasibility of seismic, acoustic, and electrical techniques for remote process monitoring was demonstrated.
- o The Solar Central Power Test Facility, largest in the world, is in operation providing experimental support in the areas of receiver evaluation, heliostat evaluation, and control systems simulation.
- o Full-scale extreme transportation accidents involving shipping casks for spent reactor fuel elements have been performed as part of a program to evaluate and reduce the risk of transporting nuclear material.

EXECUTIVE SUMMARY

Savannah River Laboratory

LOCATION: Aiken, South Carolina

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$54.2 million
STAFFING:	968
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$90.4 million

OPERATING CONTRACTOR:

E. I. duPont de Nemours and Company

RESPONSIBLE OPERATIONS OFFICE:

Savannah River

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

- Special Materials and Waste Management (59%)
- Fuel Cycle R&D (18%)
- Weapons Activities (6%)
- Environmental Research and Development (8%)
- Uranium Resources (3%)
- Nuclear Research Applications (3%)
- Work for Others (3%)

MAJOR FACILITIES:

- 3 experimental reactors
- Heat Transfer Laboratory
- Reactor Hydraulics Test Facility
- Flowing Streams Laboratory
- Limnology Laboratory
- Weather Center Analysis Laboratory
- Isotopes Process Development Laboratory
- Carbon Test Facility
- Analytical Chemistry Laboratories

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

MAJOR FACILITIES (Continued):

Californium-252 Neutron Activation Analysis Facilities
Plutonium Experimental Facility
Alpha Materials Facility
Target Fabrication Facility
Californium Packaging Facility
Californium Medical Source Facility
Nuclear Fuel Fabrication Laboratory
Semiworks Laboratories for Testing of Plant Equipment and Processes
High Level Caves
Wind Tunnel Facility
Computing Center with IBM Systems S360/195 and S370/158 Coupled
Together

SAVANNAH RIVER LABORATORY

Aiken, South Carolina

INTRODUCTION

Savannah River Laboratory (SRL), established on the Savannah River site in 1951, provides developmental and technical assistance in all areas of the nuclear fuel cycle: uranium resource evaluation, fuel fabrication, isotope production, reactor physics and engineering, fuel reprocessing, waste management, environmental monitoring, and heavy water production. It is operated for the Department of Energy DOE by E. I. duPont de Nemours and Company.

PERSONNEL

SRL employs 968 persons, as follows:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	135	Engineers	114
M.S./M.A.	66	Life Scientists	25
B.S./B.A.	<u>154</u>	Mathematicians	26
		Physical Scientists	154
Total	355	Other	about <u>649</u>
		Total about	968

CURRENT MISSION AND PROGRAM ACTIVITIES

Separations Chemistry and Engineering

Laboratory development of chemical processing facilities has increased throughput in the chemical processes of the plant and has increased the flexibility of processes so that certain isotopes may be removed selectively from the irradiated fuels. The Savannah River Laboratory has also developed new chemical processing equipment and tested this equipment at intermediate and full plant scale.

Many research studies are now under way to monitor the effects of waste storage and to develop improved storage methods. Solid forms (for example, concrete and glass) are being developed for long-term storage of waste with high levels of radioactivity. The separation and solidification processes have been demonstrated with actual plant radioactive

waste. A parallel program is being undertaken for solid radioactive wastes.

The Savannah River Laboratory is coordinating a program to assist DOE in developing the information needed by industry to complete the nuclear fuel cycle. The primary objective of the Light Water Reactor (LWR) fuel cycle evaluation program is to provide the data needed to evaluate selected alternative systems for the disposition of spent nuclear fuel so that the utilization of nuclear power for energy production will result in obtaining its benefits while minimizing nuclear weapons proliferation.

Instrumental and Analytical Support

Advanced instrumental and analytical services have evolved in support of the research and development programs at Savannah River. Some of the analytical techniques used are: alpha, beta, and gamma ray spectrometry; infrared, ultraviolet, and laser-Raman spectroscopy; d.c. arc emission spectroscopy; inert gas fusion, thermal analysis; X-ray diffraction; X-ray fluorescence; spark source and thermal ionization mass spectrometry; neutron activation analysis; atomic absorption spectrophotometry; gas chromatography with mass spectrometer; X-ray photoelectron spectroscopy; scanning Auger microprobe analysis; and electron beam microprobe analysis. Ultra-trace quantities of such things as pollutants can be routinely determined, and on-line instrument systems can be designed for process control.

Reactor Engineering

At the heat transfer laboratory, mockups of reactor components are tested to ensure safe reactor operation. Full-scale simulated fuel elements are heated with 3000 kilowatts (kW) of electricity to simulate nuclear heating and are cooled with up to 1200 gallons per minute (gpm) of water. This laboratory allows more-realistic and exacting tests than heretofore possible.

In the reactor hydraulics test facility, the behavior of large quantities of steam injected into the reactor moderator at Savannah River reactor conditions can be studied.

The fabrication laboratory studies the mechanical, metallurgy, and metal-forming processes associated with fabricating fuel and target elements for Savannah River reactors. Powder metallurgy and casting techniques are now being developed to increase the uranium content in many reactor fuel assemblies.

During 25 years of experience in operating nuclear reactors, Savannah River has developed operational techniques and protective systems to ensure safe reactor operation. Reactor operation is governed by extensive administrative controls and by the use of on-line computers. Protective systems developed by Savannah River include a highly efficient and reliable filter system for the production reactors. These

filters contain activated carbon to remove radioactive particles from ventilation air exhausted from a reactor in the unlikely event of an accidental release of radioactivity. The design bases for these filters have been widely adopted by industry. Components in the filter system have been used as a guide in designing cleanup systems for commercial reactors.

Reactor Physics

An experimental physics laboratory houses three experimental reactors where fuel assemblies and reactor lattices may be evaluated. New reactor core designs are tested to ensure safe and predictable operation of the large production reactors. Investigations range from exploratory design tests to studies in full-scale reactor lattice mockups.

Nuclear Materials

Two associated research and development facilities support the production and encapsulation of plutonium-238 fuel forms for radioisotopic-thermal generators. At the plutonium experimental facility, full size plutonium-238 fuel forms for development purposes are being fabricated and encapsulated. At the alpha materials facility, plutonium-238 powder, shards, and pellets are characterized by particle size analysis, metallography, and scanning electron microscopy. Californium-252 is encapsulated in the californium packaging facility for sale to commercial encapsulators and for DOE's californium market evaluation program.

SRL also prepares Californium-252 neutron sources for medical evaluation and university loan programs. Cells and seed assemblies are prepared for interstitial (surgically implanted) use; applicator tubes for intracavitary (non-surgically implanted in cavities) use. These sources have been sent to 15 hospitals in the United States and Japan for dosimetry, radiobiology, and radiotherapy studies.

As part of the National Uranium Resource Evaluation (NURE) program to evaluate domestic uranium resources, the Savannah River Laboratory is conducting a hydrogeochemical and steam sediment reconnaissance of 1/5 million square miles in 37 eastern and western States. About 100,000 water and stream sediment samples per year are being analyzed at Savannah River by neutron activation analysis.

Environmental Sciences

To estimate the total population exposure from radioactive and nonradioactive releases to the atmosphere and water, a dose-to-man program was initiated at the Savannah River Laboratory. The objectives of this research program are to: (1) Identify key points in the dose-to-man pathway; (2) determine where applied research is needed; (3) improve and verify calculational models for routine and accidental releases; and (4) improve the emergency response capability of the site.

Environmental Transport

At the flowing streams laboratory, water from a natural stream is diverted to six experimental streams in a greenhouse. Temperature and other conditions of each stream can be varied to determine the biological effect on the environment of cooling water discharged from reactors.

The limnology laboratory is located on the banks of a man-made reservoir which receives thermal effluent from a production reactor. This laboratory is being expanded to provide an aquatic rearing facility and additional analytical instrumentation for limnological studies.

The weather center-analysis laboratory was established as part of the dose-to-man program begun in 1972 to develop, test, and apply comprehensive mathematical models to calculate the exposure to be expected from postulated releases of materials to the atmosphere.

The Wind Tunnel Facility is used to calibrate sensitive wind instruments and has the capability for some model studies of turbulent diffusion around buildings.

Savannah River is determining the suitability of different rock formations for storage of radioactive waste. Studies will determine geologic and hydrologic characteristics, earthquake hazards, and osmotic pressures.

Computer Applications

Computations systems developed at Savannah River are applicable to reactors other than production reactors. For example, at the request of Brookhaven National Laboratory, power distributions were calculated for the equilibrium core of the High Flux Beam Reactor. With Savannah River's calculation system, the isotopic content and the average few-group diffusion parameters can be calculated at various times during core lifetime; these are used to calculate the flux and power density of the fuel rods in the core at beginning, middle, and end of the life of the core.

The JOSHUA System has been used for reactor charge design and to determine reactor behavior during abnormal conditions assumed to occur at the same time that the automatic shutdown systems in the reactors are inoperative.

PROGRAM FUNDING

		FY 1978
		Operating Funds
		(In Millions)
DOE		\$54.2
Other		2.0
Total		\$56.2

Investment in plant and equipment is \$90.4 million.

MAJOR FACILITIES

Facilities for research and development at Savannah River range from numerous well-equipped laboratories to semiworks-scale plants and include many shielded facilities designed for work with radioactive materials. Among these research facilities are zero-power test reactors, a heat transfer laboratory with 3 megawatts (MW) of electrical power, a hydraulics test facility with 8 MW of steam supply, a limnology laboratory, a flowing streams laboratory, a weather center-analysis laboratory, activation analysis facilities, facilities for handling both small and large amounts of radioactive material, a computer center, analytical chemistry laboratories, and semiworks laboratories for small, intermediate, and full-scale testing of plant equipment and processes.

SIGNIFICANT ACCOMPLISHMENTS

- o The work of the laboratory has increased production in the plant facilities well beyond their original design capacities. Safety in plant operations has improved significantly, and the environmental effects of the operations have been reduced.
- o Savannah River reactors have produced many different isotopes, including tritium, plutonium-239, plutonium-238, californium-252, uranium-233, curium-244, polonium-210, and cobalt-60 of high specific activity.
- o A significant step in the field of reactor technology was taken in 1965, when one of the Savannah River reactors achieved the highest sustained neutron flux ever attained: 6.1×10^{15} neutrons per square centimeter per second, more than 100 times the flux in most nuclear power reactors.
- o Metallurgical fabrication studies have resulted in more efficient fuel elements which can be irradiated for longer periods at higher temperature to increase the yield of nuclear products. Research in the metallurgy and crystal structure of uranium has improved the predictability of fuel element behavior in a nuclear reactor.
- o A modular, data-based, scientific, computational system (called the JOSHUA System) was designed to perform the extensive reactor physics and engineering calculations necessary to ensure safe and efficient reactor operation. It has also been used to simulate and forecast plant operations, to calculate financial information, and to predict the movement of radioactive and nonradioactive materials in the environment.

ENERGY TECHNOLOGY ENGINEERING CENTER

Canoga Park, California

INTRODUCTION

The Energy Technology Engineering Center (ETEC) is located in the Santa Susana Mountains approximately 40 miles northwest of the Los Angeles International Airport. ETEC is operated for the Department of Energy (DOE) by the Energy Systems Group of Rockwell International.

ETEC was established in 1966 as a government-owned, contractor-operated laboratory to provide facilities and engineering services for developers of the Liquid Metal Fast Breeder Reactor (LMFBR). ETEC has conducted non-nuclear sodium proof-testing of heat exchangers, steam generators, pumps, valves and control instrumentation for major reactor component manufacturers.

Recently, ETEC's work scope has been expanded to provide engineering, testing and consultation services for all DOE program areas. Formerly known as the Liquid Metal Engineering Center (LMEC), the facility was renamed ETEC in May of 1978 to better reflect the expanded scope of activities.

New management and engineering tasks have been initiated by ETEC in the fields of magnetohydrodynamics (MHD), solar central powerplants, solar demonstration programs, thermonuclear fusion, and Ocean Thermal Energy Conversion (OTEC). ETEC is also providing technical support to the U.S. Nuclear Regulatory Commission (NRC). Meanwhile, ETEC continues to serve as a component testing center, linking design with experience and providing a reputable source of engineering counsel in liquid metal technology.

PERSONNEL

The ETEC staff includes:

Highest Degree Attained	Number
Ph.D.	4
M.S./M.A.	51
B.S./B.A.	<u>109</u>
Total	164

Occupation	Number
Engineers	144
Physicists	5
Chemists	5
Other	<u>10</u>
Total	164

In addition, personnel from the Energy Systems Group of Rockwell International are available to support ETEC programs as needed.

CURRENT MISSION AND PROGRAM ACTIVITIES

The ETEC operates as an extension of DOE in providing contractors with a testing facility comparable to national laboratories, where component designs can be tested and engineering counsel obtained. The center's primary purpose has been to aid the LMFBR Program in developing an industry capability for the production of reliable and economic power from fast-breeder reactor systems. This mission is carried out by:

- o Constructing, operating, maintaining and modifying of facilities to test and evaluate liquid-metal components.
- o Providing training for industrial personnel in liquid-metal systems and component technology.
- o Providing engineering consultation and technical contract management for DOE and its contractors.
- o Preparing LMFBR-oriented standards, reviewing standards prepared by others, and developing a quality assurance program in accordance with DOE policy.

The following major programs are underway:

- o Testing of breeder reactor prototype valves, pumps, in-vessel handling machine instrumentation and materials.
- o Thermal shock testing and sodium-water reaction testing.
- o Piping snubber design for Nuclear Regulatory Commission (NRC).
- o Solar central powerplant component design.
- o Technical management and monitoring of DOE-sponsored solar demonstration programs.
- o Systems study on lithium cooling of laser fusion reactors.
- o Test Director responsibilities for initial Ocean Thermal Energy Conversion (OTEC) program.
- o Technical assistance for organization and startup of magneto-hydrodynamics (MHD) facility.

General ETEC Capabilities

- o Technical Project Management
- o Facility and Process Design
- o Construction Management
- o Plant Startup and Operational Expertise
- o System/Component Development and Testing
- o Quality Assurance in All Project Phases

Unique Onsite ETEC Capabilities

- o Large component testing, handling and cleaning facilities.
- o Test data acquisition, reduction, analysis, and evaluation.
- o Technical expertise in sodium loop chemistry, materials compatibility in sodium, precision mechanisms in sodium, thermal/mechanical stress analyses, heat transfer analyses, and sodium loop operator training.
- o Direct design services for test components, test facilities and instrumentation systems, and/or modification and service of any of the above.

These attributes are also applicable to forms of technology other than liquid metal engineering. This is demonstrated by ETEC's Thermal Transient Facility (TTF) which uses a computer-controlled nitrogen gas system to perform non-sodium thermal transient testing in conjunction with a hydraulically controlled mechanical stressing structure.

PROGRAM FUNDING

ETEC's fiscal 1978 operating budget was \$21 million, all of which was provided by DOE. The authorized investment in plant and capital equipment was \$63.5 million in 1978. The bulk of operating funds are in support of the LMFBR program.

FACILITIES

Principal component test facilities available or under construction at the center include the following:

70 Megawatt Ton Sodium Components Test Installation (SCTI)
 Sodium Pump Test Facility (SPTF)
 Small Components Test Loop (SCTL)
 Component Handling and Cleaning Facility (CHCF)
 Thermal Transient Facility (TTF)
 Large Leak Test Rig (LLTR)
 Static Sodium Test Facilities (Bldg. 032 & 057)
 Hydraulic Test Facility (HTF)

SIGNIFICANT ACCOMPLISHMENTS

- o Testing of the HEDL-II cold trap and 6-inch ETEC drag valve was completed in the SCTL. The AI Subscale Inducer Pump was installed and sodium testing was initiated. Testing of a 14-inch ETEC gate valve was initiated and will continue in conjunction with testing of the Inducer Pump.
- o Construction of the 70 Megawatt Ton SCTI sodium systems was completed and sodium inventory requirements were fulfilled. Acceptance testing of the sodium systems, including purification of the sodium inventory, was initiated.
- o Series I testing was completed in the Large Leak Test Rig. Five large sodium-water reaction tests and one non-reactive test using high pressure nitrogen were successfully accomplished. The MSG test article was cleaned in place using a circulating alcohol system and destructive examination procedures were implemented to evaluate the consequences of the leak test program.
- o Testing of the 6-inch AI pipe clamp was initiated in the Thermal Transient Facility and buildup of hardware for the Transition Joint Life Test was on schedule for start of testing early in November 1978.
- o First phase testing of an Advance Cold Trap (ACT) was completed in the SPTF. Facility modifications and preparations were on schedule to support the start of testing of the Intermediate Sized Inducer Pump early in calendar year 1979.
- o Completed testing of an approximate 1/10 scale heat pipe in support of the Fast Flux Test Facility (FFTF) fuel storage facility.
- o Completed water testing of 8-inch and 10-inch pressure reducing devices in support of SPTF high flow loop.
- o Continued with sodium leak testing and instrumentation testing in support of FFTF and general sodium technology.

- o The AI Advanced Pump was tested in water in HTF and sodium was in SCTL. Following component modification, testing in SCTL will continue.

PROGRAM-DEDICATED

FACILITIES

PROGRAM-DEDICATED FACILITIES

The program-dedicated laboratories are listed below by program:

Biomedical and Environmental Facilities

Center for Energy and Environment Research
 Comparative Animal Research Laboratory
 Environmental Measurements Laboratory
 Inhalation Toxicology Research Institute
 Laboratory for Energy-Related Health Research
 Laboratory of Nuclear Medicine and Radiation Biology
 Laboratory of Radiobiology (University of California, San Francisco)
 Michigan State University (MSU)-DOE Plant Research Laboratory
 Oak Ridge Associated Universities
 Radiobiology Laboratory (University of Utah, Salt Lake City)
 Savannah River Ecology Laboratory
 The Franklin McLean Memorial Research Institute
 University of Rochester Biomedical Laboratory

Safeguards Facilities

New Brunswick Laboratory

Fossil Energy Facilities

Bartlesville Energy Technology Center
 Grand Forks Energy Technology Center
 Laramie Energy Technology Center
 Morgantown Energy Technology Center
 Pittsburgh Energy Technology Center
 Carbondale Mining Operations Center
 Pittsburgh Mining Operations Center

Fusion Facility

Princeton Plasma Physics Laboratory

Nuclear Development Facilities

Bettis Atomic Power Laboratory
 Knolls Atomic Power Laboratory

Physical Research Facilities

Bates Linear Accelerator Facility
 Fermi National Accelerator Laboratory
 Notre Dame Radiation Laboratory
 Stanford Linear Accelerator Center

Solar Facilities

Solar Energy Research Institute
Regional Solar Energy Centers

BIOMEDICAL AND ENVIRONMENTAL
FACILITIES

BIOMEDICAL AND ENVIRONMENTAL FACILITIES

The Department of Energy (DOE), through its environmental, health and safety program, uses the expertise of 13 specialized laboratories in assessing the most serious problems and issues concerning environmental, health and safety hazards associated with energy technologies such as nuclear radiation, toxic, mutagenic and carcinogenic substances, and the destruction of wilderness and recreation areas. Activities at these laboratories are focused on research to ascertain which potential environmental, health and safety impacts of energy technology development may need to be controlled and whether there are limitations on the development or siting of these technologies which may inhibit commercialization. The specialized biomedical laboratories, each of which has its own unique attributes for carrying out a specific type of research or activity, complement the expertise and programs carried out by the multiprogram laboratories.

Staff located in DOE headquarters formulates and administers the programs, including the allocation of funds for the specialized laboratories. An operations office in the area carries out contract administration and appraisal, management overview, fiscal reviews, and may participate in DOE headquarters-directed site visits and program reviews. Management of these laboratories is carried out by experienced administrators who, in their own right, have strong backgrounds in performing laboratory studies of a very high quality. Experiments and research designs are formulated by laboratory management with collaboration by their scientific staffs to be responsive to program guidance given by DOE headquarters. This guidance is provided by documentation of issues and requirements that can best be implemented through the special expertise and facilities at each laboratory. Final decisions on program emphasis, balance, and levels of effort are made at DOE headquarters.

With the exception of the Environmental Measurements Laboratory, New York City, which is staffed by DOE employees, most of these laboratories are operated by, and closely affiliated with, a major university, nonprofit research foundation, or university associations. Thus, these government-owned facilities benefit greatly from association with institutions and research programs in related fields. As part of their research programs, many of these laboratories employ and train graduate students attending associated universities.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

San Juan, Puerto Rico

INTRODUCTION

The Center for Energy and Environment Research (CEER) is operated for the Department of Energy by the University of Puerto Rico. CEER's principal objectives are to: serve as the focal point for energy research in Puerto Rico to help the Island achieve energy independence while contributing to DOE's effort to enable the entire nation to achieve the same goal; to help Puerto Rico develop the scientific engineering and other trained personnel needed for the future in the energy, environmental and related fields; continue research and training programs in environmental sciences and technologies; and serve as a center for international cooperation in the energy and environmental fields, particularly for scientists and technicians from tropical and subtropical areas, especially in the Caribbean and Latin America.

The Center for Energy and Environmental Research, formerly known as the Puerto Rico Nuclear Center, was renamed on July 1, 1976, following program reorientation toward energy research. CEER's research is aimed at developing alternative sources of energy for Puerto Rico through use of its most abundant natural resources which are the sun, the wind and the sea.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D. or M.D.	36	Engineers	24
M.S./M.A.	52	Physical Scientists	24
B.S./B.A.	54	Life Scientists	94
Others	<u>60</u>	Other	<u>60</u>
Total	202	Total	202

CURRENT MISSION AND PROGRAM ACTIVITIES

As an operating unit of the vast University of Puerto Rico (UPR) system, CEER is attached to the Office of the President and works with all campuses and subdivisions of the UPR system; other universities, government agencies and institutions in the United States and other countries.

In the environmental field, the center has Divisions of Terrestrial, Marine and Human Ecology. In the field of energy research, the center's programs include solar technology, conservation, materials, fossil fuels, ocean thermal energy conversion (OTEC) and terrestrial and marine biomass and bioconversion technologies.

Among some 40 individual projects, many interrelated, are these: a joint project with the Puerto Rico Energy Office and the Puerto Rico Water Resources Authority to design a 5 to 20 megawatt sea solar plant to prove the feasibility of OTEC, with an associated research laboratory and mariculture project; a project to design, install, operate and test a concentrating photovoltaic solar electric system to air-condition and light the CEER headquarters building in the San Juan Medical Center; and a project using a unique concentrating solar collector to produce steam for industrial processes in collaboration with the Bacardi Corporation, Puerto Rico's largest rum producer, and the University of Chicago. If successful, this system can be adapted to the needs of many other industries in Puerto Rico, such as the pharmaceutical industry, as well as industries in other countries.

PROGRAM FUNDING

In fiscal year 1978, CEER's operating budget was approximately \$2,632,000 for research conducted for the Department of Energy. In addition, approximately \$493,000 was spent in research for others. Authorized equipment and facilities represent an investment of about \$10,945,970.

MAJOR FACILITIES

CEER occupies a total of approximately 241 acres, with facilities at four separate sites in the island. Its headquarters is in Rio Piedras with offices and well-equipped laboratories located in a building adjacent to the UPR School of Medicine. On the west coast of Puerto Rico, CEER has a major well-equipped research laboratory and associated nuclear engineering training facilities on a site adjacent to the UPR, Mayaguez campus. The marine biology research laboratories and sea water aquarium laboratory is located some 5 miles south of Mayaguez in the vicinity of Punta Guanajibo. CEER terrestrial ecology laboratories are located in the Loquillo rain forest in the northeastern part of the island.

SIGNIFICANT ACCOMPLISHMENTS

- o In cooperation with Argonne National Laboratory, significant progress was made in the establishment of a deep water Ocean

Thermal Energy Conversion (OTEC) station in the deep water trench immediately off the north coast of Puerto Rico (Punta Tuna).

COMPARATIVE ANIMAL RESEARCH LABORATORY

Oak Ridge, Tennessee

INTRODUCTION

The Comparative Animal Research Laboratory (CARL), operated for the Department of Energy (DOE) by the University of Tennessee, occupies approximately 2,000 acres of agriculturally-improved land on DOE property in Oak Ridge, Tennessee, about 20 miles northwest of Knoxville. CARL is located on the same government-owned tract of land which includes the Oak Ridge National Laboratory and other major DOE research and production facilities.

CARL grew out of a 1948 joint venture of the University of Tennessee (UT) and the Atomic Energy Commission (AEC). This program, which was designed to study the long-term effects of irradiation from the first atomic tests, soon led to the formal establishment of the UT-AEC Agricultural Research laboratory, where radioisotope uptake and transport in man's food chain and acute chronic effects of toxic agents were studied.

In 1973, the laboratory assumed its present name, and began a redirection of its research program. This redirection resulted in a de-emphasis of nuclear radiation work, and increased concentration on the comparative aspects of toxicological studies involving all kinds of energy-related pollutants.

PERSONNEL

Highest Degree Attained	Number
Ph.D./M.D./D.V.M.	19
M.S./M.A.	11
B.S./B.A.	<u>12</u>
Total	42

Occupation	Number
Life Scientists	17
Physical Scientists	2
Engineers	1
Other Professionals	9
Technicians	34
Others	<u>23</u>
Total	86

CURRENT MISSION AND PROGRAM ACTIVITIES

Research activities at CARL fall naturally into two categories: plant research and comparative toxicological research.

CARL plant scientists continue their studies of the effects of toxic materials on plants, but have shifted from ionizing radiation to energy-related pollutants. Efforts are underway to understand the mechanism of pollutant effects (e.g., sulfur dioxide effects on photosynthesis), to assess the feasibility of developing plant strains which are resistant to pollutants, to develop higher plant systems to monitor for phytotoxins and mutagens, to better understand the regulation of amino acid biosynthesis and accumulation, and to improve protein quantity and quality in seeds.

The animal toxicology programs are directed toward evaluating the mutagenic risk to man from toxic agents by studying these effects in the long-lived mammal, and studying the effects of chemical carcinogens in large domestic animals. Another part of this program is a continuation of the life span studies of irradiated burros; only some 45 burros remain, all beyond 25 years of age. In 1973, a new program was initiated on transport kinetic interactions between heavy metals and essential nutrients, metals and metabolites. This sizable program, currently centered on cadmium interactions with calcium, iron, copper and zinc, is investigating transport at the membrane, tissue, organ and whole animal levels. Since human data for metabolism of toxic agents were not available, data on interspecies comparisons is being completed. Initial studies with nuclear industry contaminants showed a complicated species variation, and a new program to develop whole body pollutant transport models for a variety of animal species was initiated. Modeling of radionuclides has been phased out, and studies of heavy metals have been initiated.

PROGRAM FUNDING

In fiscal year 1978, CARL's operating budget was approximately \$1.7 million for research conducted for DOE. In addition, approximately \$0.1 million was budgeted for research conducted for other federal agencies (e.g., the Environmental Protection Agency). Authorized equipment and facilities represent an investment of about \$6.3 million.

MAJOR FACILITIES

CARL has extensive and varied physical resources which permit performance of a wide range of research projects, including many which offer distinct advantages for evaluating the risk to man and his environment from toxic materials. The primary importance of these facilities is that they allow CARL scientists to work with reproducing herds of large animals as well as numerous species of smaller animals. CARL is unique in its capacity to handle almost any kind of animal, from birth to death, in sufficient numbers to permit accurate scientific studies. Facilities, some of them unique, include: a large central laboratory and office building; an ancillary laboratory facility; large animal and laboratory animal metabolism facilities; a "hot" laboratory which

permits experiments on small animals using radioisotopes and other extremely toxic materials; a multiple-source, low dose-rate irradiation facility; a multiple-source, variable dose-rate irradiation facility; surgery and autopsy facilities for both large and small animals; an isolation (hospital) barn for large animals; rodent breeding facility; large, fully equipped feed mill; greenhouses and field plots; a specific-pathogen-free (SPF) swine rearing facility; barns; maintenance shops; and approximately 2,000 acres of improved farmland and pastures.

SIGNIFICANT ACCOMPLISHMENTS

- o The reorientation program begun in 1973 is now essentially complete; the emphasis of CARL's research programs has now been successfully shifted from somatic effects of radiation and radiobiology to a focus on the toxicology of chemical materials and environmental pollutants in comparative studies of various large and small animal species.
- o A cadmium-binding protein (CdBP) with properties similar to those of adult metallothionein was discovered in the livers of fetal rats; the fetal and maternal CdBP showed similar characteristics. Cadmium taken up by the fetus could be bound to tissues by the newly discovered CdBP, thus affecting nutritional balances.
- o Absorption studies in rats have shown that cadmium is more readily taken up and transferred in iron-deficient animals, and that this effect is greater in females than in males. This discovery could have significant ramifications for human females, many of whom are iron deficient.
- o Recently developed techniques have permitted the identification of the spermatogenic stem cell, an observation that stem cell response to toxicants varies widely between the mouse and rat. This discrepancy indicates that the stem cell of the mouse is more mitotically active than that of the rat, and implies that the mouse is thus more vulnerable to mutational and lethal effects of toxicants. If this is the case, then the response of other species--including humans--to toxicants may also be different from that previously assumed in the literature.
- o Studies on gastrointestinal absorption of biologically incorporated plutonium by mice show that such absorption is approximately an order of magnitude less than when an equivalent dose (in citrate form) is given by gavage. Thus, it appears that plutonium absorption from contaminated foods would be less serious than had previously been assumed.

ENVIRONMENTAL MEASUREMENTS LABORATORY

New York, New York

INTRODUCTION

The Environmental Measurements Laboratory (EML) is located in downtown Manhattan. Unlike most Department of Energy (DOE)-operated laboratories, the staff members are government employees attached to DOE headquarters. The EML mission is largely research and development in the field of environmental contamination from energy-related sources. Programmatic guidance and funding come from the Office of Health and Environmental Research of DOE.

The EML program has been evolving since 1947 and has developed competence in radiation studies, aerosol physics, analytical chemistry, and instrumentation.

PERSONNEL

Highest Degree Attained	Number
Ph.D.	7
M.S.	17
B.S./B.A.	<u>29</u>
Total	53

Occupation	Number
Physical Scientists	46
Engineers	10
Mathematicians	1
Technicians	22
Others	<u>25</u>
Total	104

CURRENT MISSION AND PROGRAM ACTIVITIES

The laboratory goal is to evaluate the exposure of man to environmental radiation, radioactivity, and other toxic materials. This includes the establishment of background levels and global baselines as well as the estimation of manmade contributions. The mission is accomplished by in situ measurements or by the collection and analysis of samples from global networks and selected regional sites. EML develops and improves techniques for studying pathways of contaminants from source to man and applies new technological developments to the detection and analysis of ionizing radiation, trace metals, and other pollutants.

PROGRAM FUNDING

<u>Programs</u>	<u>FY 78 Operating Funds (in Millions)</u>
Identification, transport and conversion of energy-related pollutants in the environment	\$1.9
Energy-related supporting research	0.1
Environmental operations and DOE support activities	1.2
Characterization, measurement, and monitoring	2.0
Remedial action (former Atomic Energy Commission Contractors)	< 0.1
Total DOE	\$5.2

Authorized investment in plant and capital equipment is \$2.1 million.

MAJOR FACILITIES

Part of EML's plant and capital equipment investment represents ordinary laboratory facilities, while the rest is devoted to specialized equipment for measuring pollutants from nuclear and non-nuclear sources, measuring aerosols, and developing experimental equipment and instruments.

SIGNIFICANT ACCOMPLISHMENTS

- o Basic industrial hygiene studies of airborne materials that were originally used to establish standards for exposure to beryllium and uranium and are now being applied to other materials.
- o Establishment of background levels for a number of radioactive materials and trace metals in the environment and in man.
- o Overall evaluation of weapons test fallout up to the estimation of dose to man.

- o Application of earlier comprehensive cosmic and terrestrial radiation studies to evaluating environmental conditions near nuclear facilities.
- o Contribution to the development and maintenance standards and quality control procedures for improving environmental measurements.

INHALATION TOXICOLOGY RESEARCH INSTITUTE

Albuquerque, New Mexico

INTRODUCTION

The Inhalation Toxicology Research Institute (ITRI), operated by the Lovelace Biomedical and Environmental Research Institute, is located on Kirtland Air Force Base East at Albuquerque. ITRI benefits from its close proximity to Sandia Laboratories, also on Kirtland AFB; the University of New Mexico; and Los Alamos Scientific Laboratory, 95 miles north of Albuquerque.

Research began in 1960 on potential human health effects associated with the inhalation of fission product radionuclides. Since then, the institute's mission has broadened to include concern for the health effects of airborne noxious particles and gases, particularly those materials that might be produced in meeting man's energy needs.

Information resulting from ITRI research contributes to cost/benefits assessments for alternative energy sources in two important areas: estimation of adverse health effects and thus potential health costs, and definition of toxic substances and costs associated with necessary control technology. In addition, such information represents an essential input for the establishment of reasonable protective standards for industrial operations and the public at large. To date, ITRI research results have been used extensively in evaluating health risks associated with nuclear power production involving the light water reactor fuel cycle and the health risk of fluidized bed combustion of coal as compared to conventional combustion.

PERSONNEL

The ITRI staff includes the following:

Highest Degree Attained	Number
Ph.D., D.V.M. or M.D.	52
M.S.	18
B.S or B.A.	<u>43</u>
Total	113

Occupation	Number
Life Scientists	45
Biophysical Scientists	16
Physical Scientists	16
Engineers	5
Technicians	76
Others	<u>64</u>
Total	222

CURRENT MISSION AND PROGRAM ACTIVITIES

The ITRI research program is concerned with defining the nature and magnitude of adverse health and environmental effects associated with various energy production technologies. The general approach consists of:

- o Field definition and characterization of energy-related airborne materials which man might inhale either at the work place or from the general environment.
- o Laboratory generation and characterization of airborne toxicants associated with specific energy technologies as defined in field characterization studies.
- o Definition of dose to critical tissues in several animal species following inhalation of laboratory-generated aerosols.
- o Establishment of dose-response-time relationships for inhaled toxicants in representative mammalian species.
- o Studies which focus on the sequential alterations in biological function or structure resulting in specific diseases.
- o Development of therapeutic procedures which might be used in the event of human accidental exposure.

Research is currently being conducted to evaluate the relative health risks associated with the commercialization or expanded use of: nuclear power technology utilizing uranium, mixed oxides of uranium, and plutonium or plutonium as basic fuel; and fossil fuel technology utilizing conventional coal combustion, fluidized bed combustion, and coal gasification. The results of these comparative studies will provide data on technology-associated health costs necessary for the establishment of a rational national energy policy.

PROGRAM FUNDING

In fiscal 1978 the operating budget for the Department of Energy-supported research projects was \$4.9 million. In addition, \$2.2 million was being utilized to support complementary studies for such government agencies as the Nuclear Regulatory Commission, National Institute of Environmental Health Sciences, Consumer Product Safety Commission, and the Environmental Protection Agency. The authorized investment for plant and equipment in 1978 was \$14.2 million.

MAJOR FACILITIES

The ITRI staff utilizes a physical plant with 220,000 square feet of general office, laboratory and support space as well as a number of specialized facilities. These include:

- o Three major inhalation exposure laboratory suites with the capability for exposure of laboratory animals to test gases, vapors or particles. All suites have specialized air-handling capacity, are isolated from other laboratories and may be utilized for research on highly radioactive or potentially carcinogenic materials.
- o Modern facilities for the care and housing of over 10,000 animals ranging in size from mice to large domestic animals. Specialized hospital facilities for medical evaluation and treatment of laboratory animals with unique capability for evaluating pulmonary function of a number of animal species.
- o Pathology laboratories including transmission and scanning electron microscopes for ultrastructural studies and a scanning microdensitometry for quantitative studies.
- o Specialized aerosol research laboratories and instrumentation for the study of gases, vapors and particles in the laboratory and to provide support for field sampling at coal combustion, coal gasification and nuclear material handling facilities.
- o Analytical chemistry laboratories including instrumentation for high pressure liquid chromatography, gas chromatography, atomic absorption, spectrometry, gas chromatography/mass spectrometry, nuclear magnetic resonance, differential pulse polarography/anode stripping voltammetry, X-ray emission spectrometry, as well as extensive capability of radiochemical analyses.

SIGNIFICANT ACCOMPLISHMENTS

- o Developed techniques for generating and characterizing aerosols for carefully controlled laboratory and field studies with special attention to the size distribution, chemistry and dissolution properties of aerosols.
- o Obtained basic data describing the size and shape of the airways of laboratory animals and man as a basis for improved predicting particle deposition in laboratory animals and man.

- o Utilized laboratory animal studies with a variety of different aerosols and forms to predict the deposition and fate of inhaled pollutants in man as a basis for reviewing and revising occupational and environmental exposure standards.
- o Development of extensive data on effects (functional and cancer) resulting from inhalation of radioactive material as a basis for assessing effects of potential nuclear fuel cycle accident scenarios.
- o Determined physical and chemical characteristics of vapors and particles in the process stream of laboratory model fluidized bed combustors and a low-Btu gasifier in cooperation with the Morgantown Energy Technology Center as a basis for risk/benefit comparisons with conventional combustion.
- o Established low toxicity of a number of heat transfer fluids proposed for use in residential solar-powered heating and cooling applications.
- o Made an integrated assessment of health risk of projected Pu recycle nuclear energy operations compared to health risks of naturally occurring radionuclides released from coal-fired electrical generating plants.

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH

Davis, California

INTRODUCTION

The Laboratory for Energy-Related Health Research* of the University of California at Davis (15 miles west of Sacramento) is associated with the School of Veterinary Medicine and is operated for the Department of Energy (DOE) under a contract administered by the San Francisco Operations Office. Since its founding in 1951, the laboratory's main research focus has been upon biomedical and environmental long-term, low-level effects of internally deposited radionuclides, external irradiation and fossil fuel energy-related effluents on living systems. Current research includes early diagnosis and methods of preventing cancer of bone, bone marrow and other organs, as well as mechanisms of injury and repair of target organs and integrated assessment of exposure risks. Radionuclide and fossil fuel gaseous and particulate pollutant characterization, transport, metabolism, uptake, retention and distribution in pertinent cellular and animal models are studied. Animal models include beagles, non-human primates and rodents.

The laboratory has gained, in its 27 years of existence, the management and scientific experience to address significant problems facing an expanding national energy technology matrix. The organizational structure and scientific staff has the flexibility and control necessary to effectively adapt to changing needs and to provide expansion in critical areas with a minimum of leadtime. The intralaboratory organization by functional units allows for a high degree of cooperation between the various scientific disciplines and results in an integrated approach to problem solving (e.g., extrapolation of experimental data to human exposure, potential risk, and regulations). The various bioenvironmentally oriented schools and departments at the Davis campus serve as a significant adjunct to the laboratory's permanent staff.

*Name change pending approval by the University of California Board of Regents; formerly, the Radiobiology Laboratory.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D, D.V.M.	17	Life Scientists	16
M.S.	9	Aerosol Physicists	1
B.S./B.A.	23	Chemists	3
A.A.	4	Engineers	1
		Mathematicians	2
		Technicians	47
		Other	24
Total	53	Total	94

Interdisciplinary research capability and expertise include:

- o Aerosol physics: chemistry, transport and interactions, gases and particles.
- o Trace elements: uptake, metabolism and toxicity in cells and animals.
- o Radiation biology: dosimetry, radionuclide metabolism and latent health effects.
- o Immunology: serology, cellmediated, radioimmunoassay.
- o Cell biology: tissue culture, cell toxicology, cytogenetics, clinical hematology.
- o Pathology: carcinogenesis, mutagenesis, scanning and transmission electron microscopy, tissue injury and repair.

CURRENT MISSION AND PROGRAM ACTIVITIES

The main objective of this laboratory is to determine, study and quantify the biomedical effects of long-term, low-level exposures to nuclear and fossil-fuel-related effluents from energy production. Fundamental studies on mechanisms of effects are coupled to investigations utilizing appropriate cellular and animal models in order to best identify and quantify those sensitive indicators that may be extrapolated to man and thereby provide information necessary for rational assessments of risk.

Primary areas of interest include toxicology, immunobiology, experimental hematology, tumor biology, cytogenetics, bone pathology, aerosol physics, lung physiology and pathology, radiation dosimetry and comparative assessments.

Major goals at the laboratory include:

- o Nuclear:
 - o Evaluate long-term effects of chronic low-level exposure to strontium-90 and radium-226 (through 1984).
 - o Low-level gamma-ray studies on mechanism of leukemia production (leukemogenesis), potential for therapy and early diagnosis (through 1983).
 - o Assess health impact of iodine-129 chronic exposure to assist in developing guidance for effective nuclear fuel disposal (complete 1981).
 - o Assess radiation quality (LET and rare) on cellular and molecular processes including bone marrow (through FY 1983).
- o Fossil Fuel:
 - o Identify, characterize and measure coal combustion and conversion effluents of bioenvironmental significance (through FY 1984).
 - o Determine the effects of inhaled coal fly ash with and without other aerosols and gases. Study lung injury and repair, lung cell effects in rodents and dogs and primates, including special cell studies on macrophages, transport, toxicity (through FY 1983).
 - o Develop empiric and basic models to assess effluent exposure impact, dose effect relations and extrapolation strategies for fossil fuel cycle compounds (through FY 1983).

PROGRAM FUNDING

DOE provides the primary source of funds for the laboratory's program. Fiscal 1978 contracts total \$2.6 million in operating funds to conduct both the nuclear and non-nuclear oriented programs. The laboratory's work for others program (U.S. Nuclear Regulatory Commission and Environmental Protection Agency) is presently limited to programs which are complimentary to the laboratory's main mission.

MAJOR FACILITIES

The laboratory complex of 14 acres and 54,000 square feet presently represents an authorized capital investment of approximately \$5.5 million to house animals, whole-body counters, aerosol generating and exposure chambers, minicomputer, and gamma ray field. Analytical, tissue culture and pathology laboratories are well developed.

One major construction project is underway: a small animal (primarily rodents) housing facility (\$430,000) is scheduled for completion in 1979.

SIGNIFICANT ACCOMPLISHMENTS

- o Pathologic and life-shortening effects of single and fractionated X-irradiation in the beagle were determined.
- o A transplantation system to study benign and malignant canine tumors was developed.
- o Dosimetric, metabolic and pathologic effects of long-term, low-level alpha and beta emitting, bone-seeking radionuclides (leukemia and bone cancer interactions) were determined.
- o Extrapolation models (animal experimental data to man) for risks from radioiodine and radiostrontium in fetus, young and adult have been developed.
- o A separator system for obtaining large samples of respirable fly ash directly from powerplant smoke stacks has been designed and constructed. Fractionated fly ash obtained from the smoke stack of a coal-burning electric powerplant has been used for biologic testing.
- o Chemical and physical heterogeneity of fly ash was demonstrated; morphologic variety includes presence of spheres packed with smaller spheres, i.e., plerospheres [plero-(from Greek, pleres, full)]; chemical analyses indicate many toxic metals (e.g., Cd, As, Pb, V, Cr, Se, W, Sb and Be) are preferentially concentrated on smaller respirable particles.

- o In vitro assays for biologic damage to immune system have been developed; pulmonary alveolar macrophage assays include adherence, phagocytosis, bacterial clearance and killing, tumor cytotoxicity, clonogenicity and lymphocyte activation; lymphoid colonies have been grown from spleen, bone marrow and lymph nodes; impaired lymphocyte stimulation has been demonstrated with levels of metals equivalent to that found in ambient fly ash.
- o Dilute extracts of fly ash have been shown to be mutagenic in a bacterial assay.
- o Radioisotopic air pollutant labeling using nitrogen-13 and sulfur-38 have been developed for in vivo kinetic studies.
- o Serum copper, ceruloplasmin and zinc assays have been shown to be useful in differential diagnosis and prognosis of cancer in afflicted humans and animals.

LABORATORY OF NUCLEAR MEDICINE AND RADIATION BIOLOGY

Los Angeles, California

INTRODUCTION

The Laboratory of Nuclear Medicine and Radiation Biology (LNMRB) is located on the Los Angeles campus of the University of California, (UCLA). Research programs focus on problems of national significance in energy-related medical, biomedical and environmental fields. Multi-disciplinary team approaches, perfected during the 30 years that the laboratory has operated under contract with the Department of Energy (DOE; and predecessors, the Atomic Energy Commission and the Energy Research and Development Administration) have resulted in significant contributions to a more complete understanding of the existing and potential interrelations between man, his environment and energy products.

PERSONNEL

Highest Degree Attained	Number
Ph.D./M.D.	46
M.S.	21
B.S.	<u>49</u>
Total	116

Occupation	Number
Life Scientists	41
Engineers	5
Computer Scientists/ Mathematicians	5
Technicians	51
Other	<u>82</u>
Total	184

The laboratory interacts with UCLA, other DOE laboratories and scientific entities in developing its programs.

The laboratory is assisted in its manpower planning and utilization by an advisory committee made up of key members of the university academic community. Nineteen staff members hold academic appointments in seven different university departments. Approximately 40 postdoctoral and graduate students are actively involved in LNMRB work. Additional undergraduate work and training is funded through the Associated Western Universities.

LNMRB makes heavy use of consultants and frequently brings in visiting scientists from other laboratories or universities for short-term assignments.

CURRENT MISSION AND PROGRAM ACTIVITIES

Fundamentally, LNM RB's research efforts are directed toward contributing to the solutions of long-range, major problems in the areas of energy-related biomedical and environmental problems. These research programs are carried out by the laboratory's three scientific divisions. These are the divisions of Biomolecular and Cellular Sciences, Environmental Biology and Nuclear Medicine.

Scientists in the Biomolecular and Cellular Sciences Division are involved in studies on the mechanism of damage to cellular constituents and processes by ionizing radiation, heavy metal contaminants and atmospheric gaseous pollutants. Research is also conducted on the mechanism of action of certain hormones and neurotransmitters, control of metabolic reactions, regulation of gene expression and of carcinogenesis, and on the formation and properties of cellular membranes.

The research of the Environmental Biology Division is concerned with the environmental effects of various energy technologies on desert and agricultural systems. Special emphasis is at present centered on the effects of solar thermal, geothermal and fossil fuel power systems. Basic research on desert ecosystem biology is carried out in support of the applied studies.

The Nuclear Medicine Division has the objective of introduction of new atraumatic diagnostic procedures for earlier detection of disease. Progress is dependent on the development of new instrumentation, radiopharmaceuticals and diagnostic strategies, first applied to animals and then directly to man. Emphasis is being placed on computed tomography techniques for studying physiological processes in the heart, brain and lungs.

PROGRAM FUNDING

In FY 1978, LNM RB's operating budget was approximately \$4.0 million for research conducted for DOE. In addition, approximately \$1.1 million in research support by other Federal agencies was provided, i.e., \$0.4 million from the National Institutes of Health, \$0.1 million from the National Science Foundation, \$0.3 million from the Environmental Protection Agency and \$0.3 million from the Nuclear Regulatory Commission.

MAJOR FACILITIES

Laboratory resources include a major structure and space for the laboratory's cyclotron and nuclear medicine research in the UCLA Center for Health Sciences. Floor space in the principal laboratory structure, Warren Hall, totals some 78,000 square feet.

SIGNIFICANT ACCOMPLISHMENTS

- o Development of functional scintillation scanner.
- o Total synthesis of linoleic acid. (First total synthesis, thus final proof of structure, of a polyunsaturated fatty acid, in this case, the stem compound for all the essential fatty acids.)
- o Development and application of carefully sized macroaggregates for temporary arteriolar blockade in liver, spleen, and bone marrow scanning.
- o Delineation of temperature-control mechanisms of membrane lipid desaturation in micro-organisms.
- o Development of a method for the determination of oxygen-18 in water contained in biological systems by charged particle activation, and application to the study of energy budgets in free-living animals.
- o Development of computerized positron emission tomographic scanners.

LABORATORY OF RADIOBIOLOGY

San Francisco, California

INTRODUCTION

The Laboratory of Radiobiology is an organized research unit of the School of Medicine, University of California, San Francisco. It interacts with various academic departments through faculty appointments and research associateships, and thus has both basic science and clinical ties for its research activities. The laboratory's program revolves around the development of methods and the identification of principles for evaluation of multiresource health hazards in man. It consists of environmental and basic science components oriented to the understanding of injury and repair mechanisms at various levels of biological organization.

The laboratory's research activities are conducted by 12 life scientists with Ph.D. or M.D. degrees and a supporting staff of 28 specialists, technicians and other personnel, nearly all of whom have bachelor's or master's degrees. On the average 10 to 15 postdoctoral trainees, graduate students, and visiting scientists also participate in its multidisciplinary programs.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D. or M.D.	12	Life Scientists	12
M.S.	3	Engineers	0
B.S.	<u>19</u>	Technicians	21
		Other Professionals	2
Total	34	Other	<u>5</u>
		Total	40

CURRENT MISSION AND PROGRAM ACTIVITIES

Major activities are focused on deoxyribonucleic acid (DNA) replication and repair, chromosome structure and behavior, mammalian embryo development, regulation of blood formation, modulation of the extracellular environment, and modification of tissue sensitivity to radiations and chemical agents.

PROGRAM FUNDING

Principal support for the laboratory is derived from the Department of Energy (DOE). The FY 1978 operating cost was approximately \$1.7 million, of which nearly \$1.6 million are DOE-based costs, the remainder representing University of California salary contributions and fellowship stipends from other sources. The present DOE support budget also includes \$100,000 for capital equipment. Construction of a third-floor addition (2,900 asf) to the laboratory building completed in 1978 will provide necessary space for expanded activities, particularly in regard to development of methods for teratogenic and mutagenic assessment of physical and chemical agents associated with various energy technologies.

MAJOR FACILITIES

The existing laboratory is available for research activities, including the development of methods for teratogenic and mutagenic assessment of physical and chemical agents associated with various technologies.

SIGNIFICANT ACCOMPLISHMENTS

- o Since its inception, the laboratory has pioneered in areas relating to genetic repair, radiation protection and sensitization, and cell population growth and development.
- o The discovery several years ago of the molecular basis of a genetic disease associated with skin cancer has evoked considerable interest in the relationship of DNA repair mechanisms to carcinogenesis.
- o The subsequent development by this laboratory of a new technique for sister chromatid visualization has contributed new insights to chromosome structure and has provided a useful screening method for mutagenic and carcinogenic agents.
- o A related accomplishment, based on the presumptive role of DNA damage in carcinogenesis, is the establishment of a simple test for detection of potential DNA damaging agents.
- o Other recent advances pertain to the development of in vitro methods for evaluation of potential teratogenic agents, the elucidation of macrophage involvement in tissue damage, and the introduction of an in vivo model for study of hematopoietic stem cell defects.

MSU-DOE PLANT RESEARCH LABORATORY

East Lansing, Michigan

INTRODUCTION

The Michigan State University (MSU)-DOE Plant Research Laboratory is located on the campus of MSU and is operated for the Department of Energy (DOE) by MSU. It is housed in a modern building, half of which is occupied by the MSU Department of Botany and Plant Pathology. Established in 1964, the Plant Research Laboratory is a center for modern experimental plant biology. The laboratory is engaged in an intensive, interdisciplinary research program in plant science with related education and training functions. The research program of the laboratory is broadly based, including studies at all levels of organization from the molecular to the organismal one, drawing on plant physiology, biochemistry, biophysics, cytology (ultrastructure) and other disciplines.

PERSONNEL

<u>Highest Degree</u>		<u>Occupation</u>	
<u>Attained</u>	<u>Number</u>		<u>Number</u>
Ph.D.	31	Life Scientists	
M.S.	10	Faculty	12
B.S.	<u>30</u>	Research Associates	18
		Graduate Assistants	24
Total	71	Technicians	12
		Other	<u>14</u>
		Total	80

CURRENT MISSION AND PROGRAM ACTIVITIES

Among the current problems under investigation are exchange of water, gas and energy between plant and environment; control of plant function and development by various factors of the physical environment including stress conditions; energy transfer in biomolecules and biological systems; regulation of enzyme activity; action and function of plant hormones; structure, composition, formation and function of cell organelles (membranes, microtubules, cell wall); nitrogen fixation and development in blue-green algae; flower induction; and effects of sulfur dioxide on plants and the basis of SO₂ tolerance.

Although part of these projects is approached on a fundamental level, this results mainly from a need for fundamental information before specific applied questions can be attacked. The laboratory thus serves as a resource of expertise upon which other DOE units (and other institutions) may draw when questions about plants arise in the course of DOE's mission. However, in addition to this general function, the laboratory is also directing a large portion of its research toward specific, energy-related problems of medium to long-range importance. In particular, the following research areas are directly concerned with the role of plants in energy production, consumption and conservation.

Nitrogen fixation. The most economical solution to the nitrogen fertilizer problem and the eutrophication syndrome is an increase in biological fixation of free nitrogen which amounts to 80 percent of the earth's atmosphere and concomitant decrease in the use of nitrogenous fertilizers and the energy expenditures needed for their production. The laboratory is conducting work on nitrogen fixation by blue-green algae, one of the aims being to obtain symbiosis between these organisms and higher plants where the algae will depend on the plant for an essential growth factor while supplying the latter with reduced nitrogen.

Stress physiology. Increased energy production and consumption will increase the stresses with which plants--crops as well as native plants--will have to cope. In this area, the laboratory has been investigating the interactions between plants and their environment with respect to energy and gas flow (e.g., water, carbon dioxide). The laboratory is expanding this program to investigate the effects of environmental stresses on plant productivity as controlled by the energy exchange between the plant and the environment and to study the metabolic problems of resistance in crops to extreme drought, temperature, and high salinity.

Effect of sulfur dioxide. One of the main pollutants of coal-burning powerplants is sulfur dioxide. The goal of a new project at the laboratory is the elucidation of the biochemical basis of SO₂ damage in plants. Further, experiments are being conducted to investigate SO₂ resistance in certain varieties of cultivated plants.

PROGRAM FUNDING

In fiscal 1978, the Plant Research Laboratory obtained from DOE \$1,364,000 as operating budget and \$250,000 for equipment purchases. MSU contributed \$281,000, of which most was assigned for faculty salaries. Additionally, \$82,400 were obtained by individual faculty members as grants from Federal agencies and private foundations in support of specific research projects.

MAJOR FACILITIES

The Plant Research Laboratory has 35,000 square feet of space available, most of which is allocated to research areas. The building also contains a small library and reading room, workshops, conference and seminar rooms. The Plant Research Laboratory is equipped to perform sophisticated research at the biochemical, biophysical and ultrastructural levels. In terms of special equipment, the laboratory has specially designed equipment to measure gas exchange between the plant and its environment, including instrumentation to determine the resistance to the flow of gases and water vapor in the leaves. To conduct research on light responses, a computerized spectrophotometer has been constructed. The Plant Research Laboratory also operates plant growth chambers where light intensity and quality, temperature, photo-period, and humidity can be controlled. Incubation rooms are available for work with tissue cultures and micro-organisms. Separate from the main building, there are green house facilities with 4,300 square feet of space.

SIGNIFICANT ACCOMPLISHMENTS

- o Elucidation of the mechanism whereby plants regulate nitrate and sulfate assimilation and coordinate this assimilation with protein synthesis.
- o Explanation of the mechanisms by which light and plant hormones regulate early developmental events in germinating seeds.
- o Characterization of plant cell glycopeptide extension, which is an important component of plant cell walls.
- o Description of a technique based on heavy isotope labeling to discriminate between changes in enzyme activation and de novo enzyme synthesis.
- o Elucidation of important aspects of the mechanism whereby plant hormones and environmental factors such as carbon dioxide concentration, water availability, temperature, and light interact to control the pores (stomata) through which plants exchange gases and water with the environment; development of a model to describe the mechanism in an integrated manner.
- o Development of a technique for the production of the short-lived radionitrogen nitrogen-13 with specific activities sufficient for investigations of nitrogen metabolism; use of this isotope to demonstrate that specialized cells of blue-green algae, the heterocysts, are the main although not the sole site of the

fixation of atmospheric nitrogen by these organisms. Also, use of this isotope to elucidate directly the pathway of molecular nitrogen-2 fixation in algae and root nodules of higher plants, and the pathway of NO_3 reduction in higher plants.

- o Demonstration that some microbial cells can control cell membrane properties (lipid fluidity) in response to environmental factors such as nutritional and thermal stress.

OAK RIDGE ASSOCIATED UNIVERSITIES

Oak Ridge, Tennessee

INTRODUCTION

Oak Ridge Associated Universities (ORAU) is a not-for-profit corporation sponsored by 46 colleges and universities. Established in 1946, ORAU was one of the first university-corporate management groups. As a prime government contractor, ORAU conducts a diverse program of scientific research, education, training, and public information programs for the Department of Energy (DOE); and has developed management experience and capabilities in these areas.

PERSONNEL

Highest Degree Attained	Number
Ph.D./M.D./D.V.M.	52
M.S.	35
B.S.	<u>96</u>
Total	183

Occupation	Number
Life Scientists	36
Physical Scientists	49
Engineers	11
Technicians	16
Others	<u>241</u>
Total	353

CURRENT MISSION AND PROGRAM ACTIVITIES

The major research and development programs of the Medical and Health Sciences Division are focused on five areas of concern to occupational medicine: Effects of radiation and chemical toxicants in humans; prospective and retrospective epidemiologic studies to identify occupational dangers related to energy production; biochemical studies of the role of surfactant production in prevention of inflammatory pulmonary disease, and biochemical modification of cellular membranes to alter cellular responses to toxic and carcinogenic compounds; immunological and cellular approaches to repairing cell surveillance systems injured by fuel toxicants, with the aim of protection against occupational cancers and respiratory diseases; and development of radiopharmaceutical agents to detect the metabolic alterations that lead to various environmental cancers and chronic lung diseases. The division also participates in biomedical training program at the predoctoral and post-doctoral levels. It also assumes major responsibility for DOE in

maintaining a national Radiation Accident Registry, operating the DOE Radiation Emergency Assistance Center/Training Site (REAC/TS) and collaborates with other DOE facilities in health and mortality studies.

The Institute for Energy Analysis (IEA) examines broad questions of energy policy. More specifically, it assesses energy policy and energy research and development options through study projects on subjects ranging from alternative energy supply and demand systems to the potential impact of more efficient energy-consuming devices; from shorter range energy technology impacts on the environment to long-range impacts on the climate; from dispersed solar energy systems to centralized nuclear energy systems. The results of IEA studies are reported through DOE advisory group meetings and briefings of key energy policymakers in Washington, as well as in reports and publications.

In the field of public education, ORAU's Museum Division operates DOE's American Museum of Science and Energy. This \$3.5 million facility is a major tourist attraction and features exhibits and demonstrations on energy. ORAU also operates the national traveling exhibits program for DOE. These traveling exhibits are transported and shown at various locations throughout the United States to provide the public with information on DOE programs in energy. The division also develops for DOE low-cost, innovative classroom materials related to energy.

The Manpower Education, Research, and Training Division is concerned with meeting energy-related manpower requirements. It offers research participation opportunities at various DOE research facilities including several of the fossil Energy Technology Centers for university scientists and engineers, undergraduates, and graduate students. The division also offers special, energy-related, short courses in Oak Ridge for scientists, engineers, physicians, and undergraduate students. It also does studies of manpower needs and training methods. In addition, the division operates the Training and Technology Program (with Union Carbide, Nuclear Division), which provides industrial skill training for unemployed, underemployed, and minority persons, including migrant farmworkers.

PROGRAM FUNDING

ORAU's operating budget for fiscal 1978 was approximately \$10.5 million, of which approximately \$3.3 million represents work for other Federal agencies such as the National Institutes of Health, Food and Drug Administration, Environmental Protection Agency, and other private and public organizations. Authorized plant and equipment at ORAU represent an investment of approximately \$12 million.

MAJOR FACILITIES

Facilities in the Medical and Health Sciences Division include radiation and radioisotope handling facilities and laboratories; radiation

In addition to its usefulness as a diagnostic tool, the new Emission Computerized Axial Tomography (ECAT) Scanner at the Oak Ridge Associated Universities' Medical and Health Sciences Division is proving to be extremely useful in the study of physiological process and the functional aspects of normal and diseased organs.

scanning equipment and allied nuclear medicine instrumentation; an Emission Computerized Axial Tomography (ECAT) Scanner; biochemistry and immunobiology laboratories; animal facilities; equipment for cellular, subcellular, and histopathologic studies; a marmoset research center; and REAC/TS.

The REAC/TS facility is equipped to receive and treat individuals involved in any kind of radiation accident.

Extensive facilities and equipment are available for the various special education and training activities.

SIGNIFICANT ACCOMPLISHMENTS

- o Carbon-11 labeled radiopharmaceuticals were demonstrated to be useful as localizing agents for malignant tumors and for imaging the normal and diseased pancreas.
- o At the REAC/TS facility in Oak Ridge, 136 physicians, health physicists, and emergency technologists were trained in radiation accident emergency procedures during the past year.
- o A study has shown that there is no evidence of increased respiratory cancer among workers exposed to elemental nickel at the Oak Ridge Gaseous Diffusion Plant.
- o Studies of the effect of NO₂ on the pulmonary surfactant system have identified altered surfactant metabolism as a sensitive indicator of exposure to this fossil-fuel-derived toxicant. Other pollutants are being examined for similar effects.
- o The Institute of Energy Analysis played a leading role in identifying the importance of the possible adverse effects from increased CO₂ atmospheric accumulation that may result from the burning of fossil fuels.
- o More than 2 million persons visited the DOE traveling exhibits and the DOE American Museum of Science and Energy in Oak Ridge.

RADIOBIOLOGY LABORATORY

Salt Lake City, Utah

INTRODUCTION

The Radiobiology Laboratory, operated for the Department of Energy (DOE) by the University of Utah, occupies approximately 2.8 acres adjacent to the College of Medicine about 3 miles from the center of Salt Lake City. Senior staff members hold academic appointments in various departments of the university.

Specialized facilities include housing for more than 800 dogs and 3,000 mice. These facilities exist on leased land and consist of 10 buildings and kennels, equivalent to approximately 60,000 square feet. Specialized equipment exists for the quantitative measurement of low levels of plutonium and other alpha-emitting radionuclides, particularly with respect to bone microdosimetry.

PERSONNEL

Highest Degree Attained	Number
Ph.D./M.D./D.V.M.	12
M.S.	2
B.S.	<u>17</u>
Total	31

Occupation	Number
Life Scientists	7
Physical Scientists	7
Engineers	1
Technicians	42
Others	<u>5</u>
Total	62

CURRENT MISSION AND PROGRAM ACTIVITIES

The primary objective of the laboratory's activities is to conduct studies on the deposition, translocation, excretion, retention, and acute and late toxic effects of radionuclides; particularly the alpha-emitting isotopes; entering the body. This effort includes studies of the comparative metabolic effects of these isotopes using total body and partial body counting in vivo, and radiochemical analysis of tissues.

PROGRAM FUNDING

In fiscal 1978, funding was provided totaling approximately \$1.6 million for research conducted for DOE. Approximate evaluation of plant and equipment amounts to \$5 million.

MAJOR FACILITIES

Major aspects of the Radiobiology Laboratory are the six kennels housing over 800 beagles, St. Bernards, the Bone-Autoradiography Laboratory with its JEOL 100-S Electron Microscope and its computer-operated QTM-720 analyzer, the Physics Laboratory with its associated whole-body equipment and analyzers, the Radiochemical Laboratory and the Histopathology Laboratory.

SIGNIFICANT ACCOMPLISHMENTS

- o Description of the manner in which plutonium and other trans-uranic elements are transported in the blood to sites of deposition.
- o Study of the late effects of graded doses of plutonium and other radioisotopes entering the blood stream, resulting in bone tumors and liver tumors.
- o Developing a major research center for the study of bone physiology, microdosimetry and toxicology.
- o Comparison of the biological effects caused by various radionuclides.
- o Development and application of techniques for alpha-particle dosimetry in biological samples.
- o Estimation of the cancer risk to man from plutonium and other radionuclides.
- o Improved techniques for the removal of radioactivity from the body.

SAVANNAH RIVER ECOLOGY LABORATORY

Aiken, South Carolina

INTRODUCTION

The Savannah River Ecology Laboratory (SREL) is an ecological research facility located on the Savannah River Plant (SRP). The laboratory is operated by the University of Georgia under contract with the Department of Energy. SREL is a unit of the Institute of Ecology of the University. A recently constructed laboratory facility has greatly enhanced environmental research opportunities in conjunction with the 300 square mile SRP. This unique protected area is SREL's most important resource.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D.	16	Ecologists	16
M.S.	10	Engineers	1
B.S.	<u>16</u>	Technicians	26
		Others	16
Total	42	Graduate Students	<u>9</u>
		Total	68

CURRENT MISSION AND PROGRAM ACTIVITIES

Aquatic Stress Programs

The primary goal in these research programs is to examine the environmental effects of energy development activities in the systems available on the SRP. The release of cooling water from production reactors creates an ideal opportunity to investigate stress phenomena in natural communities. Results from these studies may be applied to geothermal utilization or other heated water discharges by industries of any type. In addition to the influence of elevated water temperatures, recent programs have centered on other forms of stress such as heavy metals and polycyclic aromatic hydrocarbons.

Mineral Cycling

The primary objective in this program is to assess the fate and gather information on movements of heavy metals, radioisotopes, toxic

materials, and stable elements through natural communities in the Coastal Plain region. Many specific projects, as with the stress program, are directly applicable to SRP energy development activities or are extrapolatable to regional considerations. Many study species are those that are abundant, conspicuous or problem species that may enter the food chain of man.

Radioecology of Actinide Elements

The general principles of mineral cycling have been applied in these studies to environmental considerations of plutonium and other trans-uranic elements in the humid climatic environments of the Southeast. These studies involve examination of plutonium uptake and distribution in natural systems and in agricultural crops. These studies are, of course, applicable to the nuclear industry on a worldwide basis.

Basic and Theoretical Ecology

Basic research has provided, and will continue to provide, a solid foundation on which to build the more directly applicable ecological research on the SRP. Without the broad ecological base of information on all major plant and animal components of the environment and the environmental systems of the SRP, the above-mentioned studies could not have been undertaken. Such studies also address questions relating to endangered species of the region and continue to provide a baseline of information for future investigators.

PROGRAM FUNDING

SREL's fiscal 1978 federally funded operating budget totals \$2.4 million. Approximately \$0.6 million comes from other Federal agencies, i.e., the Environmental Protection Agency, the National Science Foundation, and the Nuclear Regulatory Commission. Equipment and facilities total over \$5 million.

MAJOR FACILITIES

- o Facilities include a greenhouse, large animal holding facility, artificial streams, and remote research trailers.
- o The SREL facility, recently constructed, is equipped with alpha spectroscopy equipment and fully equipped nuclear detection laboratory. Large environmental chambers, freeze dryers, grinders, ovens, and instruments are available for trace metal analysis.

SIGNIFICANT ACCOMPLISHMENTS

- o SREL has contributed extensively to the scientific information on ecological systems through large numbers of publications in scientifically reviewed journals of national and international scope.
- o SREL has contributed to the National Environmental Research Park concept and will continue to promote this program by encouraging investigators to work through the laboratory to accomplish objectives deemed important.
- o The most important general contribution has been that the scientific staff and students of SREL have given much attention to the application of basic concepts of ecology to the current urgent national needs relating to pollution, energy development and land and resource management and public considerations of these.

THE FRANKLIN MCLEAN MEMORIAL RESEARCH INSTITUTE

Chicago, Illinois

INTRODUCTION

The Franklin McLean Memorial Research Institute, formerly the Argonne Cancer Research Hospital, is operated by The University of Chicago for the Department of Energy (DOE). The Institute's facilities occupy an 8-story building located on a site leased to DOE (formerly the Energy Research and Development Administration) by the university and joined to the University of Chicago hospitals and clinics on the university campus in Chicago, Illinois.

The institute was planned initially as a laboratory and hospital where the information and experience gained in wartime research on the role of radioactive materials in biological and clinical investigations could be channeled into fundamental research, and where advanced training in this field could be taken. Over the years, biomedical investigations with the use of radiation sources have led to new clinical and diagnostic techniques and to a better understanding of various cellular and molecular processes. Investigators are now exploring applications of their research techniques and expertise to problems related to energy production and pollutants.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D./M.D./D.V.	30	Life Scientists	24
M.S./M.A.	7	Physical Scientists	6
B.S./B.A.	<u>14</u>	Engineers	20
		Technicians	31
Total	51	Others	<u>22</u>
		Total	103

CURRENT MISSION AND PROGRAM ACTIVITIES

Currently, the principal research programs involve studies of chromosomal abnormalities in myeloproliferative disorders; tracers for nuclear medicine and biomedical research; improved radionuclide and X-ray

imaging techniques; a wide range of biochemical studies (erythropoietin, lymphocyte activation, RNA and protein synthesis, mitochondrial transcription, regulation of muscle growth, initiation of protein synthesis, including development of a plasma lipoprotein model; production of radionuclides and radiopharmaceuticals for use in medical and environmental studies; and dosimetry of neutrons from californium sources. In many of the studies, the effects of the substances associated with energy production and related environmental pollutants are now being investigated.

PROGRAM FUNDING

In fiscal 1978, the operating budget was approximately \$2.5 million for research conducted for DOE. In addition, approximately \$0.05 million was available for research funded by the Environmental Protection Agency. Equipment and facilities represent an investment of about \$4.7 million.

MAJOR FACILITIES

The institute is equipped with research laboratories, high-energy radiation sources, machine and electronics shops where much of the research apparatus is designed and built, and a small animal facility; two patient floors have been turned over to the university clinics for their use. Special facilities include three high-energy radiation therapy machines; the medical cyclotron; a portable Pho-Gamma III Anger camera and data collection system; a multiplane tomographic imaging system for use with short-half-life positron emitters; a total-body counting and scanning system; and equipment for studies in biochemistry and cell and molecular biology, including a sequencer for determining amino acid sequences in proteins, an amino acid analyzer, a 100-liter fermentor for growing of bacterial cells, a Model E high-speed analytical centrifuge, and a tissue culture facility.

SIGNIFICANT ACCOMPLISHMENTS

- o Outstanding work has included studies on blood and blood-forming tissue, the production and diagnostic application of various short-lived radionuclides, the development of neutron sources for radiation therapy, studies on tumor immunology, investigations on chromosomal abnormalities in hematologic diseases, initiation and control of cellular protein synthesis, and advances in radionuclide and radiologic imaging techniques.

UNIVERSITY OF ROCHESTER BIOMEDICAL LABORATORY

Rochester, New York

INTRODUCTION

The University of Rochester Biomedical Research Laboratory is operated for the Department of Energy (DOE) by the University of Rochester. The laboratory is an integral part of the University of Rochester Medical Center which is located on land immediately adjacent to the main campus at the university. Approximately two-thirds of the 200,000 square feet occupied by the laboratory is university owned; the remaining space is DOE property.

The laboratory was established initially in 1943 as part of the Manhattan Project. It was organized at the request of the Manhattan District of the United States Army Corps of Engineers. The initial purpose of the laboratory was to carry out research and to provide monitoring services and consultation on the health hazards expected to arise at installations which were working on the development of the atomic bomb. Research programs were established in two broad fields: the biological effects of external radiation and the toxicity of various radioactive and chemical materials. In December 1946, the laboratory was transferred to the jurisdiction of the newly formed United States Atomic Energy Commission.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D./M.D./D.V.M.	78	Life Scientists*	77
M.S./M.A.	9	Engineers	0
B.S./B.A.	<u>59</u>	Other Professionals	7
		Technicians	69
Total	146	Others	<u>56</u>
		Total	209

*Biophysicists, Biochemists,
Biologists

CURRENT MISSION AND PROGRAM ACTIVITIES

The principal research programs at the laboratory involve studies of the effects of toxic materials associated with energy production. A wide

variety of toxic agents are studied, including external and internal radiation, heavy metals, organo-mercurials and fluorides. These agents may produce their toxic effects by external exposure or by internal exposure during or after entry through the lungs or the intestinal tract.

The types of radiation used in the studies include gamma rays, X-rays and microwaves. A high-intensity, power frequency field source is presently under construction in order to evaluate the effects of high-voltage electric power transmission lines.

The studies are conducted using a variety of biological targets, ranging from whole, small animal exposures through the use of tissues (bone, intestine, lung), single cell populations (intestinal cells, bone cells, erythrocytes, yeast), and subcellular materials (deoxyribonucleic acid, membrane proteins, specific enzyme systems).

The methods for assessing the effects of the toxic substances include: Whole animal survival data; multidisciplinary studies of observed pathological changes; evaluations of the impact on important cellular functions such as ion and metabolite transport and accumulation; and molecular-level studies involving genetic damage and repair and specific interactions between biologically important molecules and toxic substances. The experiments usually involve the elucidation of the details of the biological process as a prerequisite for the interpretation of toxic effects.

PROGRAM FUNDING

In fiscal 1978, the operating budget of the Biomedical Laboratory was approximately \$3.4 million for research conducted for DOE. In addition, approximately \$3.1 million for research were obtained from other sources, including other Federal agencies. Authorized equipment and facilities represent an investment of about \$5.6 million.

MAJOR FACILITIES

Equipment and facilities at the laboratory are suitable for conducting sophisticated laboratory experiments as well as short and long-term studies involving common laboratory animals. The facilities include: Laboratory and office space; exposure facilities for gamma ray, X-ray, ultraviolet and microwave energies; a computer facility; an electron probe analyzer; scanning and transmission electron microscopes; aerosol generators and analyzers; and animal housing, isolation and surgery space.

SIGNIFICANT ACCOMPLISHMENTS

- o The research program has evolved in such a way that it now represents a wide-ranging approach to the assessment and study of the biological effects of many of the toxic substances associated with the production and transmission of energy. The studies are often oriented so as to provide data on the mechanism of toxic damage in addition to a determination of the magnitude of toxic effects.

IV-185

FOSSIL ENERGY FACILITIES

FOSSIL ENERGY FACILITIES

Five Energy Technology Centers, formerly part of the U.S. Energy Research and Development Administration, and two Mining Operations Centers, which were transferred from the Bureau of Mines, Department of Interior, as part of the reorganization under which the Department of Energy (DOE) was established, make up DOE's fossil energy facilities. Two of these facilities have been in operation for almost 60 years. The centers and their general areas of specialization include:

Bartlesville Energy Technology Center	- Enhanced Oil Recovery
Grand Forks Energy Technology Center	- Coal (lignite)
Laramie Energy Technology Center	- Oil Shale and In Situ Coal Gasification
Morgantown Energy Technology Center	- Gas from Devonian Shales and Coal Gasification
Pittsburgh Energy Technology Center	- Coal Liquefaction
Carbondale Mining Operations Center	- Surface Mining/ Environmental Effects
Pittsburgh Mining Operations Center	- Underground Mining

The level of funding for the centers was fairly minimal before transfer to DOE. The budgets for all seven totaled about \$10 million in 1974. In 1978, however, the centers' operating budgets rose to about \$110 million to support the management or monitoring of extensive projects, often with matching funds from industry. The centers report directly to the Program Manager for Fossil Energy, and administrative support is provided through selected operations offices. The key mission of the centers, as in-house federal laboratories, is to provide the government with a competent staff of engineers and scientists to conduct research and development activities and to implement selected government programs.

A major decentralization of program implementation is in progress. This effort will focus various programmatic activities in specific centers which will provide monitors for major contracts and will be responsible for maintenance of the technology base in their assigned area.

EXECUTIVE SUMMARY

Bartlesville Energy Technology Center

LOCATION: Bartlesville, Oklahoma

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$24.7 million
STAFFING:	207
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$7.5 million
NUMBER OF ACRES:	10
NUMBER OF BUILDINGS:	15
FLOOR SPACE:	124,662 sq. ft.

OPERATING CONTRACTOR:

Federally Operated

RESPONSIBLE OPERATIONS OFFICE:

San Francisco

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

- Research on Petroleum (100%)
- Production (40%)
- Fuel/Engine Systems (34%)
- Chemistry and Refining (20%)
- Thermodynamics of Petroleum and Synthetic Crudes (6%)

Some work is being done on development of petroleum substitute fuels. BETC also provides technical project offices for enhanced oil and gas recovery projects.

MAJOR FACILITIES:^{2/}

None.

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

^{2/} Acquisition cost \$5 million.

BARTLESVILLE ENERGY TECHNOLOGY CENTER

Bartlesville, Oklahoma

INTRODUCTION

The Bartlesville Energy Technology Center (BETC), originally established by the Bureau of Mines in 1918, is devoted primarily to research and engineering on petroleum and natural gas. The research program concerns first the near-term goals of enhanced oil and gas recovery and conservation of transportation fuels; and secondly, the refining and use of synthetic crude oils made from coal, tar sands, and oil shale. The maintenance of a technology base through basic research and resource studies is also part of the program.

As part of the enhanced oil and gas recovery program, BETC furnishes technical project officers for more than \$100 million in contracts and has the capability for managing much of the enhanced oil recovery program. The center also furnishes members of evaluation and negotiation teams for developing contracts and evaluating unsolicited proposals. Members of the staff also serve on national task forces concerned with developing programs or policy positions related to energy and petroleum in particular.

For many years BETC depended on contracts with other government agencies or with industrial groups for a major part of its support, at one time more than 50 percent of its total funding. This experience in dealing with various agencies enables a better management of contracted work. It also assures a wide knowledge of places where work related to the BETC program is under way.

The strength of BETC in conducting its own research is shown by the extensive publication record. The additional necessity to transfer technology developed at BETC to an established industry (oil and gas) has caused BETC to develop skills in technology transfer not normally present in a research unit. An outstanding example of such efforts was the introduction of secondary recovery methods to the Mid-Continent oil fields through the use of publications, oil field tours, specially organized waterflooding (secondary recovery) groups and personal conferences and aids to beginning waterflooders. Adaptation of this kind of technology transfer program to tertiary recovery is beginning. A major accomplishment is the national symposium on enhanced oil and gas recovery that BETC conducts annually.

PERSONNEL

The BETC staff includes:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	20	Engineers	32
M.S.	24	Physical Scientists	50
B.S.	<u>55</u>	Technicians/Aides	52
		Others	<u>73</u>
Total	99	Total	207

In addition, twelve full-time and eight intermittent State of Oklahoma employees are assigned to supporting services.

CURRENT MISSION AND MAJOR PROGRAM ACTIVITIES

The primary mission of BETC is improvement and demonstration of technology in petroleum and natural gas exploration, production, refining, and utilization. This includes basic research as well as investigation of materials which may substitute or supplement petroleum and natural gas.

Petroleum production programs include enhanced oil and gas recovery, heavy oil recovery, improved drilling, methods, and determination of residual oil. These programs comprise the major part of research and engineering conducted at BETC, especially in recent years. Thermodynamics research includes determination of properties needed in coal conversion processes as well as the properties of pure hydrocarbons or other compounds found in fuels. The center maintains a data bank of information on crude oil properties and marketed fuel properties, determines composition of crude and its refining properties, applies similar methods to syncrudes for advance information on problems likely to be encountered in their use, and is developing technology for re-refining waste lubricating oil. Demonstration of waste lube oil re-refining is planned for fiscal 1979. The research on fuel/engine systems includes testing of fuels from synthetic sources in current and prototype engines, studies of use of diesel engines in underground mining, and assessment of current technology with respect to fuel economy and emissions. Demonstration of a methanol-fueled car is expected by fiscal 1979.

The enhanced oil recovery program is expected to add 500,000 barrels of oil per day to the U.S. supply by 1985.

The enhanced gas recovery program is expected to add 3 billion cubic feet per day of natural gas to the U.S. supply by 1985.

PROGRAM FUNDING

In fiscal 1978, BETC's operating budget was about \$25.2 million, of which \$24.7 million was for Department of Energy (DOE) work and the remainder was primarily for other Federal agencies.

The distribution by program was:

	(\$ Millions)
Coal	\$.9
Petroleum	21.8
Natural Gas	.9
Conservation	.8
Energy Preparedness	.2
Multiresources	.1
DOE Total	\$24.7
Other Agencies	.5
Total	\$25.2

In addition, \$1,250,800 has been allotted for purchase of land and for modifications and additions to the buildings.

MAJOR FACILITIES

The facilities consist of 15 buildings valued at \$3.5 million on 10 acres of land. Acquisition of an additional 7.5 acres and replacement of one building by a new structure are under way at a cost of \$800,000

Laboratory equipment and auxiliary equipment include such items as mass spectrometers, computing equipment, research calorimeters, electron microscope, dynamometers, re-refining pilot plant equipment, shops, library, and trailer laboratories. The total value of such equipment is \$4.0 million.

Field studies conducted by the center usually involve cooperation with a company owning an oil field or gas field rather than the purchase of such properties, and the investment in field equipment varies with projects actually underway.

Requests have been made for two additional buildings. One is a fuel engine systems building to replace the present structure (which has been remodeled many times) with a properly designed facility. The other is a technology transfer center to house the library, information services, conference rooms, and some computing facilities. The two buildings, including enlargement of the power plant to accommodate them, are budgeted at \$5.2 million. If the proposed schedule is followed, they will be completed in fiscal 1980.

SIGNIFICANT ACCOMPLISHMENTS

Over the past 60 years, BETC has made significant contributions to petroleum technology. Some of the major accomplishments are as follows:

- o Encouragement of research efforts by industry.
- o Development of principles of conservation in petroleum production.
- o Assistance to industry in adopting waterflooding as the major secondary oil recovery tool.
- o Composition studies of crude oils.
- o Determination of thermodynamic properties of hydrocarbons and the sulfur and nitrogen compounds of petroleum.
- o Development of methods for automotive emissions measurements and determination of their relation to fuel properties.

EXECUTIVE SUMMARY

Grand Forks Energy Technology Center

LOCATION: Grand Forks, North Dakota

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$5.0 million
STAFFING:	90
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$4.1 million
NUMBER OF ACRES:	8.3
NUMBER OF BUILDINGS:	5
FLOOR SPACE:	58,600 sq. ft.

OPERATING CONTRACTOR:

Federally Operated

RESPONSIBLE OPERATIONS OFFICE:

San Francisco

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Coal (100%)

MAJOR FACILITIES:^{2/}

None

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

^{2/} \$5 million or more acquisition cost.

GRAND FORKS ENERGY TECHNOLOGY CENTER

Grand Forks, North Dakota

INTRODUCTION

The Grand Forks Energy Technology Center (GFETC) specializes in research on combustion, gasification, and liquefaction of western United States coals, primarily those coals that are low in rank (geologically young). The center was dedicated in 1951 as the Charles R. Robertson Lignite Research Laboratory, becoming the first permanent facility for research on North Dakota lignite.

GFETC is recognized as the principal center of expertise in the United States, in the technology and use of lignite and other low-rank western coals. For over 25 years the center has worked closely with the lignite mining industry and the lignite-burning electric utilities both informally and by means of cooperative research agreements, to develop ways to better utilize the huge reserves of lignite in the Northern Great Plains and Texas Gulf Coast.

Technology transfer is emphasized at GFETC. The technical staff is active in presenting reports of its results at major national meetings, such as the American Power Conference and the American Society of Mechanical Engineers conferences. For nearly two decades GFETC has joined the University of North Dakota in sponsoring the biennial Lignite Symposium, at which invited technical papers are presented by GFETC and other speakers. The symposium is recognized as the country's most important scheduled meeting on low-rank coal technology.

GFETC relations with industry and energy consumers are aided by the guidance of a formal advisory committee, composed of representatives of mine owners, labor, and the public. The Lignite Advisory Committee is authorized by Federal statute and meets annually to review and advise on the center's technical program.

PERSONNEL

GFETC full-time staff includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	6	Physical Scientists	30
M.S.	8	Engineers	18
B.S.	<u>38</u>	Technicians	5
Total	52	Others	<u>37</u>
		Total	90

CURRENT MISSION AND MAJOR PROGRAM ACTIVITIES

GFETC's present research activities emphasize studies of specialized problems in industrial-scale combustion of low-rank coals, plus extensive pilot-scale studies of coal conversion into clean gases and liquids.

American low-rank coals (lignites and subbituminous coals) are characterized by higher moisture content, lower sulfur content, and lower heating values than the geologically older high-rank coals (bituminous coals and anthracites). As further points of comparison, the low-rank coals are found almost exclusively in the West and constitute only about 12 percent of the Nation's current coal production. Their utilization characteristics differ from those of the more widely used high-rank coals, and historically their level of research attention has been low. However, the low-rank coals presently are receiving greatly increased industrial attention because of the recent demand for low-sulfur coal and the looming shortages of oil and natural gas.

Using a unique 75-pound per hour pilot combustor, combustion characteristics of coals are being studied and evaluated, with special attention to fireside tube fouling to determine the mechanism of fouling and methods for its control. Improved methods for removal of fly ash and sulfur oxide (SO) from power plant stack gases are under development. Combustion techniques are also being studied, using fluidized beds.

A 25-ton per day fixed-bed gasification unit, constructed and studied for operating characteristics from about 1956 to 1965, has been reactivated. The gasifier is designed for operation at high pressure with slagging (molten) discharge of ash. Low-rank coals are particularly well adapted to this type of gasification because they are nonagglomerating and highly reactive. Major emphasis during current operation of GFETC's slagging gasifier is to characterize, control, and treat liquid effluents from the process.

An investigation is also being conducted of the liquefaction of low-rank coals, using an organic base solvent and a carbon monoxide-hydrogen atmosphere at moderate pressure and temperature. Kinetics of the process are studied by autoclave. A continuous bench-scale unit is used for studies of such process variables as slurry preheating, reactor residence time and intensity of mixing.

Long-range (10-year) plans at GFETC include increased emphasis on coal liquefaction and gasification and on the nature and control of liquid effluents produced by the gasification process. Work on fly ash fouling on boiler tubes will continue, evaluating the fouling potential of western coals and studying mechanisms and control. Studies will also continue on the problems of removing environmental contaminants--primarily SO₂ and fly ash--from power plant stack gases. Additional emphasis will be given to advanced environmental control technology, particularly in the stack gas cleaning area.

Continuous process unit equipment used in carbon monoxide-steam liquefaction studies at Grand Forks Energy Technology Center.

New initiatives will include:

- o Control of SO₂ by reducing sulfur in coal before combustion, as well as minimizing sulfur oxide emissions during the combustion process using dry sorbent and other advanced environmental control technology.
- o Drying and storage of low-rank fuels.
- o Studies of improved equipment for utilizing low-rank coal in fluidized-bed combustion.
- o Possibilities for utilizing peat as fuel for combustion or conversion.
- o Improved control methods for fine particulates, trace element, and hydrocarbon emissions.

PROGRAM FUNDING

GFETC's fiscal 1978 operating budget was about \$5.0 million, all of which is for coal-related programs including coal combustion and emission control, coal gasification, coal liquefaction, and exploratory research.

MAJOR FACILITIES

GFETC has a number of one-of-a-kind specialized research facilities as indicated below:

- o 25 ton-per-day pressure fixed-bed slagging gasifier pilot plant being used to develop data on the second generation gasifier.
- o 75-pound per hour furnace used to evaluate ash fouling characteristics of western coal deposits.
- o 75-pound per hour pulverized-coal combustor used to produce fly ash for study in a pilot electrostatic precipitator.
- o Wet scrubber pilot plant used to study ash-alkali scrubbing process developed at GFETC, to remove SO₂ from combustion stack gases.
- o 6-inch diameter atmospheric fluidized-bed combustor used to study this combustion process with lignite and other western coals. Also under construction is an 18-inch atmospheric fluidized bed combustor.

- o Coal liquefaction equipment for study of the carbon monoxide-steam process:
 - a specially modified batch autoclave that can be charged hot and sampled periodically
 - a 5 pound per hour continuous process unit with gas and slurry recycle for studies on reactor design
- o Mobile laboratory capable of supporting SO_x, NO_x, and particulate emissions control studies in the field.
- o Carload lot coal splitter used to obtain representative aliquots from carload-size coal samples for use in the research program.
- o Major analytical facilities:
 - High and low resolution mass spectrometer and computerized data system
 - Scanning and analyzing electron microscope
 - X-ray fluorescence and X-ray diffraction equipment
 - Inductively coupled argon plasma spectrometer
 - Atomic absorption spectrophotometer
 - High-temperature heated stage microscope
 - Differential scanning calorimeter
 - Differential thermal analyzer--Thermal Gravimetric Analyzer
 - Polarizing microscope

SIGNIFICANT ACCOMPLISHMENTS

- o Development of techniques for safe large-scale storage of lignite. Techniques proven by a 25-year storage of 2 million tons at the Garrison Dam site.
- o Development of a process for controlling freezing in railroad cars by the use of dried lignite fines. Process used commercially in North Dakota.
- o Successful demonstration of the slagging fixed-bed gasification process for lignite.
- o Demonstration to the power industry that the serious problem of ash deposition on the fire side of boiler tubes is caused largely by the sodium content in the lignite; that sodium content is highly variable in the North Dakota lignite deposits, and that sodium surveys in advance of mining should be performed.
- o Development of a bank of data on relative ash fouling characteristics of lignites and subbituminous coal deposits to aid in the design of boilers for new powerplants.

- o Development of the ash-alkali scrubbing process for lignite. This process will be used in a 450 megawatt commercial scrubber at the Milton R. Young Station, Center, North Dakota.
- o Development of a data bank on the factors affecting electrical resistivity of fly ash from lignite and other western coals. First to show that sodium present in lignite is effective in reducing electrical resistivity. These data are being used by designers of commercial electrostatic precipitators.
- o Development of new methods for predicting power required to pulverize lignite. Method showing relationship of ease of grinding with moisture content is universally used by the industry.
- o Demonstration for the first time on a commercial scale that lignite and subbituminous coal can be safely handled, transported, and stored after being dried. Over 600 tons have been safely stored at GFETC for about 3 years.

EXECUTIVE SUMMARY

Laramie Energy Technology Center

LOCATION: Laramie, Wyoming

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$26.2 million
STAFFING:	168
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$11.3 million
NUMBER OF ACRES:	2.2
NUMBER OF BUILDINGS:	9
FLOOR SPACE:	67,577 sq. ft.

OPERATING CONTRACTOR:

Federally Operated

RESPONSIBLE OPERATIONS OFFICE:

San Francisco

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Oil Shale (57%)
Underground Coal Conversion (25%)
Petroleum and Natural Gas (18%)

MAJOR FACILITIES:^{2/}

None

^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

^{2/} \$5 million or more acquisition cost.

LARAMIE ENERGY TECHNOLOGY CENTER

Laramie, Wyoming

INTRODUCTION

The Laramie Energy Technology Center (LETC) has maintained a strong in-house research and engineering program on oil shale and shale oil for 40 years. The center has achieved lead laboratory responsibility in oil shale and also significant leadership responsibilities in underground coal gasification and in situ tar sand oil recovery. LETC has consistently sought maximum involvement of regional institutions and other resources. A recent contract with the Rocky Mountain Institute of Energy and Environment (University of Wyoming) continues to demonstrate this involvement. This contract adds socioeconomic, agricultural, geographic and health dimensions to the LETC programs.

The location of LETC in the fossil-energy-rich Rocky Mountain region is also a distinct advantage in addressing the problems of developing alternative sources of energy from the available fossil energy resources that cannot be tapped with today's technology.

LETC employs a matrix organization which flexes with the demands put on it by new challenges in the laboratory or in the field. With this organization, the center has the capability of facing new technical assignments by mobilizing interdisciplinary task forces of engineers, scientists, and support personnel. Duplication of effort is reduced considerably and the best use of Federal personnel is achieved. Employees with varying technical knowledge and expertise are brought together to concentrate their efforts on the problem at hand. This form of organization is especially adapted to project management activities.

PERSONNEL

Employment in fiscal 1978 totaled 208 (including 40 other than full-time permanent employees) and consists of the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	27	Physical Scientists	47
M.S.	20	Engineers	40
B.S.	78	Mathematicians	2
A.S.	5	Technicians	46
		Others	73
Total	130	Total	208

LETC and the University of Wyoming are next-door neighbors and cooperate under a formal agreement. This proximity has been mutually beneficial, allowing for full use of human and technical resources in the area and the ready sharing of problems and expertise. Four LETC staff members are adjunct professors. Associated Western Universities (AWU) provide appointments for approximately 20 professors and students for assignments on current LETC research efforts. Close relationships are also maintained with other key western universities.

CURRENT MISSION AND MAJOR PROGRAM ACTIVITIES

LETC, a petroleum coal, and oil shale research center, is primarily concerned with developing technology for the in situ recovery of the energy values of oil shale, coal and tar sands, thereby allowing use of otherwise unrecoverable resources. Field experiments in each of the three commodities are conducted at locations 80 to 300 miles from Laramie. LETC is nationally and internationally recognized for its expertise in oil shale and shale oil processing research. This expertise arises from a continued involvement in oil shale research since the center was established under the Synthetic Liquid Fuels Act of 1944.

An in situ shale oil recovery experiment was recently successfully completed near Rock Springs, Wyoming. The experiment consisted of site and formation preparation, ignition, and product recovery. The experiment yielded 70 barrels of crude shale oil. Other field sites near Rock Springs have been cored and preparations for recovery experiments are underway. These oil shale field sites provide the necessary platform for LETC's concurrent environmental research and monitoring efforts. Energy conservation is a key part of the overall development scenario.

LETC has also successfully managed the Department of Energy's (DOE's) Anvil Points Oil Shale Facility near Rifle, Colorado. This facility was used over a 3-year period by a 17-company consortium to study the above-ground retorting of oil shale. This same facility is being used by Development Engineering, Inc., to produce 100,000 barrels of crude shale oil under contract to DOE and the Office of Naval Research. The recovered oil will be used in refining research and to produce specification-grade military fuels.

At LETC's North Site, the 10-ton and 150-ton retorts were used to demonstrate for the first time that large blocks of oil shale could be retorted in situ. The data from these retorts are being used to mathematically model in situ recovery of shale oil. As one of the three government projects in the United States that are actually producing shale oil, these retorts provide LETC and many other oil shale and shale oil researchers data and samples for technology and environmental research efforts.

LETC has also completed several successful field tests of in situ coal gasification at a site near Hanna, Wyoming. The most successful

HANNA III — Underground Coal Gasification Experiment — near Hanna Wyoming

underground coal gasification test ever conducted (Hanna II) was recently completed, the results of which received national and international attention. The Hanna II experiment produced gas of higher heating value and yielded higher resource utilization and thermal efficiency than any other experiment ever conducted. Over 6,700 tons of coal were gasified. Maximum gas production achieved was 11.5 million standard cubic feet (scf) per day. This gas has had a heating value of 175 Btu/scf which is equivalent to 325 barrels of oil per day. The tars produced in association with the gas amount to about 5 percent of the Btu value of the total product and are being examined for potential use. The Hanna III test was conducted as an environmental burn and Hanna IV is presently in progress as a gasification experiment.

The coal gasification tests at Hanna, Wyoming, have been of longer duration than any tests other than those conducted in the USSR. LETC is planning subsequent tests of an even larger scale to determine overall process control, environmental impact, and economic considerations--all leading to a demonstration of power generation by the early 1980's with major industrial involvement.

In situ thermal recovery methods, including combustion and steam drive are being experimentally applied to recover oil from United States tar sands. Two field experiments, in the Northwest Asphalt Ridge deposit near Vernal, Utah, have tested a combination of reverse and forward combustion processes. Concurrent supporting research includes characterization of liquid and gaseous products for processing and utilization and for environmental considerations. The second experiment, conducted in FY 1978, recovered 25 percent of the original oil-in-place. These experiments have provided encouragement for application of the combustion processes to tar sands on a larger pilot scale to determine economic parameters. They have also identified and provided indications of solutions to major problem areas such as process control and efficient handling of the extremely viscous produced oil.

Investigation of the technical feasibility of the steam drive process, DOE Enhanced Oil Recovery Project 10, was initiated in FY 1978. This project involves both laboratory and field experiments with the steam drive process and its variations. These thermal processes (if successfully demonstrated) are potentially applicable to a majority of the currently known 30 billion barrel tar sand resource in the United States.

PROGRAM FUNDING

In fiscal 1978 the operating budget for LETC was about \$26.2 million. The distribution by programs is as follows:

Programs	FY 1978 Operating Funds (In Millions)
Oil Shale (Field & Support)	\$21.0
Tar Sands (Oil & Gas)	1.5
In Situ Coal Gasification	<u>3.7</u>
Total	\$26.2

LETC's budget reflects the anticipated commercialization of specific energy recovery technologies beginning in fiscal 1980-1982. Once industrial interest is developed, industrial participation and funding will augment Laramie's efforts to the point that government funding will begin to decrease even though these programs move into their most expensive stages. It is expected that government participation will decline even further as these technologies near full commercial application by fiscal 1982-1985.

LETC has Technical Project Officer (TPO) responsibilities on five major cooperative field projects in oil shale. They are with: Talley Energy Systems, Inc.; Equity Oil Company; Geokinetics, Inc.; Occidental Oil Company; and Dow Chemical Company. Funds for these major field projects are awarded from the Office of the Assistant Secretary for Energy Technology. These projects involve support from various levels of government industry cost sharing. These cooperative efforts are undertaken to demonstrate the technical, economic, and environmental feasibility of recovering energy from oil shale.

MAJOR FACILITIES

- o Facilities at LETC include in-house research laboratories, offices, and seven auxiliary buildings on a 2.13 acre site on the northwest corner of the University of Wyoming campus. The facility houses a wide variety of modern equipment and instrumentation, some of which are unique. LETC's spectroscopic facility is the largest in the region devoted to fossil fuel research and characterization. The Fischer Assay Laboratory is also located here, which could well be the largest in the world in terms of total numbers of analyses.
- o Two pilot plants area located 1 mile north of Laramie occupying a leased 17-acre plot which includes the 10 and 150-ton retorts, a control center, a small office building and several storage buildings and the oil shale gasification facilities.
- o The Rock Springs, Wyoming, in situ oil shale retorting field site includes about 200 acres of leased land, plus smaller nearby drill sites and a hydraulic fracture site on land managed by the Bureau of Land Management. Two shop buildings and a number of trailers and office buildings are located on the site.

- o The Hanna, Wyoming, underground coal gasification site consists of 320 acres. Equipment is housed in one shop building, four instrument buildings, and trailers and storage vans, and a large compressor building.
- o The Vernal, Utah, in situ tar sand recovery site is located on a 10 acre plot. Facilities include shops, storage buildings, trailers, and compressor buildings.
- o The Rifle, Colorado, oil shale facility consists of a pilot plant and semiworks for above ground oil shale retorting, laboratories, shop, control and administration buildings, and an oil shale mine in the Mahogany zone of the Green River Formation.

SIGNIFICANT ACCOMPLISHMENTS

- o In situ oil recovery experiments were successfully completed at Rock Springs, Wyoming.
- o Coal gasification field tests were successfully completed at Hanna, Wyoming.
- o A breakthrough was made in the ability to chemically characterize "asphaltiness," an important, often troublesome but little understood component of petroleum and syncrudes.
- o An alternative method for producing oil from oil shale was suggested by experiments in which oil shale kerogen was converted to an oil-soluble bitumen by its reaction with carbon monoxide and water.
- o Exploratory study showed that the optical activity of shale oils decreased with retorting rate, thereby suggesting a method of determining temperature history of in situ produced shale oils.
- o Asphalt studies have identified the chemical groups at the asphalt-aggregate interface that are responsible for road failures due to "water stripping." This knowledge will allow better design, improve highway life, and thus save significant amounts of asphalt for use as fuel.
- o Technical feasibility of the in situ combustion process for production of oil from United States tar sands was successfully demonstrated by recovery of 25 percent of the original oil-in-place in the second small-scale field experiment.
- o Oil shales of the Mahogany zone and overlying beds were evaluated in Report of Investigations 78/2, Colorado's Primary Oil-Shale Resource for Vertical Modified In Situ Processes.

EXECUTIVE SUMMARY

Morgantown Energy Technology Center

LOCATION: Morgantown, West Virginia

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$37.8 million .
STAFFING:	250
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$4.9 million
NUMBER OF ACRES:	45.2
NUMBER OF BUILDINGS:	15
FLOOR SPACE:	142,825 sq. ft.

OPERATING CONTRACTOR:

Federally Operated

RESPONSIBLE OPERATIONS OFFICE:

Oak Ridge

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Coal (78%)
Gas (11%)
Petroleum (5%)
Conservation (2%)

MAJOR FACILITIES:

None

* ^{1/} Percentages represent total staff (full-time equivalent) devoted to that activity including indirect.

MORGANTOWN ENERGY TECHNOLOGY CENTER

Morgantown, West Virginia

INTRODUCTION

The Morgantown Energy Technology Center (METC) is a federally-owned and operated laboratory located in northern West Virginia. The facility dates back to 1946 when a coal research station was established by the Bureau of Mines, Department of the Interior, at West Virginia University in Morgantown. In 1954, the station was moved to its present 45-acre site along with a Bureau of Mines Petroleum Research Laboratory. In 1969, the coal and petroleum research activities were combined into the Morgantown Energy Research Center. It remained under the Bureau of Mines until transferred to the U.S. Energy Research and Development Administration (ERDA) in January 1975. Then in October 1977, the ERDA functions were incorporated into the U.S. Department of Energy. METC is readily accessible to the coal, oil, and gas fields of the eastern half of the country, is well-endowed with human and physical resources, and enjoys long-standing and active working relationships with industrial, academic, and government entities.

METC has an essential role in meeting the challenge of satisfying national energy demands and the equally urgent need to maintain the quality of the environment. The major research effort and research talent is devoted to capitalize on the in-place strengths and knowledge of the center personnel in Enhanced Oil and Gas Recovery, Fluidized-Bed Combustion, Low-Btu Coal Gasification, Gas Steam Cleanup, Underground Coal Conversion, and Project Synthesis Management. In so doing, this center has emerged as one of the Department of Energy's lead technology laboratories in research and development (R&D) capabilities in such categories as enhanced oil and gas recovery, atmospheric fluidized-bed combustion, synthetic fuels processes research, environmental research related to gas stream cleanup/end use of coal/coal-derived fuels, materials and component research/testing associated with coal conversion and utilization, extraction utilization of energy from unmineable coalbeds, and basic research in fossil related disciplines.

Scientific and engineering talent of the center is grouped into functional, highly efficient operating teams with strong contractor-support base which is capable of managing research and significant technology-based projects in partnership with the Oak Ridge Operations Office. Expertise and facilities are also available to effect efficient and professional collection of data, research oriented analysis, and on-line analysis and control of multiple experiments, post-experiment data analysis, communications, data base management, and report generation.

Highlighting current efforts is the establishment under METC management of a major program for recovering methane from the tight Devonian Shale formations of the eastern United States. Related to this is an

increased R&D capability in enhanced oil/gas technology that can be rapidly expanded into new initiatives leading to demonstration and commercialization projects boosting production of these vital hydrocarbons from conventional sources. Natural gas recovery methods are also being tested in coal strata for source location volume, duration and enhancement.

METC expertise in fluidized-bed combustion of coal, an efficient method of generating electric power, has led to a principal role in the design and future experimentation with a 65 ton per day atmospheric fluidized-bed coal combustion test facility. Extensive experience with fluidized-bed combustion technology and problems associated with direct firing of coal for electric power generation warranted this major project and program responsibility.

Scientists from METC also have a long and distinguished record in the publication of research results in technical, scientific, and trade journals. METC's formal publication output on fossil energy-related research is approaching 1,000. METC authors have received regional and national awards and made hundreds of presentations before scientific and engineering conferences and symposia. METC has also hosted numerous national and regional seminars and symposia on energy- and environment-related subjects, engaged in regular conferences with industrial, academic, and governmental groups, and has provided experts to serve on many committees and study groups on fossil energy and environmental matters.

PERSONNEL

The permanent full-time METC professional staff includes:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	17	Engineers	54
M.S.	22	Scientists	39
B.S.	46	Other Professionals	2
		Technicians	124
		Other	31
Total	85	Total	250

PROGRAM AND MISSION

Attention is being devoted to research to improve technology for processing and utilizing coal and for extracting petroleum and natural gas. A 42-inch diameter by 28-foot high stirred-bed coal gasifier is being

modernized and upgraded to operate as a reliable, steady-state source of pressurized low-Btu gas usable in a variety of gas cleanup, waste treatment and gas use research endeavors. A full stream gas cleanup system is being installed, that in addition to improving the successful side stream cleanup effort, will also eliminate the H_2S through the use of a Holmes-Stretford catalytic reactor. The gasifier will be a test base for such variations as tests on extruder feeding of coal, and lock-hopper valve systems from the valve program. Technology is also being developed and demonstrated for in situ gasification of eastern U.S. coals into low-Btu gas, with field tests planned for 1978 including a small-scale burn to obtain design data for full-scale field experiments in 1979.

Solid sorbents studies are being developed to remove particulates and sulfur from hot coal-derived to make it environmentally acceptable as a fuel and to save heat energy that is lost during cleanup of gas by conventional wet scrubbing methods. In addition to particulates and sulfur, studies are also being made to remove fixed nitrogen compounds and metal alkali from the hot coal-derived gas. While sulfur removal has been proven by the sorbent method, using iron oxide in bench-scale tests, it now needs to be incorporated in the removal of the particulate, nitrogen and alkali compounds. These studies are planned to include sorbents, catalysts and their regeneration, plus the recovery of items such as sulfur in a marketable form.

A slurry-feeding system is being developed as an alternative to troublesome lock-hopper systems for introducing crushed coal to pressurized coal conversion reactors. Construction of a bench scale plant was completed in 1978; experiments will follow to obtain design data for drying coal slurries with superheated steam for pressurized feeding of solid fuels.

Valves for pilot- and demonstration-size coal conversion plants are being evaluated, and new valves are being developed for service under severe conditions of temperature, pressure, and corrosive materials.

Chars produced as by-products of coal gasification and liquefaction processes are being analyzed to help establish the chemical and physical properties that limit or enhance their use in gasification, hydrogen generation combustion, or other applications. Advanced coal gasification concepts are being surveyed for possible ways to improve technology, reduce process costs, and accelerate the development of commercial coal conversion processes. Exploratory coal liquefaction research includes catalytic/organometallic reactivities seeking information on reactor packings and mechanisms involved in the reactions.

In coal combustion for electric power generation, fluidized-bed combustion has been under investigation at METC as a firing method for boilers in central station powerplants. An Atmospheric Fluidized-Bed Combustion

Morgantown Energy Technology Center stirred-bed gasifier for converting bituminous coals into low btu-gas cleanup, waste treatment and gas utilization studies.

Component Test and Integration Unit (AFBC/CTIU) is to be built in Morgantown and operated by DOE to develop and evaluate materials, components and control systems; resolve key technical issues; and define unknown factors in fluidized-bed combustion. Construction of the AFBC/CTIU was started in 1978 and to be completed by mid-1980's, with operations to proceed thereafter for hardware development, boiler optimization, combustion studies, and research on emissions control.

Boiler tube fouling and corrosion by coal ash is being studied. Tests and studies are ongoing on chemisorbed species, surface chemistry and mechanisms of the reactants involved in developing such deterrents to boiler efficiency and availability. This will follow a study on the chemisorbed species and surface and mechanisms of the reactants involved in developing such deterrents to boiler efficiency and availability.

Petroleum and natural gas research includes a broad, multi-organizational effort to locate gas in the tight Devonian Shales of the eastern United States and evolve technology that will reduce economic uncertainties and encourage exploitation by private industry. This program, together with field demonstration projects and economic analysis, will extend to about 1980. Contract work is already underway involving several companies on gas resource evaluation, field tests of fracturing techniques, and other aspects of the program. Success in this endeavor, according to some estimates, might add several trillion cubic feet of natural gas to reserves in the Appalachian Basin.

Research projects are also underway on utilizing natural and induced fracture systems in oil- and gas-bearing rock and new fracturing fluids and methods to stimulate and complete wells. Tests are being conducted to compare liquefied gases, foam, propellants, explosives, and large volumes of the more commonly used fracturing fluids (water, polyemulsions, and gelled alcohol).

Health and safety aspects of energy and fuels production and utilization matters of vital concern in METC's mission in recent years, are receiving increased attention by way of expanded programs and initiation of cooperative efforts with major medical and occupational safety and health research organizations and facilities. Specific attention has been directed to basic research on the environmental effects of coal conversion and combustion processes and methods of reducing them to acceptable limits.

PROGRAM FUNDING

METC's in-house operating budget for fiscal 1978 was about \$37.8 million of which approximately \$33.9 million was assigned to fossil energy research and about \$3.4 million to conservation and environmental programs.

Programs	FY 1978 Operating Funds \$ Millions
Coal	\$13.6
Gas	15.1
Petroleum	5.7
Conservation	2.9
Environmental Research	<u>0.5</u>
Total	\$37.8

The in-house research effort is supplemented by research projects under contract to private concerns and academic institutions. Primary contract support activity relates to the eastern gas shale program, enhanced oil recovery by carbon dioxide injection, and fluidized-bed combustion of coal.

In addition, METC has project monitoring responsibility for an additional \$15.1 million for an atmospheric fluidized-bed combustor/component test and integration unit which is funded through DOE.

MAJOR FACILITIES

- o A 42-inch-diameter stirred-bed pressurized (atmos.-300 psi) coal gasifier for low-Btu gas (100,000 scfh from 1.5 tph of bituminous coal) with a full stream cleanup system and low-Btu gas combustion test facility.
- o Facilities for testing and developing valves for coal conversion plants, including a dynamic lock-hopper simulator, static test units, metrication laboratory, and fluidized-bed and slurry stream supply systems to be added.
- o Two 18-inch diameter fluid-bed coal combustors and a 6-foot square by 6-foot high coal model for flow dynamics testings.
- o A 1,000 pph coal slurry and superheated stream drying test system for high pressure (1,000 psi) process feeding.
- o A 3 1/4-inch plug-flow combustor for fireside fouling and corrosion studies.
- o Facilities for the studies of reactions and bonding occurring on surfaces include Electron Spectroscopy for Chemical Analysis (ESCA), Scanning Auger Microprobe (SAM), Secondary Ion Mass Spectroscopy (SIMS), Scanning Electron Microprobe (SEM), and Fourier Transformed Infrared Spectroscopy (FT-IR).

- o Facilities for studying the reaction kinetics of reactive and/or corrosive species in a hot gas stream by a modified DTA-TGA analyzer equipped with a quadruple mass spectrometer for entrained mineral matter absorption and/or volatilization. Gas phase reactions are studied by a fast flow system heated to stream temperature with detection by a modulated beam mass spectrometer and/or laser induced fluorescence.
- o A laboratory scale gasifier to be used on Hot Gas Cleanup Projects has been constructed. This unit will supply a gas stream at a flow rate of 30-100 standard cubic feet per hour (scfh) and operate at temperatures up to 1800°F. This unit will be used to obtain data to develop cleanup technology for the removal of tars, alkalis, particulates, NO_x and SO_x from a gasification stream.
- o A 1-gallon stirred-batch liquefaction reactor and two 300-ml stirred-batch reactors for direct catalytic studies.
- o Laboratory testing facilities for oil displacement tests and phase behavior studies. •

SIGNIFICANT ACCOMPLISHMENTS

- o Determination of basic fluidized-bed combustion properties and pollution-emission characteristics of coals and low-grade fuels leading to design of a 65 ton per day facility to test and develop materials to facilitate development of commercial fluidized-bed boilers. The work on anthracite culm (refuse bank material) is being expanded by the Department of Energy through three proposed site selections for commercially sized units in the Pennsylvania anthracite region.
- o Completion of preliminary tests and studies that provided the technical background for a broad R&D program to locate and extract gas from the tight Devonian Shales in the eastern United States and thus encourage commercial production.
- o Development of fundamental information and engineering expertise leading to the design and installation of facilities for testing and improving valves to perform satisfactorily in pilot and demonstration oil conversion plants.
- o Design and development of first stirred-bed pressurized gasifier to convert highly caking coals into low-Btu gas.
- o Development of process feed stream nuclear monitors for sulfur and moisture content of coal that overcomes the sampling errors

and constraints inherent in conventional methods. Collaborated with British National Coal Board in developmental testing of nuclear meter for coal ash content.

- o Development of online atomic emission monitor for sodium and potassium corrodant concentrations in gasification/combustion gas stream (contracted from Ames Laboratory).
- o Analyses and compilation of a data base on a mineral content of coal, including elemental and mineralogical data on bituminous, subbituminous, anthracite, lignite coals from 200 locations.
- o Development of a sulfur removal technique from hot raw coal gasification streams (iron oxide pellet).
- o Analyses of advanced magnetic separation techniques.
- o Development of a novel catalytic hydrogenation process using hydrogen diffusion through porous reactor wall having an inner coating of catalyst, with resultant high hydrogen consumption while maintaining a clean catalyst.
- o Demonstrated the advantages of the two-step hydroliquefaction process in which a nominally non-catalytic packing was used in the first step.
- o Completion of characterization and process studies on low-temperature coal tar that provided essential data that would be required to establish a chemical industry based on low-temperature tar.
- o Analysis by infrared spectroscopy of lunar rocks and dust from several Apollo space missions--the only infrared examination by any of the 193 worldwide scientific teams assigned to lunar analytical studies.
- o Engineering studies of petroleum fields in the Pennsylvania grade crude oil area, which placed recovery of the hydrocarbon on a more scientific basis.
- o Development of unique concepts for stimulating marginally productive natural gas reservoirs by directionally drilling wells to intersect natural fracture systems.
- o Development of well-plugging technique for abandoned oil and gas wells to facilitate safe mining through wells interfering with underground coal mining operations.

EXECUTIVE SUMMARY

Pittsburgh Energy Technology Center

LOCATION: Pittsburgh, Pennsylvania

STATISTICS: (FY 78)

DOE OPERATING BUDGET:	\$19.3 million
STAFFING:	379
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$54.5 million
NUMBER OF ACRES:	41
NUMBER OF BUILDINGS:	14
FLOOR SPACE:	171,438 sq. ft.

OPERATING CONTRACTOR:

Federally Operated

RESPONSIBLE OPERATIONS OFFICE:

Chicago

PRINCIPAL PROGRAM ACTIVITIES:^{1/}

Coal Technologies: 100%

MAJOR FACILITIES:

None

^{1/} Percentages reflect total staff (full-time equivalent) devoted to that activity including indirect.

PITTSBURGH ENERGY TECHNOLOGY CENTER

Pittsburgh, Pennsylvania

INTRODUCTION

The Pittsburgh Energy Technology Center (PETC), conducts research and development as part of DOE's overall program to promote production of clean energy from coal. Established in 1948 as an energy research laboratory of the Office of Synthetic Liquid Fuels, U.S. Bureau of Mines, PETC is the largest fossil energy research and development center in the United States. PETC has a staff of about 379 scientists, engineers, technicians, and support personnel and is the major Federal laboratory for research in coal combustion and conversion of coal to clean fuels. It is located in a semirural area near Bruceton, about 12 miles south of Pittsburgh, Pennsylvania.

While PETC's emphasis has been on coal research and development, the individual projects and their nature change to meet the Nation's energy needs. Some of our major projects, such as coal-oil slurry combustion and the chemical cleaning of coal, are only 1 or 2 years old (but have major near-term impacts) whereas others, such as coal liquefaction, combustion and high Btu gasification represent multiyear efforts. The program will change over the next few years as it has in the past.

PETC is currently in the process of preparing to participate in the management of selected projects being moved out of headquarters and into field organizations. PETC is going through a process of educating itself in preparation for this move and is already involved in the management of the Coal Science Program. It is anticipated that the coal-oil slurry and magnetohydrodynamics (MHD) combustion field projects will be managed from PETC as well as several other coal conversion and utilization-related projects. As a means of increasing the flexibility of the PETC organization, in light of field management assignments, PETC is currently in the process of reorganizing to a matrix form of organization. The basic structure would include a program arm, a functional arm and a support arm. This new organization form would enable PETC's current in-house R&D efforts to be efficiently continued as well as establish an effective management structure for management of those field projects assigned to PETC. PETC is also currently in the process of contracting for outside management support services for both in-house research and development (R&D) programs and anticipated field project management assignments.

PERSONNEL

PETC's staff includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	53	Engineers	78
M.S.	30	Physical Scientists	73
B.S.	<u>104</u>	Computer Scientists/ Mathematicians	9
Total	187	Technicians	140
		Clerical	38
		Other	<u>41</u>
		Total	379

CURRENT MISSION AND PROGRAM ACTIVITIES

PETC's fossil energy program encompasses a broad spectrum of developing processes for industrial use of coal and its derived synthetic fuels in an environmentally sound manner that emphasizes overall energy conservation. PETC objectives include the development and extension of a sound technology base to: (1) Obtain significant breakthroughs in fossil processes and technologies for the future, (2) offer technical and environmental support for the various processes and contractors supervised by headquarters, and (3) enable PETC to evaluate new and ongoing projects, providing sound advice, direction, and suggestions for improvement technically, environmentally, and in the area of energy conservation.

PETC today is in the lead in coal conversion and utilization research. Modifying conventional coal combustion equipment to permit efficient, clean firing of coal-oil slurries and solvent-refined coal may appreciably reduce the use of petroleum to generate electric power. Progress is also extensive in developing new processes for converting coal to cleaner, more adaptable fluid fuels. These processes include the hydroliquefaction of coal using inexpensive disposable catalysts; SYNTHANE--a second generation process to produce high Btu pipeline quality gas from coal, and dilute-phase hydrogasification--a highly efficient and relatively simple third generation process to make pipeline gas by direct hydrogenation of coal.

Gasoline and other light distillates can be produced by adaptations of these liquefaction and gasification processes. Research is also being performed on the chars produced in coal conversion processes to utilize them in hydrogen production and in combustion for power generation. Coal combustion research programs emphasize combustion development of a unique two-stage coal gasifier-combustor to supply a high temperature plasma for a combined cycle MHD powerplant to produce electricity from coal more efficiently than is presently done.

Several of these processes are now being scaled up. A 700 horsepower (HP) boiler facility for coal-oil slurry firing was completed at PETC in 1978. A SYNTHANE prototype pilot plant that processes 72 tons of coal per day into over one million cubic feet of gas is operating at PETC. Construction is nearly completed on a liquefaction process development unit designed to convert 10 tons of coal per day to 30 barrels of low-sulfur oil. A 5 MW (12 tons of coal/day) gasifier-combustor, as part of MHD power generation research, is currently operating at PETC. These processes will help preserve the environment while meeting the nation's increasing energy needs.

As a necessary and continuing effort, extensive process and engineering research is also being conducted:

- o A promising method of removing much of the sulfur from coal by pressurized air-water treatment is under development.
- o Techniques for refining and upgrading coal liquids and producing valuable chemicals, such as ethanol and ethylene, are being investigated.
- o Research is being conducted to develop new and improved catalysts for coal liquefaction and gasification processes.
- o An important effort is devoted to development of new analytical tools and techniques to characterize coal and coal products from energy conversion processes.
- o Both experimental and theoretical engineering studies are being done on reactor modeling.

In all research and development studies, environmental impact and conservation techniques are an integral part of each project scheme.

PROGRAM FUNDING

In fiscal 1978, the operating budget for PETC was about \$19.3 million; with the exception of \$80,000 in solar energy development, the PETC budget was for coal research--coal liquefaction, high Btu coal gasification, coal combustion, MHD, materials and exploratory work, and support demonstration plants.

MAJOR FACILITIES

PETC buildings and auxiliary facilities, including the SYNTHANE pilot plant and liquefaction Process Development Unit (PDU), occupy an area of 41 acres. There are 14 buildings, containing 171,438 sq. ft. of laboratory/process and administrative space.

The following is a list of large or unique facilities or equipment at PETC:

Liquefaction

Bruceton Liquefaction Process Development Unit
(operation to start in FY 1979)
Liquefaction Laboratory Units (2)
Slurry-Phase hydrogenation facilities
Other high-pressure facilities

Gasification

SYNTHANE pilot plant (operating)
SYNTHANE process development units
Dilute Phase hydrogasification facilities
Fischer-Tropsch synthesis facilities

Combustion

700 HP, 200 HP, and 20 HP coal slurry facility
100 HP coal slurry combustor
500 pound per hour pulverized-coal-fired furnace

MHD

5 megawatt (MW) gasifier-combustor
Atmospheric high-temperature combustor

Process Support

Analytical and spectrometric facilities
Coal carbonization pilot plant
High-temperature fluidized-bed pyrolysis facilities
Bench-scale catalyst testing units, autoclaves, and reactors
Computer facilities

SIGNIFICANT ACCOMPLISHMENTS

- o Operation of the SYNTHANE prototype pilot plant to produce synthetic natural gas from coal.
- o Development of a third generation process, dilute-phase hydrogasification; for synthetic pipeline gas that may prove even more efficient and economical than processes now being advanced.

- o Construction of the 10 ton per day Liquefaction Process Development Unit to produce a low-sulfur low-ash oil from coal.
- o Development of the CO-STEAM coal liquefaction process for lower rank coals, using synthesis gas rather than hydrogen and without expensive catalysts (transferred to Grand Forks Energy Technology Center).
- o Operation of a 5 MW development unit to produce from coal a clean, hot plasma suited for the potentially highly efficient, pollution-free generation of electric power by MHD.
- o Operation of a unique pulverized-fuel-fired furnace to study power generation from alternate carbonaceous fuels by low pollutant emission techniques.
- o Construction of a 700 HP coal-oil slurry facility to determine operating characteristics and efficiency of firing coal-oil mixtures in conventional power plants.

EXECUTIVE SUMMARY

Carbondale Mining Operations Center

LOCATION: Carbondale, Illinois

STATISTICS: (FY 1978)

DOE OPERATING BUDGET:	\$4 million
STAFFING:	25
CAPITAL INVESTMENT:	\$2,262 million
NUMBER OF ACRES:	25
NUMBER OF BUILDINGS:	5
FLOOR SPACE:	38,000 sq. ft.

OPERATING CONTRACTOR:

Federally Owned and Operated

RESPONSIBLE OFFICE:

Assistant Secretary for Energy Technology

PRINCIPAL PROGRAM ACTIVITIES:

Mining Research and Development

MAJOR FACILITIES:

None

CARBONDALE MINING OPERATIONS CENTER

Carbondale, Illinois

INTRODUCTION

The Carbondale Mining Operations Center is a new Department of Energy (DOE), federally-owned and operated, research facility currently under construction in Illinois. Its location, 8 miles east of Carbondale is central to both the eastern and western mineable energy resources and directly on the southern edge of the Illinois coal basin. A midsize university, Southern Illinois University at Carbondale, provides a close contact with the academic community.

PERSONNEL

Highest Degree Attained	Number	Occupation	Number
Ph.D.	1	Engineers	10
M.S.	11	Geologists	2
B.S.	<u>9</u>	Physical Scientists	2
		Technicians/Aides	2
		Others	<u>9</u>
Total	21	Total	25

The center is staffed with an excellent core of technically oriented science and engineering personnel. The backgrounds of both government and industry of the center's personnel contribute greatly to the center's level of excellence.

CURRENT MISSION AND PROGRAM ACTIVITIES

The center's advanced mining research and development activities were transferred to DOE from the Department of the Interior, Bureau of Mines. Program activities at the center are designed to support DOE's Division of Fossil Fuels Extraction, a part of the Fossil Energy Office in the Energy Technology Program.

MAJOR FACILITIES

The Carbondale Mining Operations Center is situated on 25 acres of land adjacent to Crab Orchard National Wildlife refuge in the southern tip of

Administration Building
Carbondale Mining Operations Center

Illinois. A 4-year-old dormitory facility, purchased from Southern Illinois University, was converted to the administration building for the complex.

SIGNIFICANT ACCOMPLISHMENTS

The individuals associated with the Carbondale Mining Operations Center have contributed greatly to the advancement of mining technologies for this Nation's solid fossil-energy fuels. Center personnel were responsible last year for implementing and monitoring approximately \$22 million of the extraction program funded to outside industry. In addition, they have contributed much to the planning and programming of future DOE programs.

EXECUTIVE SUMMARY

Pittsburgh Mining Operations Center

LOCATION: Bruceton, Pennsylvania

STATISTICS: (FY 1978)

DOE OPERATING BUDGET:	\$5.35 million ^{1/}
STAFFING:	86
CAPITAL INVESTMENT (PLANT AND EQUIPMENT):	\$35 million
NUMBER OF ACRES:	
NUMBER OF BUILDINGS:	7 ^{2/}
FLOOR SPACE:	210,950 ^{2/}

OPERATING CONTRACTOR:

Federally Owned and Federally or/Contractor-Operated

RESPONSIBLE OFFICE:

Assistant Secretary for Energy Technology

PRINCIPAL PROGRAM ACTIVITIES:

Mining Research and Development

MAJOR FACILITIES:

None

^{1/}Includes \$2.5 million for Support Contractor

^{2/}When all facilities under construction are completed (approximately 1980).

PITTSBURGH MINING OPERATIONS CENTER

Pittsburgh, Pennsylvania

INTRODUCTION

The Pittsburgh Mining Operations Center (PMOC) is a federally-owned and federally/contractor-operated technology development center located at Bruceton, Pennsylvania, in the Greater Pittsburgh area. Also located at this Federal coal research complex are the Department of Energy's Pittsburgh Energy Technology Center, the Technical Support Center of the Department of Labor's Mine Health and Safety Administration, and the Bureau of Mines' Pittsburgh Mining and Safety Research Center. This complex of Federal facilities is located in the principal coal-producing area of southwestern Pennsylvania near the headquarters of some of the Nation's major captive and commercial coal companies, mining equipment manufacturers, research institutions, and universities.

PMOC was formed in October 1977 when the Coal Preparation and Analysis Group and those personnel conducting energy-related mining research in the Pittsburgh Mining and Safety Research Center were transferred from the Bureau of Mines into the newly formed Department of Energy (DOE).

The mining group, while recent in terms of institution, brought with it much "corporate knowledge" in underground coal mining. As the criterion for transferring personnel from the Department of Interior (DOI) to the DOE was the portion of time personnel were allocated to energy-related research or health and safety research, the personnel ultimately transferred were mostly professionals, administering technical contracts, i.e., writing Statements of Work, chairing technical evaluation committees and technical clarification sessions, participating in negotiations, and acting as technical project officers. As a result, the mining group is made up essentially of professional engineers and scientists highly skilled in contract research.

PERSONNEL

The current staffing of PMOC is:

	Mining Group	Preparation Group	Total
Full-time Professionals	22	16	38
Clerical	3	4	7
Technicians	1	21	22
Vacancies	<u>2</u>	<u>1</u>	<u>3</u>
Subtotal	28	42	70

		Mining Group	Preparation Group	Total
OTFTP*	Professionals	3	1	4
	Clerical	1	1	2
	Technicians	0	9	9
	Vacancies	<u>0</u>	<u>1</u>	<u>1</u>
	Subtotal	4	12	16
	Totals	32	54	86

Highest Degree Attained	Mining Group	Preparation Group	Total
Ph.D.	3	3	6
M.S.	8	1	9
B.S.	23	10	33
B.A.	<u>0</u>	<u>5</u>	<u>5</u>
	34	19	53

*Other than Full-Time Personnel

CURRENT MISSION

PMOC is one of two mining operations centers; the other center, Carbondale Mining Operations Center, is located at Carbondale, Illinois. The joint mission of these two centers is to conduct the research required to more efficiently mine and prepare the coal supply needed to meet the Nation's current and projected demand. By efficiently is meant to extract and prepare the required quantity and quality of coals for direct combustion and conversion to metallurgical coke and liquid and gaseous fuels in a manner which will: conserve our non-renewable coal reserves through high coalbed recovery and efficient coal preparation; minimize adverse environmental impacts through good mine plant design, proper choice of mining method and proper operation of preparation plants; minimize the hazards to the mine worker and guarantee him a healthy work environment both in the mine and in the preparation plant; minimize overall production costs; maximize production of salable coal; and, be in the best public interests.

The center consists of three subdivisions: Coal Mining, Coal Preparation, and Test Facilities.

The coal preparation group has a long and productive history. Established in Bruceton in 1946 when the Federal Government expanded its synthetic liquid fuels activities, this group is the only federally-funded coal preparation activity; all other federally-supported coal

preparation work at Seattle, Tuscaloosa, Denver, and Schuylkill-Haven was terminated during the 1960's. The present group has offices and laboratories in Oakland (Pittsburgh), and offices, laboratories, and a pilot plant in Bruceton.

MAJOR FACILITIES

The development of the advanced systems, subsystems, machines, and ancillary equipment intended for use in commercial underground coal mines is made complex by the fact that it ultimately must prove its value in a hostile and, often hazardous, environment; inadequacies can be dangerous to the safety and health of the miner and costly in terms of production losses to the mine operator.

One way to reduce the cost, decrease development time, and minimize hazards is to test and evaluate (to the extent practicable) innovative mining equipment and methods at full scale in a surface test facility with the equipment operating under load and in typical underground geometries. Performance deficiencies thus can be identified and corrected prior to going underground. Equally important, the prototype equipment under test does not require the Mining Safety and Health Administration certification (often a long and onerous task) and its technical performance can be demonstrated under load in a simulated mine situation to prospective users.

The advancement of coal preparation technology has been constrained by the lack of suitable laboratory and pilot plant facilities. New coal preparation processes and equipment generally must be demonstrated at commercial scale and in a fully integrated circuit before they are accepted by the industry. It is no simple task to extrapolate laboratory studies or unit pilot plant test data to commercial scale and, hence, the transfer of technological advances operating at less than commercial scale are often difficult to transfer to industry. If a commercial operator wishes to use the new technology in his plant, he often finds that his plant does not have adequate facilities. With the completion of PMOC's new preparation test facilities, coal preparation personnel now housed in five separate buildings will be consolidated in a single integrated facility.

PMOC's facilities when completed and operating will constitute the most advanced coal mining and preparation test facilities in the world. This facility includes in addition to a shop, warehouse, and office spaces, five major units:

- (1) A 180 by 300 ft. facility for assessing the technical performance of a wide variety of innovative and advanced underground longwall and room-and-pillar mining equipments, full scale, and under the kinds of loads normally experienced in practice by using blocks of simulated "coal" cast in underground configurations;
- (2) a 180 by 300 ft. facility for assessing the maneuverability of such

novel underground mining and transportation equipment as remote-controlled continuous miners, automated extraction systems, automated shuttle cars and advanced haulage systems; (3) a facility for evaluating the effects of such parameters as pipe diameter, length, material, velocity, solids concentrations and size consist on the efficiency and economics of transporting mined materials hydraulically--especially run-of-mine coal; (4) a mine roof simulator capable of exerting up to 1,500 tons vertically and 800 tons horizontally on a 20- by 20-foot platen in order to study the effects of the magnitude, rate, and direction of loads applied to such artificial roof supports as frames, chocks, shields, cribs, and packwalls; and (5) a coal preparation plant which includes: a dense medium cyclone, water-only cyclones, wet concentrating tables, and froth flotation cells; and area for batch testing of new equipment and processes; and a raw coal handling facility for crushing, sizing, drying, and storing coal samples for testing.

The total investment in physical plant is about \$35 million; it is estimated that operating costs will be about \$2.5 million per year.

PROGRAM ACTIVITIES

The major current activities of the Mining Group include:

- o Full Extraction Systems Development--Full extraction mining systems include longwall and shortwall methods. Although 95 percent of the coal mined underground in the United States is mined by partial extraction systems (room-and-pillar methods), full extraction systems offer potential for increasing unit coal production, improving coal workers' productivity, increasing coalbed recovery, reducing maintenance and enhancing the health and safety of the face workers.

Typical of the kinds of projects being done under contract include: encouraging the use of longwall system through improved reliability, availability and other operations-type studies; automation and increased cutter/loader efficiency, higher capacity face conveyors, and cost-sharing demonstrations of longwall technology in thick, thin, and pitching coalbeds and in geologic environments unsuitable for mining by partial-mining methods.

- o Transport and Other Services--The ability to move people, supplies, materials, and coal in and out of underground workings is crucial to the support of face operations. Typical of the kinds of projects being conducted under contract includes the development of face haulage systems for use with continuous miners and loading machines; increased capacity, cableless and automated shuttle cars, hydraulic transport, higher capacity conveyor belts and automated rail haulage.

The major current activities of the Coal Preparation Group include:

- o Coal Characterization--Washability studies of coals have been conducted for over 13 years, and have led to publication of comprehensive reports detailing the sulfur reduction potential of United States coals. Using petrographic techniques, the correlation of sulfur reduction potential with pyrite particle size is being investigated. In addition, trace element studies are being carried out under contract.
- o Physical Beneficiation--Efforts are underway to evaluate the performance of dense-medium cyclones for fine coal cleaning at ultra-low specific gravities. Performance evaluations of coal cleaning devices commonly used in the United States is nearing completion. High-gradient magnetic separation as a potential technique for removing pyrite from coal is being investigated.
- o Physicochemical Beneficiation--The Coal-Pyrite Flotation Process which was developed at PMOC is being demonstrated cooperatively in a commercial coal preparation plant. Research also is underway to extend the range of current froth flotation methods to the efficient cleaning of ultra-fine coals.

Recent initiatives in chemical coal cleaning include: studying the mechanisms involved in the removal of organic sulfur from coal by peroxygen compounds; the reaction of organic sulfur in coal with aqueous hypochloride; and novel sulfur removal reactions which may facilitate the development of new and/or better methods for precombustion removal of sulfur from coal are being evaluated. Under contract, the Low Temperature Chlorinolysis process is being investigated by the Jet Propulsion Laboratory.

- o Ancillary Unit Operations--Methods for improving the dewatering of fine-size coal are being investigated. A mass-flow instrumentation system for controlling reagent feed to coal-slurry processing units in coal preparation plants is being developed and tested. Demonstration of a lignite pelletizing and pellet drying process is being carried out under contract.
- o Coal Analysis--This section performs analyses in support of the coal preparation activities, and analyzes coal, coke, and other related materials for other Government agencies. All federally purchased coal is analyzed by this group to insure contract compliance. Research directed toward the improvement of analytical methods is also carried out.

SIGNIFICANT ACCOMPLISHMENTS

- o Under a cost-sharing agreement with the Kaiser Steel Company, it was determined that thick coalbeds can be mined with caliber-type longwall shields.

- o Work by the National Aeronautics and Space Administration to date has shown that the cutting drums on double-ranging drum longwall shearer-loaders can be totally automated.
- o An articulated chain face conveyor and an advancing monorail belt conveyor were demonstrated on a shortwall face at the Valley Camp Coal Company. An advancing tailgate was maintained successfully during this demonstration.
- o Through a cost-sharing demonstration with the Old Ben Coal Company, the ability to longwall coal in the Illinois Basin has been demonstrated. Several earlier attempts with chock-type roof supports failed.
- o The mining of coalbeds less than 3 feet is being demonstrated under a cost-sharing agreement with the Leeco Mining Company, in eastern Kentucky.
- o A simulation program for predicting the production/productivity from a longwall face as a function of panel dimensions, coalbed thickness, and machine characteristics has been developed by Pennsylvania State University.
- o General Electric Company, under a DOE contract, developed a sensor to determine whether a longwall drum is cutting coal or rock, by analyzing the vibration spectrum of the machine frame as measured by accelerometers.
- o By injecting polyurethane resin into holes drilled into the roof, a 200-foot-long section of "bad top" was stabilized in the Beatrice Pocahontas Mine and allowed longwall mining to proceed through this disturbed area.
- o As most coal mined underground is hauled from the working face to secondary haulage via shuttle cars, improvements in this transport system can represent significant improvements in coal production. An improved shuttle car design has been completed and the cars are not being demonstrated in a West Virginia coal mine.
- o The absence of an electric trailing cable makes battery-powered vehicles for transporting people, coal and supplies and materials attractive for use underground. However, lead-acid batteries now being used on these vehicles allow use of the vehicle for only short time periods. An iron-nickel battery pack has been built to provide increased energy density so that scoops may operate underground for substantially longer time periods. An iron-nickel battery-powered scoop is scheduled for underground testing in coal mines located in Kentucky and Pennsylvania.

- o Continuous face haulage has the potential for increasing the unit shift production by 45 percent compared with shuttle car haulage. An in-house design for such a system has been completed and a cost-sharing contract has been negotiated to develop this system for general use by the mining industry.
- o A continuous miner/continuous face haulage system interface vehicle has the potential for improving shift production by 33 percent over a mining system using only a continuous miner and continuous haulage; by using this interface vehicle with roof bolting capability, a total shift production increase of almost 100 percent is possible. A scale model of this interface vehicle has been built which confirmed the results predicted by computer simulations; a follow-on underground demonstration is planned.
- o Panel belt conveyor used to transport coal from the face area to a main haulage system has to be moved or extended periodically in about 100-foot increments to keep pace with the face advance. The process of extending panel belt conveyors in low-coal mines may require up to eight manshifts. A service machine has been built which can extend the belt with four or five people in about 45 minutes. This machine is scheduled for underground demonstration in a Colorado coal mine.
- o A working-scale model of a conveyor belt using intermediate drive modules to power long belts of virtually unlimited single lengths has been built. This belt drive system will be demonstrated soon in a New Mexico coal mine.
- o Production of coal from some present and future high-capacity longwall faces requires a high-capacity armored face conveyor with above average reliability. A conveyor that will transport up to 1,200 tons per hour in surges and be capable of operating with 90 percent reliability is now being built and is scheduled for underground testing in a West Virginia coal mine.
- o A Coal-Pyrite Flotation Process has been developed in-house which provides superior pyritic sulfur reduction over existing technology for washing of minus 1/2 millimeter coal. A full-scale demonstration of the process is underway in Barnes and Tucker's No. 24 preparation plant.
- o A chemical coal desulfurization process, Low Temperature Chlorinolysis, has achieved reductions in organic and pyritic sulfur of 60 and 99 percent, respectively, in laboratory tests. This process was developed under contract with Jet Propulsion Laboratory.

- o Washability studies and sulfur reduction potential have been completed and the results published on almost 500 coalbed samples collected from the major coalbeds in the United States. This information assesses the impact physical coal cleaning can have on the level of sulfur oxide emissions from stationary coal combustion sources.
- o A Coal Preparation Plant Simulator computer model has been developed to assist engineers in the design of new plants. The simulator aids in the selection of the proper coal-washing devices to achieve maximum yield of coal of the desired quality with minimum loss of salable coal to refuse.
- o The use of high-gradient magnetic separation for removing pyrite from fine coal has been investigated (both in-house and under contract) to the extent that developmental work on a large scale, continuous unit can now be undertaken.
- o The feasibility of utilizing an analog computer for accurately measuring and controlling an unusually low specific gravity in a dense-medium cyclone circuit was demonstrated in a pilot plant; this advanced control technique is to be incorporated into the Homer City coal preparation plant.
- o Pelletized lignite containing about 40 percent moisture, was successfully dried to approximately 10 percent moisture. Pellets made with 5 percent asphalt emulsion binder were resistant to breakage during handling, weathering, and spontaneous heating. The lignite pelletizing drying process soon will be demonstrated in a 5-ton-per-hour capacity plant.
- o Oil agglomeration has been demonstrated to be effective in recovering fine-size coal (minus 44 microns) from preparation plant refuse slurries. More than 80 percent of the fuel values were recovered from a commercial refuse thickener using from 4 to 6 percent of light oil. A contract is being negotiated to demonstrate the oil agglomeration process in an 8-ton-per-hour installation at the Vesta-Shannopin Preparation Plant.
- o The use of surfactants in dewatering fine coal by vacuum filtration results in significantly drier filter cakes. Washing coal filter cakes with a hot surfactant solution before the air-drying cycle was found to reduce the cake moisture content by about 8 percentage points.

FUSION FACILITY.

PRINCETON PLASMA PHYSICS LABORATORY

Princeton, New Jersey

INTRODUCTION

The Princeton Plasma Physics Laboratory (PPPL) is located at the James Forrestal Research Campus, 3 miles from the university's main campus in Princeton, New Jersey. It is one of four major controlled thermonuclear research facilities supported by the U.S. Department of Energy (DOE).

Although thermonuclear applications are the laboratory's specialty, the staff and facilities of PPPL are able to conduct experimental, theoretical, and computer investigations into all branches of plasma physics. Currently, the low-density toroidal research at PPPL is leading the world effort in advanced heating methods, attainment of high-electron and ion temperatures, and development of detailed diagnostics for high-temperature toroidal plasmas.

PERSONNEL

The PPPL staff includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	119	Physicists	97
M.S.	65	Mathematicians	18
B.S.	79	Engineers	148
		Technicians	496
		Other	172
Total	263	Total	931

The laboratory, an integral part of Princeton University, has access to the university library, computer, and administrative services which are not reflected in the above personnel figures.

CURRENT MISSION AND PROGRAM ACTIVITIES

The mission of DOE's Princeton Plasma Physics Laboratory is to produce and control thermonuclear fusion for the purpose of developing a source of electrical energy that would be economic, inexhaustible, and environmentally attractive. Since its founding in 1951, the laboratory has

devoted its attention entirely to understanding the physics and engineering aspects of low-density plasmas produced and confined by magnetic fields in toroidal systems. It has been the focus for a major controlled thermonuclear effort and continues as an international leader in this field.

PROGRAM FUNDING

The total operating budget for fiscal 1978 is \$40.0 million. The authorized investment in plant and equipment is \$379.8 million.

MAJOR FACILITIES

A variety of controlled thermonuclear and plasma research devices exist at PPPL:

- o The Princeton Large Torus (PLT) is the largest operating tokamak fusion device.
- o The Poloidal Divertor Experiment (PDX) is under construction and is scheduled to begin operation in November 1978.
- o The Tokamak Fusion Test Reactor (TFTR), now under construction, will be twice the size of the PLT.

The laboratory also has very large power supplies, up to 200 megawatts, and specialized shops for fabrication of magnet coils and ultrahigh vacuum systems.

SIGNIFICANT ACCOMPLISHMENTS

- o Discovery of the basic principles of toroidal confinement
- o Development and experimental testing of equilibrium and stability theory for the Stellarator and the Tokamak
- o Improvement of the Tokamak concept by new electronic and heating techniques
- o Design, construction, and operation of the Princeton Large Torus (PLT), which is the world's largest currently operating Tokamak device

NUCLEAR DEVELOPMENT

FACILITIES

Nuclear Development Facilities

The activities of the nuclear development laboratories, which are government-owned facilities, are oriented primarily toward engineering, development, and testing. Some of the laboratories are involved to somewhat lesser extents and to varying degrees in applied research and technology development. All of these laboratories are operated by industry under contract to the Department of Energy (DOE). Contract administration, appraisal, and management oversight are usually the responsibility of a nearby DOE field office. Headquarters program divisions are responsible for formulation of programs and allocation of funds, usually with the advice and participation of the appropriate field office and laboratory management. As with the other laboratories, final decisions on program emphasis, balance, and levels of effort are made at DOE headquarters.

Most of the work at any one of these laboratories may be identified with a single DOE program. The Bettis and Knolls Atomic Power Laboratories carry out work under the Naval Reactors program.

Since much of the effort undertaken by the nuclear development laboratories is directed to an end product, such as a major test facility or a specific propulsion plant, their activities are directed and coordinated most closely by headquarters than those activities involving the more generic types of basic research conducted by the energy technology laboratories. Even so, laboratory management participates extensively in the planning of such programs and projects and in the formulation of budgets, through periodic annual budgetary submission, planning conferences, and frequent program and budget reviews.

BETTIS ATOMIC POWER LABORATORY

Pennsylvania and Idaho

INTRODUCTION

The Bettis Atomic Power Laboratory includes two sites which are operated by the Westinghouse Electric Corporation for the Department of Energy (DOE). The principal one, known as the Bettis Site, is in western Pennsylvania approximately 10 miles from Pittsburgh. It performs research and development of naval nuclear propulsion plants and the Shippingport light-water breeder reactor projects. The Shippingport Atomic Power Station established in 1954 and operated by the Duquesne Light Company has been used to demonstrate the feasibility of pressurized light-water power reactor systems and has produced electricity for the commercial power grid. The second site, the Naval Reactors Facility (NRF), is at the Idaho National Engineering Laboratory. This installation operates three prototype naval reactor plants and a facility for examination of expended naval reactor cores. The entire Bettis program is directed by the Division of Naval Reactors at headquarters.

The Pittsburgh Naval Reactors Office (PNR) administers the Bettis and Shippingport operations.. PNR is located at the Bettis site and consists of 88 administrative and engineering DOE personnel.

Through use of a project-type organization, Bettis has developed a large and highly experienced team of scientists, engineers, and technicians for work in the field of naval nuclear propulsion.

PERSONNEL

At the end of fiscal 1978, laboratory employment was 3,309 (including personnel on Navy work). Of this number, about 750 workers were assigned to the Idaho site.

<u>Highest Degree</u> <u>Attained</u>	<u>Number</u>
Ph.D.	155
M.S.	345
B.S.	<u>845</u>
<u>Total</u>	<u>1,345</u>

<u>Occupation</u>	<u>Number</u>
Scientists	128
Engineers	942
Other Professionals	836
Technicians	652
Others	<u>751</u>
<u>Total</u>	<u>3,309</u>

CURRENT MISSION AND PROGRAM ACTIVITIES

The basic mission of the Bettis Atomic Power Laboratory is development of improved naval nuclear propulsion plants and reactor cores in a wide range of power ratings to meet military requirements of the Department of the Navy. In addition, a developmental light-water breeder core has been fabricated and began operation in the Shippingport plant in late 1977.

PROGRAM FUNDING

The fiscal 1978 operating budget for Bettis Laboratory was about \$201 million, with \$154.6 million provided by DOE for naval and light water breeder reactor development, and \$46.4 million provided by the Navy for naval reactor development and testing. The authorized plant and capital equipment investment at Bettis Laboratory and the Naval Reactors Facility is \$302.1 million.

MAJOR FACILITIES

Special facilities include: the digital computation laboratory with two CDC-6600 computers and a CDC-7600 computer used for rapid solution of complex reactor design problems; the hot laboratory for examining materials following exposure to radiation; the nuclear core process development laboratories; several critical facilities; thermal and hydraulic test facilities; three prototype reactor plants for training of naval personnel and testing purposes; and the expended core facility where components and materials from spent cores are dismantled and examined to determine the effect of irradiation upon core material and components.

SIGNIFICANT ACCOMPLISHMENTS

- o The first nuclear power plant to produce power in significant quantities (NAUTILUS prototype).
- o First nuclear reactor to propel a ship (USS NAUTILUS).
- o First reactor plant solely for a full-scale nuclear electric generating station (Shippingport Atomic Power Station).
- o First reactor plant to propel a fleet-type submarine (USS SKATE).
- o First reactor plant to propel a large surface ship (USS LONG BEACH).

- o First reactor for a ballistic missile submarine (USS GEORGE WASHINGTON).
- o First reactor plant for a high-speed attack submarine (USS SKIPJACK).
- o Development of zircaloy, which is an alloy of zirconium and other metals used in manufacturing nuclear reactors.

KNOLLS ATOMIC POWER LABORATORY

Schenectady, New York

INTRODUCTION

The Knolls Atomic Power Laboratory (KAPL) includes three sites, the principal one being in Niskayuna, Schenectady County, New York. The laboratory is operated for the Department of Energy (DOE) by the General Electric Company (GE). GE also operates the land-based prototypes of shipboard pressurized-water reactor plants located at the Kenneth A. Kesselring site in nearby West Milton, New York, and at Windsor, Connecticut. DOE's Division of Naval Reactors administers the entire KAPL program with the exception of a limited Intelligence Technology Analyses and Application effort directed by the Office of International Affairs. KAPL is administered by the Schenectady Naval Reactors Office which is located on-site and which is staffed by 72 DOE employees with administrative and engineering capabilities.

PERSONNEL

At the end of fiscal 1978, KAPL employment was about 2,936 including personnel on Navy work, of which approximately 770 were assigned to the two landbased prototype sites. Their education and expertise were as follows:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	100	Scientists	143
M.S.	430	Engineers	1,051
B.S.	755	Other Professionals	608
		Technicians	157
Total	1,285	Other	977
		Total	2,936

CURRENT MISSION AND PROGRAM ACTIVITIES

KAPL's mission is the design and development of improved naval nuclear propulsion plants and reactor cores in a wide range of power ratings to meet military requirements of the Department of the Navy. Particular emphasis is placed on developing improved longer-life cores and on increasing the reliability and maintainability of reactor plant components. KAPL has been assigned the responsibility for the development of

the reactor required for the Trident ballistic missile submarines, including construction of a full-scale nuclear propulsion plant prototype for this project at the Kesselring site.

PROGRAM FUNDING

The fiscal 1978 DOE operating budget for KAPL was approximately \$99.0 million:

	(\$ Millions)
DOE Naval Reactor Development and Intelligence	
Technology Analysis & Application	\$ 99.0
Department of Defense/Navy Research & Development	<u>62.3</u>
Total	\$161.3

The authorized investment at the three sites operated by KAPL for plant and equipment is \$357.3 million.

MAJOR FACILITIES

Special facilities include four operating land-based naval nuclear propulsion prototype plants, six critical facilities, a major computer facility including dual CDC-6600 computers and a CDC-7600 system, a radioactive materials laboratory, thermal and hydraulic engineering test facilities, and ion microprobe, a scanning electron microscope, and several mass spectrometers.

SIGNIFICANT ACCOMPLISHMENTS

KAPL developed the reactor plants currently operating in six different classes of naval nuclear powered ships. Included are the smallest naval nuclear propulsion plant, which is installed in the Nuclear-Powered Research and Ocean Engineering Vehicle, NR-1, and development of the reactor for the largest naval nuclear propulsion plant, currently being installed in the Nimitz--class aircraft carriers. Other reactor development work by KAPL included the sodium-cooled reactor plant initially installed in the USS SEAWOLF, the second nuclear-powered submarine, and the reactor plants for the USS TRUXTUN, the Nimitz-class aircraft carriers, and the Los Angeles-class nuclear-powered cruisers.

In the process of designing, developing, and operating this array of nuclear propulsion plants, KAPL has contributed significantly to the physical sciences as well. KAPL is credited with the discovery of the isotope tantalum-180 in 1954 and, in cooperation with Los Alamos Scientific Laboratory, the discovery of the isotope plutonium-244 in 1972.

PHYSICAL RESEARCH

FACILITIES

PHYSICAL RESEARCH FACILITIES

Important aspects of the Department of Energy's (DOE's) programs that involve research in frontier fields of basic science and the development of detailed data, processes, and equipment, in particular and specialized areas of the physical sciences require the resources available at specialized laboratories:

Bates Linear Accelerator Facility, Middleton, Massachusetts
Fermi National Accelerator Laboratory, Batavia, Illinois
Notre Dame Radiation Laboratory, Notre Dame, Indiana
Stanford Linear Accelerator Center, Stanford, California

These laboratories provide DOE with specialized expertise for the conduct of research in the fields of elementary particle physics, nuclear physics, and radiation chemistry. The three accelerator facilities are supported through DOE's Office of High Energy and Nuclear Physics; each of the three is developed around a particle accelerator with characteristics unique in this country. The Notre Dame Radiation Laboratory is supported through DOE's Office of Basic Energy Sciences which conducts research in the physical sciences underlying the full range of energy technologies. The Notre Dame Laboratory is a leader in research on the mechanisms of chemical changes following the absorption of high energy radiation by any state of matter.

The three accelerator-based laboratories are used primarily by experimental groups assembled for particular experiments from universities and laboratories throughout the United States, and, in some cases, from throughout the world. Over half of the usage is by university faculty and students with support independent of the DOE laboratory. The choice of experiments is guided by advisory panels selected from among the Nation's outstanding high energy or nuclear physicists.

In the case of each of these laboratories, a single division at DOE Headquarters is responsible for program formulation, budgeting, and review. In each case, the laboratory activities are only one part of the division's program. Each of the laboratories is operated under contract with DOE by a university or university consortium. The contractor operated laboratories are staffed entirely by non-government employees.

The laboratory director and his staff maintain major responsibility for the content and scientific excellence of the research which they carry out. They typically propose sets of specific research tasks annually as an early step in the annual budget cycle. These are discussed and reviewed with the staff of the DOE program divisions and, although final authority rests with the divisions, the laboratory programs are in effect jointly formulated by laboratory and division staff.

BATES LINEAR ACCELERATOR FACILITY

Cambridge, Massachusetts

INTRODUCTION

In fiscal 1966, funding was authorized for the construction of a 400 million electron volts (MeV) electron linear accelerator (LINAC) at a location near the Cambridge campus of the Massachusetts Institute of Technology (MIT). The Bates LINAC was completed in 1972, and in 1974 achieved a 400 MeV beam on target. Since that time a vigorous experimental program has been conducted involving approximately 30 percent non-MIT user/collaborator effort. Total beam hours in fiscal 1978 totaled 5,200 with 60 percent delivered to experiments.

PERSONNEL

The Bates Linear Accelerator Center staff includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	15	Physicists	15
M.S./M.A.	5	Engineers	16
B.S./B.A.	<u>11</u>	Technicians	39
		Other	<u>5</u>
Total	<u>31</u>	Total	<u>75</u>

In addition, the center draws on the MIT campus for the annual assistance of approximately 35 students as summer students who are involved in a variety of laboratory activities.

CURRENT MISSION AND PROGRAM ACTIVITIES

Experimental work at Bates is closely coordinated with a major theory program at MIT. The principal emphasis of the Bates program is the following:

- o Determination of electric charge, magnetic moment, and current distributions in nuclei by high resolution, high precision electron scattering experiments.

- o Measurement of electromagnetic properties of nuclear states and nuclear deformation parameters by high-resolution, high-precision electron scattering.
- o Investigation of the momentum distribution of nucleons bound within complex nuclei, rate of nucleon resonances in nuclear structure, and fundamental pion production amplitudes by means of photon-induced reactions.

PROGRAM FUNDING

Fiscal 1978 operating funds total \$4.0 million. Authorized plant and equipment totals \$35.67 million.

MAJOR FACILITIES

The 400 MeV Bates Accelerator provides research with a high-intensity beam of electrons spread over a very narrow band of energy, which makes possible very accurate measurements of the fine structure of the nucleus. The accelerator is matched to an electron scattering spectrometer with magnetic field control precise to better than one part in ten thousand, improving previous capability in this area of research by more than one order of magnitude. A second experimental area is under construction that will provide facilities for expanded research; here, bremsstrahlung will be used to induce nuclear reactions of interest.

The capability of the Bates Accelerator for basic studies of electromagnetic properties of nuclei is unique in the United States. Within the past few years, a number of universities and other institutions have participated in basic nuclear research with the Bates high resolution spectrometer facility.

SIGNIFICANT ACCOMPLISHMENTS

- o Analysis of high-resolution electron-nucleus scattering experiments indicates that electron scattering is quite sensitive to deformation of nuclear cores, and detailed studies of this fundamental bulk property of nuclei are proceeding. Coordinated theoretical work at MIT shows that electron scattering data provide a direct and reliable determination of nuclear deformation.
- o Analysis of photon-induced nuclear reaction data shows the presence of a major contribution of high momentum components to the overall momentum distribution of nucleons bound within nuclei and shows possible influence of nucleon resonances in nuclei.

- o The high resolution spectrometer has attained Mark I design parameters which include energy resolution of one part in ten thousand. This major instrument is now in regularly scheduled research use.

FERMI NATIONAL ACCELERATOR LABORATORY

Batavia, Illinois

INTRODUCTION

The Fermi National Accelerator Laboratory (Fermilab) is located near Batavia, Illinois, some 35 miles west of Chicago. The laboratory, engaged principally in high energy physics research, is operated by the Universities Research Association, Inc. (URA), a consortium of 53 universities throughout the United States and Canada. Its principal instrument, the world's most powerful accelerator, is capable of operating at 500 billion electron volts (GeV). Development of the Energy Doubler/Saver now underway will increase this energy to 1,000 GeV.

Fermilab has been developed with the support of the entire U.S. community of high-energy physicists and seeks to broaden man's understanding of the basic structure of matter. At present, activities at the laboratory are divided into three parts: carrying out a physics research program that involves more than 2,000 researchers from all around the world, improving the operation of the present facilities, and developing more powerful facilities for future research activities.

PERSONNEL

The Fermilab staff includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	161	Physicists	170
M.S.	75	Engineers	87
B.S.	<u>185</u>	Computer scientists	39
		Technicians	450
Total	425	Other	<u>693</u>
		Total	1,439

CURRENT MISSION AND PROGRAM ACTIVITIES

The central purpose of Fermi National Accelerator Laboratory is to explore the field of elementary particle physics, a science which lies at the forefront of mankind's understanding of the structure of matter.

Because the phenomena involved are at the core of many physical processes, a broader understanding of particle physics may well shed light on other scientific questions as well.

Physics Research

The Fermilab research facilities are used to attack almost the total range of problems in elementary particle physics. One of the principal among these is the question of what particles such as the proton are made of. It is now widely believed that protons and other particles are built out of quarks, tiny particles that give rise to the shape and structure of the proton but have never been isolated.

Many experiments at Fermilab have shown evidence of the presence of quarks including experiments using beams of neutrinos and muons. Other so-called jet experiments indicate the presence of head-on collisions of quarks.

In 1977 striking evidence for a fifth type of quark was uncovered at Fermilab. A new particle, the upsilon, was discovered that was nearly a factor of three heavier than any other particle. Two additional particle states were discovered in the same experiment that are even heavier than the upsilon. It is now thought that the upsilon is made up of a new type of quark and anti-quark whimsically called "bottom" or "beauty."

Among the central projects for the utilization of the Energy Doubler/Saver at Fermilab will be the search for other types of quarks and still more information on the quark hypothesis.

The accelerated proton beam can be used for research in four major areas, all of which can be run simultaneously, so that 10 or more separate experiments are normally underway at the same time.

1. In the Neutrino Laboratory, a neutrino beam is created by producing an intense beam of pions and kaons which are allowed to decay into mu-mesons and neutrinos in a 1000-foot long vacuum pipe. The interactions of the neutrinos can be studied with large electronic systems and with a 15-foot diameter bubble chamber. The mu-mesons from the decaying pions are also formed into a useful beam. In addition, beams of hadrons are sometimes brought into a smaller bubble chamber to aid in the study of the nuclear force.
2. The Proton Laboratory utilizes the primary proton beam split into parts directed at three separate target stations.
3. In the Meson Laboratory, the proton beam is used to bombard a metal target. Nuclear fragments leaving the target are formed into six secondary beams of particles such as protons, neutrons, pions, kaons, hyperons, and the corresponding anti-particles.

4. In the Internal Target Laboratory, the proton beam passes directly through very thin gas and foil targets during the acceleration process. Nuclear particles scattered out of the target are detected and measured.

Accelerator Improvement

It was recognized early in the original design of the accelerator that a high energy and a better duty cycle could be achieved more economically by adding a ring of superconducting magnets in the same tunnel as the main ring. Thus, extra space in the tunnel and service buildings was provided for such a possibility. Because superconducting bending magnets can reach a field strength of about 45 kilogauss (kG), compared with 22.5 kG for the present conventional magnets, the energy that can be achieved in such a ring may be as high as about 1,000 GeV. The installation and testing of this superconducting magnet ring is now in progress.

Cancer Therapy

The possibility of utilizing the protons produced in the linac when that accelerator is "idle"--that is, between the linac pulses required for injection--has led the laboratory to become deeply involved in a project outside the field of high energy physics: a medical radiation therapy facility to investigate the use of fast neutrons for cancer therapy. A patient treatment room has already been constructed, using funds raised privately, by physicians in the Chicago metropolitan area; and a grant has been obtained from the National Cancer Institute to support the operation of a Cancer Therapy Facility.

Technology Utilization

Fermilab also contributes in many areas of technology through the spin-off from the development of advanced research techniques. The present development of a superconducting ring of magnet is the largest single activity in the world involving the use of superconductivity. The superconducting industry has received a significant impetus from the program at Fermilab and benefits from the interaction with Fermilab engineers and scientists. Beyond the superconducting ring at Fermilab, the technology is expected to be useful in the Nation's fusion energy program; and it may have broad application for an improvement in the efficiency of distribution of electrical energy in power networks. Developments at Fermilab in fast electronics for nuclear detection and integrated systems for using minicomputers have been widely emulated. The Laboratory has participated in a number of programs studying applications of accelerators to other fields.

PROGRAM FUNDING

In fiscal 1978 Fermilab's budget for operating expenses was \$60.5 million. All but \$0.9 million is furnished by the Department of Energy. The laboratory has an authorized investment in plant and capital of \$359.5 million.

MAJOR FACILITIES

The principal scientific instrument of the Fermi National Accelerator Laboratory is a particle accelerator system capable of accelerating protons to energies of up to 500 GeV. The system consists of four distinct accelerators, a Cockcroft-Walton pre-injector, a linac (linear accelerator) capable of reaching 200 million electron volts, a booster synchrotron that normally operates at 8 GeV, and the main ring which carries the protons to operating energy, usually 400 GeV. Experimental facilities include 15 beams for various types of particles, several large multi-particle spectrometers and neutrino detectors, a sophisticated single arm spectrometer and two bubble chambers.

SIGNIFICANT ACCOMPLISHMENTS

- o In May 1976, protons were accelerated to an energy of 500 GeV, two and a half times the original design specification for Fermilab. The accelerator can operate at 2.5×10^{13} protons per pulse.
- o An Energy Doubler/Saver project is now underway at Fermilab to increase the accelerator energy to 1,000 GeV and open the possibility for substantial power savings in normal operation. That project has already utilized more superconducting wire and technology than all the prior projects in the world up to this time. The new central helium liquefier facility will shortly double the world capacity for helium liquefaction. More than 200 experiments have been performed by researchers from every corner of the United States and the world.
- o A new meson, the upsilon, was discovered in 1977, giving strong evidence for a new type of quark. The upsilon is 10 times heavier than the proton.
- o A group working with the world's largest bubble chamber has discovered the first direct evidence for the production of a specific charmed particle with neutrinos.

An aerial view of the Fermi National Accelerator Laboratory, Batavia, Illinois. The largest circle is the main accelerator. Three experimental lines extend at a tangent from the accelerator. The 16-story, twin-towered central laboratory is seen at the base of the experimental lines.

- o Many experiments at the Laboratory have found curious examples of reactions in which several muons come out. Charmed quark processes may explain some of these but a tantalizing residue remains.
- o More than 150 cancer patients have now been treated in a comprehensive program of research into fast neutron therapy.

NOTRE DAME RADIATION LABORATORY

Notre Dame, Indiana

INTRODUCTION

The Notre Dame Radiation Laboratory is a Department of Energy (DOE)-owned facility on the campus of the University of Notre Dame at Notre Dame, Indiana, and is operated for DOE by the university. It has proven to be a training ground for a substantial fraction of the world's experts on radiation effects and as a result maintains active relations with other similar laboratories throughout the world. Particularly important is the wide breadth of capability within the laboratory which allows a variety of interactions between scientists of diverse interests. These interactions tend to provide a maximum understanding on particular problems and permit the build up of a broad background of expertise among the resident scientists.

PERSONNEL

<u>Highest Degree</u>		<u>Occupation</u>	
<u>Attained</u>	<u>Number</u>		<u>Number</u>
Ph.D.	42	Life Scientists	2
M.S./M.A.	4	Physical Scientists	50
B.S./B.A.	<u>11</u>	Engineers	2
		Technicians	14
		Other	<u>11</u>
Total	57	Total	79

CURRENT MISSION AND PROGRAM ACTIVITIES

The objectives of the laboratory's researches are to obtain detailed descriptions of the mechanisms of chemical changes that follow absorption of high energy radiation and light, and to construct predictive models that will be useful in experimental and technological applications where reactions are initiated by radiation chemical and photochemical methods. Experimental approaches used in the laboratory include examination of chemical and physical properties of intermediates produced by electron and laser radiation using optical spectroscopic and electron spin resonance methods for which the laboratory has unique experimental facilities. Information from these experiments is integrated with studies of the overall chemical effects to give as complete as possible a description of the details of radiation-produced reactions. Emphasis is on the structure and kinetic behavior of reaction intermediates.

This type of information can be expected to be generally useful in applications to energy related problems in nonradiation environments. For example, the reactions of atomic hydrogen have been studied by a special electron spin resonance method developed in the laboratory. Since atomic hydrogen cannot be studied easily by the more conventional methods usually used in kinetic studies, these investigations have made available a large volume of otherwise unavailable information. Rate information such as this can be expected to be useful in a variety of chemical applications. The experimental program is strongly coupled with a substantial theoretical effort intended to obtain a deep understanding of the phenomena being investigated so that design of future experiments and applications can be optimized.

PROGRAM FUNDING

<u>Programs</u>	<u>FY 78 Operating Funds (In Millions)</u>
DOE	
Basic Energy Science	\$ 1.70
Environmental Research	0.03
National Bureau of Standards	
Radiation Chemistry Data Center	0.05

The authorized investment in plant and capital equipment is 4.5 million.

MAJOR FACILITIES

The laboratory maintains an outstanding complement of equipment such as linear and Van de Graaff accelerators, cobalt-60 gamma ray sources, lasers, and photochemical sources. Unique facilities include a coupled Van de Graaff-ESR spectrometer for studying radiation-produced intermediates, laser apparatus for similar studies of intermediates produced by visible and ultraviolet light, and computer controlled apparatus for acquisition and processing of optical data.

SIGNIFICANT ACCOMPLISHMENTS

- o The laboratory has contributed to a fundamental understanding of the nature of radiation tracks, particularly to the tracks

associated with heavy particle radiation. This understanding is essential to the development of the potential application of heavy particle radiation in cancer therapy.

- o The kinetic and spectroscopic studies carried out in recent years have provided an abundance of information on the reactivity of a large variety of radiation produced intermediates. For example, in addition to the studies of atomic hydrogen indicated in a previous section, extensive studies have been carried out on the oxidant OH, on the hydrated electron and on other basic intermediates such as methyl, vinyl and phenyl. The latter species, which is of considerable importance in the chemistry of many aromatic hydrocarbon systems, has been shown to be at least a factor of 50 times more reactive than heretofore suspected.
- o Studies on micelles and chemically produced membranes have provided considerable information on the transport of reactive entities across interfaces. This basic physical information is of importance to modeling of biological processes and to the use of detergents and other multiphase systems in pollution control.
- o Studies of centers in thin films provide a basic understanding of dielectric breakdown phenomena, a topic of considerable importance in the development of supervoltage transmission lines.
- o Gas phase measurements of the rate for reaction of electrons with oxygen, nitrous oxide, and the halocarbons are of importance to processes that occur in the upper atmosphere.
- o The Radiation Chemistry Data Center provides both literature services and critically evaluated compilations of basic kinetic and spectroscopic data which are highly valued by the scientific community.

STANFORD LINEAR ACCELERATOR CENTER

Stanford, California

INTRODUCTION

The Stanford Linear Accelerator Center (SLAC), operated by Stanford University, is located in Palo Alto, California. The center's main research instrument is a 2-mile-long linear electron accelerator that can produce intense beams of electrons at energies up to 22 billion electron volts (GeV), or of positrons with energies up to 15 GeV. SLAC carries out experimental and theoretical research in high energy physics, and also developmental work in new techniques for particle acceleration and for experimental instrumentation. The center is operated as a national facility, available to any qualified user in the United States and overseas; experiments are accepted on the basis of their scientific merit.

PERSONNEL

The SLAC staff includes the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	134	Physicists	120
M.S./M.A.	84	Engineers	162
B.S./B.A.	<u>217</u>	Computer Scientists/ Mathematicians	21
Total	435	Technicians	354
		Other	<u>527</u>
		Total	1,184

CURRENT MISSION AND PROGRAM ACTIVITIES

The continuing experimental program at SLAC is directed toward a deeper understanding of the elementary particles that are the building blocks of all matter, and of the forces through which these particles interact with each other. The emphasis in the current program is on studies of the new family of fundamental particles, called the psi or J particles, that were first discovered in late 1974 at the SPEAR storage ring at SLAC and simultaneously at Brookhaven National Laboratory.

SPEAR has proved to be the single most productive research instrument for producing this important new family of particles and for studying their properties. In addition, the SLAC electron accelerator is presently being used: in studies of the detailed structure of the proton and neutron, the constituents of all atomic nuclei; in experiments which make use of intense gamma-ray beams to create many kinds of little-known particles through the well-understood electromagnetic force; and in experiments which test the validity of certain of the most fundamental physical principles governing the behavior of matter.

As a part of the program to develop and construct the new Positron Electron Project (PEP) storage ring at SLAC, a significant engineering design effort is being devoted to the development and testing of the technical components and systems that will make up the complete storage ring.

PROGRAM FUNDING

SLAC's operating costs (Department of Energy) for fiscal 1978 were \$32.7 million. The total authorized investment in plant and equipment through 1978 was \$191.4 million. SLAC support from other Federal agencies is minor, amounting to about \$0.3 million in fiscal 1978.

MAJOR FACILITIES

SLAC facilities include the accelerator, which is the largest of its kind in the world; a complement of large experimental detection devices used in particle physics experiments, including bubble and streamer chambers and several magnetic spectrometers of different design; a triplex computation facility consisting of two IBM 370/168 and one 360/91 computers; and an electron-positron colliding-beam storage ring (SPEAR) having a maximum single-beam energy of 4 GeV.

Located at SPEAR is the Stanford Synchrotron Radiation Project (SSRP), a facility that makes use of the synchrotron radiation that emerges from the SPEAR storage ring to carry out many kinds of important experiments in the fields of chemistry, metallurgy, atomic physics, and biology.

SLAC's 40-inch diameter bubble chamber, pulsing at rates up to 12 expansions per second, is the world's fastest chamber. SLAC has become the Nation's top producer of bubble chamber photographs, although about 85 percent of the pictures are analyzed elsewhere.

In addition, construction of a larger storage ring (PEP), with single-beam energies up to 18 GeV, is expected to be completed in 1980.

SIGNIFICANT ACCOMPLISHMENTS

- o The first major research achievement of SLAC was the discovery, during the late 1960's, that protons and neutrons had a composite, extended structure, and that they appeared to consist of smaller, more fundamental subunits that have been given the name "quarks." This discovery was the first direct evidence for the validity of an earlier theoretical model which postulated that all of the known particles (more than a hundred) could be explained as simply different combinations of only three truly basic entities, the three quarks, and their corresponding antiparticles. As such, it opened the way toward a new simplicity in understanding the nature of matter.
- o The second major accomplishment has been the discoveries at the SPEAR storage ring of the new family of psi particles mentioned previously. At present, this work is interpreted as evidence for a fourth fundamental quark; and this realization has provided explanations for a number of outstanding open questions about the elementary particles and their behavior. In recognition of this achievement, the 1976 Nobel prize in physics was awarded jointly to Burton Richter of SLAC and to Samuel Ting of MIT.

Remarkable physics discoveries of the past few years at the SPEAR Storage Ring at the Stanford Linear Accelerator Center (SLAC) stimulated a desire to study the electron-positron annihilation process with higher precision and to ask new experimental questions that the Mark I Magnetic Detector at SPEAR was not designed to answer. The Mark II Detector Facility was built by the continuing collaboration between SLAC and the Lawrence Berkeley Laboratory. It incorporates several new detector technologies that make it superior to the Mark I in many ways.

SAFEGUARDS FACILITY

SAFEGUARDS FACILITY

In addition to the three weapon laboratories, the Savannah River Laboratory and the weapon testing and production complex, there is one other laboratory dedicated to defense activities, the New Brunswick Laboratory.

The New Brunswick Laboratory, which is supported through the Department of Energy's (DOE's) Office of Safeguards and Security, is responsible for the development and improvement of chemical and instrumental methods for the measurement of fissile, fertile and control materials essential to United States nuclear energy programs. It conducts interlaboratory measurement evaluation programs; provides inventory verification confirmatory measurements for United States safeguards; and prepares and characterizes reference calibration and test materials.

The New Brunswick Laboratory is staffed by Federal employees and its director reports for administrative purposes to the Manager of the Chicago Operations and Regional Office.

NEW BRUNSWICK LABORATORY

Argonne, Illinois

INTRODUCTION

The New Brunswick Laboratory (NBL) in Argonne, Illinois, on the Argonne National Laboratory site, is the only Department of Energy (DOE) laboratory specializing in the analytical chemistry of materials related to U.S. nuclear energy programs. The laboratory is operated directly by DOE employees and reports to the Chicago Operations Office. Relocation to newly constructed facilities on the Argonne site was completed by September 1977.

PERSONNEL

Employment in fiscal 1978 totaled 62 with a professional/technical staff consisting of the following:

Highest Degree Attained	Number	Occupation	Number
Ph.D.	7	Physical Scientists	41
M.S.	12	Electronic Engineers	3
B.S.	<u>27</u>	Technicians	7
		Other	<u>5</u>
Total	46	Total	56

CURRENT MISSION AND PROGRAM ACTIVITIES

NBL serves as the U.S. Government Nuclear Materials Measurements Laboratory. It develops and disseminates improved measurement technology for nuclear materials; prepares, characterizes, and distributes reference and calibration material standards; evaluates the ongoing level of measurement performance through extensive interlaboratory comparison of government and private laboratories engaged in handling nuclear materials; and provides highly accurate and precise measurements on samples of a broad variety of nuclear material types taken by field inspectors for inventory verification. In addition, NBL provides training for inspectors for the U.S. and the International Atomic Energy Agency.

PROGRAM FUNDING

In fiscal 1978, NBL's operating budget was \$2.3 million--\$1.6 million funded by DOE and \$0.7 million funded by the Nuclear Regulatory Commission (NRC). The authorized investment in plant and capital equipment was \$5.9 million.

MAJOR FACILITIES

Newly constructed facilities for NBL house modern and sensitive equipment for classical chemistry, neutron activation, electrochemistry, nondestructive assay, isotope ratio mass spectrometry, optical emission, and X-ray spectrometry. Glove box laboratories are dedicated to trans-uranic element measurements. Instrument and machine shops provide for instrumental development.

SIGNIFICANT ACCOMPLISHMENTS

- o Characterized the first uranium oxide (U_3O_8) material for uranium assay and supplied the National Bureau of Standards with the first uranium metal samples for use as Standard Reference Material.
- o Developed a highly precise, accurate and rapid method for measuring uranium that is now used in many domestic and foreign laboratories as a routine method.
- o Directs an international interlaboratory comparison program to determine the level of routine performance of measurements of nuclear material.

SOLAR FACILITIES

SOLAR ENERGY RESEARCH INSTITUTE

Golden, Colorado

INTRODUCTION

The Solar Energy Research Institute (SERI), established by the Solar Energy Research, Development and Demonstration Act of 1974, began operations at Golden, Colorado in July 1977. Its primary mission is to serve as the Department of Energy's (DOE's) lead institution for solar energy research, development and demonstration. SERI's programs are designed to assure the development of solar energy technologies to the point where they are capable of making meaningful, reliable contributions to the Nation's energy supply.

SERI's responsibilities include management and performance of assigned research, development and demonstration (RD&D) programs and projects; market analysis and assessment of institutional barriers to solar technology; planning support for the Assistant Secretary for Energy Technology in the development of national solar energy policies, program plans and strategies; international solar technology programs; solar information dissemination, education and training; and the design and development of a Solar Energy Information Data Bank.

SERI is managed under contract to Midwest Research Institute and presently housed in the Denver West Office Park in Golden, Colorado. Operations will continue in these facilities until permanent facilities are designed and constructed in the early 1980's. Both the interim and future facilities accommodate administrative, laboratory, library and conference operations, as well as outdoor field experiments.

PERSONNEL

<u>Highest Degree Attained</u>		<u>Occupation</u>		<u>Number</u>
Ph.D.	67	Management		36
M.S.	100	Engineering		
B.S.	<u>99</u>	& Scientific		230
		Administrative		28
Total Degrees	266	Clerical		<u>56</u>
Other	<u>84</u>			
Total Staff	350	Total		350

CURRENT MISSION AND MAJOR PROGRAM ACTIVITIES

Consistent with its role as DOE's lead institution in solar RD&D, SERI's R&D efforts are aimed at providing a wide range of options for solar energy conversion, as well as the necessary technical information to enable DOE to make informed decisions concerning selections among these options. Within the range of solar technologies being addressed at SERI, the major programs currently are: photovoltaics, clean fuels from biomass, dispersed wind energy systems, solar industrial processed heat, passive solar technologies and central solar power systems. SERI also supports DOE in the technical management of selected research programs and the development of major solar energy experimental test facilities.

In conjunction with these RD&D programs, SERI fosters a number of supporting programs, including: solar program planning and analysis, solar energy information systems, international solar technology programs, university solar energy research, basic and applied solar energy research, solar energy economics and social science research, program management, education and training and reliability and standards development.

SERI activities also encompass a number of programs designed to support greater awareness of solar energy information among specific user and interest groups. These programs include an extensive schedule of conferences relating to the widespread use of solar energy and distribution of solar information through an evolving communications and public media effort. In this regard, SERI is designing and developing a Solar Energy Information Data Bank (SEIDB). The SEIDB will incorporate information and data to serve the research community, legislative bodies, commercial and industrial groups and, eventually, the general public.

PROGRAM FUNDING

SERI's fiscal 1978 budget (operating and capital equipment) was about \$11.1 million.

SIGNIFICANT ACCOMPLISHMENTS

- o Established the National Solar Energy Research Institute for the Department of Energy. Its staffing for fiscal 1978 included 350 highly qualified solar energy scientists, engineers, management and support personnel. Research laboratory facilities are scheduled to be operational prior to the end of the fiscal year.
- o SERI accepted major program management and subcontracting responsibilities for DOE during fiscal 1978, including: the Absorber Coatings Program; the Solar Thermal Test Facility Users

Association; the Photoelectrolysis and Directed Photosynthesis Hydrogen Production; and the SERI Permanent Facilities Plan. Other programs are expected to be transferred from DOE to be managed by SERI, such as the Innovative Wind Energy Program, Photovoltaic Materials R&D Program, and others.

- o SERI has been given responsibility for all operational aspects of programs to be conducted under the Saudi Arabian-United States Project Agreement for Cooperation in the Field of Solar Energy. The benefits to be derived from this project are the development of solar energy systems for the needs of the Kingdom of Saudi Arabia, the United States, and developing countries. It also should result in the enhancement of the capability within Saudi Arabia and the United States to develop and apply solar technology.
- o SERI has become the focal point for major conferences and workshops addressing solar energy. Such meetings average one each week, with total attendance exceeding 2,000 during fiscal 1978.
- o The SEIDB mandated by the Solar Energy Research, Development and Demonstration Act of 1974, is being implemented and operated by SERI. Online access to the library file (computerized card catalog) will be available. DOE and commercial data bases are searched routinely. Preliminary data bases are being established, including solar equipment manufacturers and solar installations. A Solar Energy Information Locator has been prepared, and 20,000 copies distributed in response to requests. An SEIDB coordinating committee operates to establish compatibility among the several existing sources of solar information, such as the Technical Information Center, Franklin Institute, National Oceanic and Atmospheric Administration, etc.
- o The Annual Review of Solar Energy is a major product of SERI. The review is intended to provide a comprehensive overview of the United States' solar energy effort, and to evaluate its effectiveness in responding to long-term national goals and needs. The review's intended audience includes all who have a serious interest in solar energy development: Federal energy officials, members of Congress, state and local energy decision-makers, consumer and industry interests, and concerned private citizens. Because of the early stage of SERI's development, this first review is predominantly descriptive rather than evaluative. Future volumes of the review will focus on specific issues, trends, technological problems, and social options relevant to the future development of solar energy as a resource for serving human needs.

REGIONAL SOLAR ENERGY CENTERS

Northeast - Cambridge, Massachusetts
Mid America - Eagan, Minnesota
Western - Denver, Colorado (interim location)
Southern - Atlanta, Georgia

INTRODUCTION

The "Solar Energy Research, Development, and Demonstration Act of 1974," Public Law 93-473, Section 10, called for the establishment of a Solar Energy Research Institute (SERI) to perform research, development and related functions in furtherance of the objectives of this act. In 1976, the Energy Research and Development Administration (ERDA) issued a request for proposals for a manager/operator for SERI. On March 24, 1977, ERDA announced the selection of Midwest Research Institute for negotiation of a contract for management and operation of SERI in Golden, Colorado. With this announcement, ERDA also announced its intent to establish Regional Solar Energy Centers to encourage widespread use of solar energy on a regionally diversified effort. Four organizations, representing the Northeast, Mid America, Western and Southern regions of the United States, were subsequently awarded planning grants to promote widespread solar energy utilization. These planning grants, typically 6-month efforts, were awarded over the May-December 1977 time period.

In March of 1978, the Secretary of Energy assigned the responsibility for SERI to the Assistant Secretary for Energy Technology and the responsibility for the Regional Solar Energy Centers to the Assistant Secretary for Conservation and Solar Application.

PROGRAM FUNDING

The Northeast region is represented by the Northern Energy Corporation which operates the Northeast Solar Energy Center located in Cambridge, Massachusetts. This center was in a startup phase as of May 1, 1978, with a program budget for May-September 1978, of \$1.5 million. The fiscal 1979 funding is approximately \$4 million.

The Mid America region is represented by the Mid-America Solar Energy Complex located in Eagan, Minnesota. This center was also in a startup phase as of May 1, 1978, with a program budget for May-September 1978, of \$1.2 million. The fiscal 1979 funding is approximately \$4 million.

The Western region is represented by the Western Solar Utilization Network and was established June 23, 1978. The center is located in Portland, Oregon and the fiscal 1979 funding is approximately \$2 million.

Regional Solar Energy Centers

DC7902076

IV-277

The Southern region is represented by a planning group under the Southern States Energy Board and is located in Atlanta, Georgia. The fiscal 1979 funding is approximately \$3 million.

MAJOR FACILITIES

The regional boundaries and the office locations for the Regional Solar Energy Centers are shown on the map on the preceding page. In the Western Center, Hawaii also represents Guam, the Commonwealth of the Northern Marianas, American Samoa, and the Trust Territories of the Pacific Islands. The Southern region includes the District of Columbia, Puerto Rico and the Virgin Islands.

CURRENT MISSION AND PROGRAM ACTIVITIES

The primary missions of the Regional Solar Energy Centers were defined as solar research, development and demonstration for SERI and commercialization of solar technologies and conservation activities integral to solar applications for the Regional Solar Energy Centers. In concert with their primary mission in support of the Conservation and Solar Applications Office, the Regional Solar Energy Centers will undertake a variety of solar commercialization and related activities as assigned by DOE. The activities include:

- o Consumer Protection--Standards, certification, product information, etc.
- o Outreach--Technical assistance, training and education, workshops/ conferences, information dissemination.
- o State Coordination Support--Legislation, codes, training, etc.
- o Market and Resource Assessment--Market analyses, regional energy outlook, labor force assessment, etc.
- o Specific Project Management Support.

Emphasis is being placed on solar heating, especially solar water heating and passive heating, as the technologies most suitable for commercialization. In performing the program support activities, the Regional Solar Energy Centers will interact with Federal, State and local governments, the industry sector, business and individual consumers, and many others (lenders, appraisers, unions, professional societies, etc.)

SECTION V

PRODUCTION, TESTING AND FABRICATION FACILITIES

NUCLEAR MATERIALS PRODUCTION FACILITIES

WEAPONS TESTING AND FABRICATION COMPLEX

NUCLEAR MATERIALS PRODUCTION

The nuclear materials production complex consists of many diversified operations which cover a wide spectrum of nuclear energy activities--from research on exotic elements to the production of nuclear materials for weapons components, commercial power generation and medical/industrial uses.

The complex includes:

1. The three gaseous diffusion plants for the enrichment of uranium with the isotope uranium-235 at Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio.
2. The feed-materials processing plants at Fernald and Ashtabula, Ohio.
3. The plutonium, tritium and other nuclide production reactors at Aiken (Savannah River), South Carolina; the plutonium production reactor at Richland (Hanford), Washington; and the associated chemical processing plants at these sites.
4. The Idaho Chemical Processing Plant at the Idaho National Engineering Laboratory which recovers uranium from irradiated Navy reactor and test reactor fuels is described under the Idaho National Engineering Laboratory.
5. The Y-12 Plant at Oak Ridge, Tennessee, which processes highly enriched uranium in support of the production reactors and produces deuterium and enriched lithium compounds for use in weapon fabrication is covered in detail under Weapons Production Plants in this section.

The management structure for the production of nuclear materials is based on a decentralized management system. The Department of Energy (DOE) headquarters program staff formulates policy and program guidance and allocates funding levels to the cognizant field offices, who in turn implement and direct and control the program through DOE contractor organizations. DOE production contractors operate facilities owned by the government. DOE headquarters also interacts with the Congress and government agencies relative to program requirements and needs.

GASEOUS DIFFUSION PLANTS: URANIUM ENRICHMENT PRODUCTION

INTRODUCTION

The Uranium Enrichment Program consists of the operation and development support for the three gaseous diffusion plants and experimental gas centrifuge facilities and a current capital project for a new gas centrifuge enrichment facility.

Currently, the major part of the Free World's capacity for the production of enriched uranium is represented by the three existing Department of Energy (DOE) gaseous diffusion plants. Two of the plants, located in Oak Ridge, Tennessee; and Paducah, Kentucky; are operated by the Nuclear Division of Union Carbide Corporation. The third, located near Portsmouth, Ohio, is operated by Goodyear Atomic Corporation. The three plants operate as an integrated complex to enrich uranium in the isotope U-235 for use in nuclear power and propulsion reactors. The importance of these operations is reflected by the large toll enrichment revenues received since the toll enrichment program's inception in 1969. Total revenues from these services have exceeded \$3.9 billion, and the fiscal 1978 revenue was \$925 million.

PERSONNEL

The personnel that have developed and engineered the highly sophisticated and complex systems are trained in such fields as cryogenics, temperature measurement and control, vacuum techniques, project management and cost control, chemical processes, and computer applications. The staffing levels at the three plant sites and their academic training is as follows:

Occupation	<u>Number of Individuals</u>		
	Oak Ridge	Paducah	Portsmouth
Engineers	475	133	236
Physical Scientists	225	30	75
Computer Scientists/ Mathematicians	32	4	30
Technicians	570	182	156
Other:			
Salaried	1,283	498	859
Nonsalaried	<u>2,950</u>	<u>1,528</u>	<u>1,640</u>
Total	5,535	2,375	2,996

Highest Degree Attained	Oak Ridge	Numbers	
		Paducah	Portsmouth
Ph.D.	53	3	9
M.S.	265	45	71
B.S.	<u>1,054</u>	<u>328</u>	<u>511</u>
Total	1,372	376	591

CURRENT MISSION AND PROGRAM ACTIVITIES

Originally, the primary mission of the three gaseous diffusion plants was the production of enriched uranium for defense purposes. Over the intervening years, the production emphasis has changed most significantly to the extent that production is currently directed primarily to the production of slightly enriched uranium (up to 5 wt. % U-235) for use in nuclear power reactors and to a lesser degree to the highly enriched products used in nuclear propulsion and special types of reactors.

Some of the specialized capabilities and facilities that exist at the gaseous diffusion plants are also contributing directly to the solution of energy and pollution problems including highly complex and automatic welding techniques; facilities for working with very high vacuums; the fabrication of parts from exotic metals; control of highly corrosive chemicals, such as fluorine; the adoption of the latest and most advanced process control systems that utilize computers and numerical control systems; and the capability to make routinely very accurate dimensional measurements that are ordinarily made in the laboratory.

New Enrichment Capacity

The full capacity of DOE's three uranium enrichment plants, including that capacity to be gained by the cascade improvement program and the cascade up-rating program, has been contracted for. In order to provide additional enriching capacity, DOE has initiated plans to add approximately up to 8.8 million separative work units (SWU)/year capability. The addition would raise the uprated and improved capacity from 28 million SWU/year to 36.8 SWU/year. The plants will use gas centrifuge technology to provide the additional enriching capability. In addition to being a newer technology with promise to produce separative work at a lower cost, the centrifuge process requires significantly less electric power than would have been required by the gaseous diffusion process. Oak Ridge Operations Office is presently managing and directing the project and has established a project organization under a Deputy Manager for Enrichment Expansion Projects. The plant site is located adjacent to the Portsmouth Gaseous Diffusion Plant.

The project was authorized at a funding level of \$180 million at the end of fiscal 1977. Continuation of design and initiation of procurement and construction were authorized, with additional funding of \$150 million made available in fiscal 1978. The FY 1979 budget contains \$150 million to continue the project.

Uranium Enrichment Process Development

The uranium enrichment program has supported the separation of uranium isotopes by the gaseous diffusion and gas centrifuge processes.

Gaseous Diffusion Development and Technical Support

The gaseous diffusion development program has provided support for the long-term support of the three existing gaseous diffusion plants and for the Cascade Improvement Program (CIP) and the Cascade Upgrading Program (CUP). Development and plant test programs were undertaken in the 1950's to increase expansion of the capacity of the gaseous diffusion plants. The current CIP program was initiated in 1971 to increase plant capacity by approximately 5.4 million separative work units (SWU) at no increase in plant power. The CUP program was initiated in 1974 to increase plant capacity by approximately 4.6 million SWU at a plant power increase of approximately 1,300 MW. The combined CIP and CUP programs represent an increase of United States uranium enrichment capacity of nearly 60 percent. The annual savings of these programs as compared to the cost of production from a new diffusion plant is about \$650 million.

With the CIP and CUP programs nearing their 1981 completion, emphasis has been focused on technical support programs required to ensure the continued operation of the gaseous diffusion plants in the post-CIP/CUP time period. The major objectives of the technical support programs are to complete the CIP/CUP programs, ensure efficient, reliable and safe operation of the plants through the year 2000 or for as long as needed and economically justified, and to comply with external requirements concerning the environment, health, safety, etc.

Gaseous Diffusion Technical Support Program

FY 1979

Budget level operating costs
Manpower (scientific man-years)

\$16.1 million
141

Gas Centrifuge Development

The gas centrifuge process was considered for a uranium isotope separation plant during World War II, but the activity was terminated in 1944 due to the success of the gaseous diffusion project.

As a consequence of the work at the University of Virginia (1955-1960), the Atomic Energy Commission authorized (in 1961) a 3-year development program at a funding level of \$6 million.

The Gas Centrifuge Development Program has been successful and the process has been chosen for new plant expansion, offering the advantage that it uses about 4 percent of the power required for gaseous diffusion. Improvements have been making the process more economical than the gaseous diffusion process. The success of this effort was due to three major contractors: Union Carbide Corporation, Oak Ridge, Tennessee; AiResearch Manufacturing Company, Torrance, California; and the University of Virginia.

Increased funding has recently been provided to support the level of effort required for the design and construction of a new plant. The total level of effort during the period from 1961-1978 was about \$270 million. The present program is divided into centrifuge physics, materials, technology development, machine manufacturing development, systems manufacturing development, development facility operations, recycle/assembly development, and support and special studies. The total funding and manpower are:

<u>Gas Centrifuge Development Program</u>	<u>FY 1979</u>
Budget level operating costs	\$57.05 million
Manpower (scientific man-years)	329

The major facilities of the program are valued at about \$175 million. Facilities located in Oak Ridge are used for manufacturing development, reliability testing, and as a pilot plant including two cascades of centrifuges. The building, owned by AiResearch in Torrance, California, is fully provided with government-furnished equipment for manufacturing and advanced machine development.

Industrial Participation in Uranium Enrichment

In June 1971, the Atomic Energy Commission (AEC) announced a policy and a plan to provide classified uranium enrichment technology to industry, and to allow industry to build the next required enrichment plants. As a backup plan, if government were required to add capacity, industry would provide the major equipment systems for government facilities. The latter plan is being followed in that the Gas Centrifuge Enrichment Plant (GCEP) is being designed by architect-engineer firms, all materials and equipment will be procured from industrial sources and construction will be performed by private construction firms under contract to DOE.

Twenty-two companies participated in the limited-access step I of the program in 1972; seven of those companies submitted proposals in 1973

for 5-year R&D "no-fund" full-access contracts; all were accepted. Later, the AEC incorporated enrichment technology in the Access Permit Program to allow industry to conduct design and construction studies.

Nine industrial firms or consortia now have full-access step II contracts or equivalent subcategory C-24 B access permits. (Seven other industrial firms have subcategory C-24 A access permits which allow them limited technology for the purpose of determining their interest). Through their R&D efforts and engineering studies, industry has invested about \$100 million in this program to date.

Four proposals were submitted to the Energy Research and Development Administration for private enrichment plants: one gaseous diffusion plant proposed by Uranium Enrichment Associates, and three smaller centrifuge plants proposed by Exxon Nuclear, Centar, and Garrett Airesearch. These four plants were subject to Congressional action under the Nuclear Fuel Assurance Act. That Act was tabled in September 1976, the diffusion proposal was withdrawn, and no new action has yet been initiated. Four of the industrial firms, Goodyear, Aerospace, Exxon Nuclear, Boeing and Garrett Airesearch are rapidly establishing centrifuge manufacturing capability.

PROGRAM FUNDING

Program funding at the Oak Ridge, Paducah, and Portsmouth Gaseous Diffusion Plants, excluding gas centrifuge development is as follows:

	FY 1978 (In Millions)
Portsmouth	\$234.9
Paducah	257.1
Oak Ridge	<u>167.4</u>
Total	\$659.4

MAJOR FACILITIES

The enrichment of uranium is carried out in ten major process buildings at the three sites. In addition, the plants are, in general, self contained, including a complete range of modern maintenance shops to maintain the thousands of pieces of sophisticated production, electrical, and mechanical equipment, modern laboratories and test facilities with a broad spectrum of technical personnel, police forces and fire departments with adequate emergency equipment, complete water supplies

and water treatment as well as sewage disposal plants, hospitals, cafeterias, and transportation facilities.

The Computer Technology Center located at the Oak Ridge Gaseous Diffusion Plant is a consulting and problem-solving facility serving the research, development and production functions of all three gaseous diffusion plants and several other DOE-owned facilities.

The total investment in plant and capital equipment at the three sites is \$3.5 billion.

FEED MATERIALS PRODUCTION CENTER

Fernald, Ohio

The Feed Materials Production Center (FMPC), located at Fernald, Ohio, began operating in 1953. National Lead of Ohio has operated the FMPC since its inception. The plant is a large-scale fully integrated facility capable of converting uranium feed into finished uranium metal target and fuel elements for the DOE production reactors. FMPC's capabilities include: conversion of concentrates and recycle materials to refined uranium trioxide (UO_3) for eventual use in the gaseous diffusion plants; solvent extraction refining of slightly enriched uranium (< 1.25 percent U-235) nitrate solutions; denitration of slightly enriched uranium nitrate solutions to uranium trioxide (UO_3); reduction of UO_3 to UO_2 and conversion of UO_2 to green salt (UF_4); reduction of UF_4 to uranium metal; vacuum induction casting of uranium ingots; rolling uranium ingots to rods; machining uranium fuel and target elements for the production reactors at Richland, Washington, and Aiken, South Carolina.

PERSONNEL

The FMPC staff includes the following:

<hr/>		<hr/>	
Occupation	Number	Highest Degree Attained	Number
Engineers	30	B.S.	62
Computer Science/Tech.	5	M.S.	13
Physical Scientists	19	Ph.D.	0
Technicians	27	J.D.	<u>2</u>
Other	<u>502</u>		
Total	583	Total	77
<hr/>		<hr/>	
Hourly	322		
Salary - Exempt	168		
Salary - Nonexempt	<u>93</u>		
Total	583		
<hr/>		<hr/>	

CURRENT MISSION AND PROGRAM ACTIVITIES

Current activities include production of uranium target and fuel elements for production reactors, production of uranium metal for Y-12 and Rocky Flats, and conversion of recycle materials to U_3O_8 . The U_3O_8 is then shipped to Portsmouth, where it is converted to UF_6 and fed into the gaseous diffusion plant cascades.

PROGRAM FUNDING

The funding level at the FMPC for fiscal 1978 was \$18.1 million:

	FY 1978 Operating Funds (Millions)
Uranium Enrichment	1.4
Special Materials Production	15.6
Environmental Control Technology	0.3
Work for Other Federal Agencies	<u>0.8</u>
Total	<u>\$18.1</u>

MAJOR FACILITIES

The FMPC is currently being utilized for DOE programs to the extent of only 20 percent of design capacity. Space and equipment for energy or national defense projects are available along with supporting facilities. The site has a total of 73 buildings which include a technical laboratory with approximately 60,000 sq.ft. of area, and buildings, such as security, health and safety, and administration buildings containing about 50,000 sq.ft. The total area under roof is about 19 acres.

The investment in plant and equipment is \$121.2 million.

Unique facilities include:

Rolling Mill

The FMPC rolling mill is the only high tonnage, production mill in the country that is fully dedicated to uranium work. It has a capacity of about 30,000 tons per year. This mill and the supporting facilities, now in standby, have a replacement value of approximately \$25,000,000.

The rolling mill, designed by Birdsboro, includes a two-high reversible blooming mill and a six-stand finishing (continuous)

mill for producing rod stock up to 2-1/32" OD. The blooming mill will handle ingots up to 9-1/2" OD and 60" long.

This unique facility could supply the rod feed stock for a major laser enrichment program. An experimental quantity of stock produced by this mill has already been supplied to one of the nation's major energy companies for this purpose.

Refinery

The FMPC refinery with a nominal capability of 14,000 separative work units per year was placed in standby in June 1977. This facility, valued at over \$20,000,000 could be utilized to supply uranium refining capacity to supplement facilities in the private sector when those facilities, existing and planned, are not adequate to satisfy demand.

Boiler Plant

With much of the FMPC idled, the coal fired boiler plant could be used in support of experimental programs being carried out by the DOE Energy Technology Centers. The plant has four boilers, each with a capacity of 75,000 pounds of steam per hour at 475°F and 150 psi. Two of the boilers are being equipped with electrostatic precipitators; these two units will satisfy planned FMPC requirements. The other two could be used to evaluate new ideas and concepts at the plant scale level.

EXTRUSION PLANT

Ashtabula, Ohio

The Reactive Metals, Incorporated (RMI), extrusion plant in Ashtabula, Ohio, is a privately-owned facility housing two DOE-owned extrusion presses.

Depleted and slightly enriched uranium ingots from the DOE-owned Feed Materials Production Center (FMPC) in Fernald, Ohio, are extruded into tubes at RMI. The depleted uranium tubes are returned to the FMPC for "finishing." At the FMPC, depleted uranium tubes are cut into pieces and machined to form hollow cores, which are then shipped to Savannah River for use in the production reactors. Slightly enriched uranium ingots are fabricated into billets at RMI. These billets are shipped to Richland where they are co-extruded to form fuel elements for N-Reactor.

Under their contract with DOE, RMI can use the DOE-owned extrusion presses for commercial work provided that (1) this work does not interfere with RMI's work for DOE and (2) DOE is reimbursed for press time devoted to commercial work. At present, commercial work takes up about half the press time available each month.

The contract with RMI dates back to 1952. Since that time the company has been involved in the investigation of a wide range of uranium forming processes, culminating in its current position as probably the leading large quantity extruder of uranium in the country.

PERSONNEL

The RMI staff included the following:

Highest Degree Attained	Number
Ph.D.	0
J.D.	0
M.S.	9
B.S.	<u>6</u>
Total	15

Occupation	Number
Engineers	2
Computer Scientists/ Mathematicians	0
Physical Scientist	0
Technicians	7
Other	53
Hourly (38)	
Salaried (24)	<u> </u>
Total	62

PROGRAM FUNDING

The funding level at Ashtabula for fiscal 1978 was about \$1.6 million. The program is totally funded under special materials production.

MAJOR FACILITIES

The facility is unique in that both company and government-owned buildings are located on property owned by RMI. The area of the site is 8.3 acres which is enclosed by perimeter fencing.

Located on the site are two government-owned buildings with a total area of approximately 32,000 sq.ft. The utilization of the space is as follows:

- 2,000 sq.ft. - Pyrophoric materials incineration facility
- 10,000 sq.ft. - Materials and supplies storage and work-in-process storage
- 5,000 sq.ft. - Office area
- 3,000 sq.ft. - Metallurgical laboratory and metal working equipment
- 2,000 sq.ft. - Plant maintenance machine shop
- 10,000 sq.ft. - Processing area

Four site buildings owned by RMI have a total area of approximately 27,500 sq. ft. These are:

<u>Buildings</u>	<u>Approx. Area (sq.ft.)</u>
Guard House	225
Office Building	900
Storage Building	600
Main Production Building	25,775

Significant equipment located at the Ashtabula site consists of (1) a large, 3850 ton, horizontal extrusion press and (2) supporting heating, handling and processing equipment designed to handle production levels of metal extrusion, primarily uranium. A small laboratory size extrusion press, 360 ton, and limited metallurgical laboratory facilities exist in support of the production effort. Investment for the presses and the major support and processing equipment was approximately \$2.1 million.

SAVANNAH RIVER PLANT

Aiken, South Carolina

INTRODUCTION

On November 22, 1950, the Atomic Energy Commission formally approved selection of 250,000 acres in Aiken, (Allendale, and Barnwell Counties) South Carolina, as the site for the Savannah River Plant. Operations began with the start-up of a unit of the heavy water extraction plant on October 3, 1952, and the beginning of nuclear operations in the first production reactor was achieved on December 28, 1953. Construction of the basic plant was completed in 1956 at a cost of more than \$1.1 billion, including the land. The Savannah River Plant borders the Savannah River for 22 miles and is located 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia.

Although activities at the facility are primarily defense oriented, many of the programs, and radioisotopes produced, have peacetime applications. For example, plutonium-238 is being used as a long-lasting energy source in the nation's space program and in cardiac pacemakers. Californium-252 is a prolific source of neutrons with many promising applications including the treatment of cancer. Some of the other radioisotopic products include uranium-233, curium-244, polonium-210, and high-activity cobalt-60.

The Savannah River Plant is under the jurisdiction of the Savannah River Operations Office and is operated for DOE by E.I. duPont de Nemours and Company. The Savannah River Laboratory and the Construction Division of duPont's Engineering Department are separate entities operating at the plant site, but are a part of the duPont Corporation. DuPont is the only contractor in the DOE system that maintains the unique capability of handling all aspects of a project, including the research and development, testing, construction, and operations.

The Savannah River Laboratory conducts extensive research and development studies to support the operation of the Savannah River Plant and other DOE missions. This research and development work has increased production in plant facilities, improved an already outstanding safety record, and has reduced the environmental effects of plant operations.

PERSONNEL

The Savannah River Plant, the Savannah River Laboratory, and duPont Construction employ approximately 7,500 at the plant site. Of that total more than 1,300 people hold college degrees, primarily in mathematics, engineering, life sciences and physics. One hundred sixty-six of the duPont staff hold doctorate degrees. Nonprofessional employees at the

site--reactor operators, laboratory technicians, mechanics, health physics inspectors, clerks, etc.,-- total approximately 6,200.

CURRENT MISSION AND PROGRAM ACTIVITIES

Fuel and Target Fabrication

The fuel and target elements and control rods for the production reactors are manufactured in the fuel and target fabrication facilities. The shape and composition of each element are tailored to specific production needs. Elements can be tubular or cylindrical, and are clad with aluminum to maintain the integrity of the element during irradiation. Enriched uranium fuel elements are alloys of uranium with aluminum. These elements are made from castings that are simultaneously sheathed with aluminum and formed into long thin tubes by a co-extrusion process.

Isotope Production in Nuclear Reactors

The Savannah River Plant has three operating production reactors, and two in standby condition. Each reactor consists of a large shielded stainless steel tank filled with heavy water. Inserted into the heavy water are columns of fuel, target, and control rods. Heat generated by nuclear fission in these reactors is removed by circulating heavy water in closed loops through the reactor, then through heat exchangers and back into the reactors.

Chemical Separations

Reactor products are separated and purified in two chemical separation plants. Plutonium and uranium in irradiated fuel and target elements are separated and converted to nitrate form in remotely controlled shielded facilities. Plutonium nitrate is subsequently converted to metal or oxide form for shipment offsite. Other separation processes extract and purify special isotopes produced in the reactors.

Waste Management

Production facilities at Savannah River generate liquid, solid, and gaseous radioactive wastes. The objective of the Savannah River Waste Management Program is to handle these wastes in a manner so that they will not endanger the health and safety of employees or the public, and they will not have an adverse impact on man's environment.

High-level liquid alkaline waste is received from the chemical separations areas and stored in near-surface carbon steel tanks until short-lived radionuclides decay and insoluble solids settle out. The waste is then processed through an evaporator to reduce the volume requiring storage. Solid radioactive waste is packaged and stored in a burial ground according to its radiation level. Gaseous wastes are passed

through a filter or a series of filters before they are released to the environment in a controlled manner. Research, development and conceptual design are currently aimed at conversion of Savannah River Plant high-level liquid and solid defense wastes to stable non-leachable solid forms such as concrete or glass. Either of these forms will be suitable for long-term storage in a federal repository.

Heavy Water Extraction

The heavy water extraction plant, the only such operating plant in the United States, separates tons of heavy water from natural water drawn from the Savannah River each year. The plant produces heavy water of 99.75 percent purity. Heavy water is used in Savannah River reactors and is sold to research laboratories and private industry.

PROGRAM FUNDING

Fiscal 1978 operating funds for the Savannah River Plant was as follows:

	<u>\$ Millions</u>
Nuclear Energy Development	\$ 65.3
National Defense	217.4
Program Support	<u>0.1</u>
Total	<u>\$282.8</u>

MAJOR FACILITIES

The authorized investment in Savannah River Plant facilities and equipment totals over \$1.5 billion. Major facilities include the following:

- o Nuclear production reactors moderated and cooled by heavy water. Three of the five original reactors are currently operating.
- o Two chemical separation plants for separating and purifying reactor products.
- o Facilities for separating and handling tritium.
- o Fuel fabrication plant for manufacturing fuel, target, and control elements for the reactors.
- o Heavy water extraction plant.
- o Waste management facilities which provide safe storage of both high-level and low-level radioactive defense wastes generated from the production facilities at SRP.

- o Extensive research and development facilities at the Savannah River Laboratory.
- o Supporting facilities such as computer systems, a weather analysis laboratory, power plants, library and publication services, and transportation and communication networks.

HANFORD PRODUCTION OPERATIONS

Richland, Washington

INTRODUCTION

Production operations represent an important part of the programs at the 570-square mile Hanford Reservation in southeastern Washington. The production of plutonium for use in World War II was the original high priority mission of the Hanford complex when construction was begun in 1943. This wartime construction program resulted in three reactors, three separation plants and fuel fabrication facilities.

Today, Hanford's mission under DOE has been considerably broadened, but production operations remains a key programmatic responsibility. These operations which consist of reactor fuel fabrication and chemical separation/waste management, are performed by United Nuclear Industries, Inc. (UNI), and Rockwell Hanford Operations, Rockwell International, respectively.

PERSONNEL

The Rockwell staff currently includes:

Highest Degree Attained	Number
Ph.D.	42
M.S.	111
B.S.	<u>514</u>
Total	667

Occupation	Number
Engineers	317
Mathematicians	15
Physical & Earth Sciences	156
Life Sciences	32
Technicians	337
Other	<u>2,279</u>
Total	3,136

N Reactor front face showing charge/discharge equipment.

Zirconium clad fuel element assembled by United Nuclear Industries, Inc., for use in N Reactor.

The UNI staff currently includes:

Highest Degree Attained	Number	Occupation	Number
J.D.	2	Engineers	104
Ph.D.	7	Physical Scientists	49
M.S.	43	Mathematicians	5
B.S.	<u>181</u>	Life Scientists	1
		Other	<u>676</u>
	Total 233		
		Total	835

PROGRAM ACTIVITIES

Reactor/Fuel Operations

United Nuclear, Inc., is involved in fuel fabrication, and reactor operations, engineering, maintenance, and development.

UNI is responsible for one operating dual-purpose reactor (N reactor) which produces plutonium and by-product steam. N reactor operates at 3800 MWt and delivers sufficient steam to the Washington Public Power Supply System to operate their electrical generating plant at 860 MWe and produce 4.5 billion kilowatt hours per operating year. Since start of operation in 1966, the plant has generated over 40 billion kilowatt hours of energy. N reactor can also be used for various test programs provided that these programs do not interfere with plutonium production.

UNI management expertise includes specialized application of equipment maintenance standards, quality assurance, nuclear safety and environmental protection, radiological protection, and safeguards and security. Technical expertise includes reactor physics, thermal hydraulics, materials effects, water treatment and purification, engineering development, and research and development planning and implementation.

Chemical Separations/Waste Management

Rockwell Hanford Operations (Rockwell) conducts three major technical programs and provides vital support services for the entire site; e.g., patrol, fire protection, transportation, central stores, and electrical distribution. The major technical programs are:

- o Chemical processing of irradiated production reactor fuel and plutonium-containing scrap, including recovery and conversion of plutonium for defense and reactor research programs; recovery

and purification of neptunium-237 and americium-241, and other radioactive isotopes; and recovery and conversion of irradiated uranium for re-use as reactor fuel.

- o Solidification into a salt cake form of the millions of gallons of liquid waste which have been generated during the past 33 years at Richland by processing of production reactor fuels. The high heat-producing isotopes in the high-level waste system, cesium-137 and strontium-90, are removed and independently solidified, encapsulated in double-walled metal capsules, and stored in a water-cooled vault.
- o Research studies on various modes of interim and long-term storage of radioactive wastes, and spent nuclear fuels, e.g., conversion of salt cake to a highly insoluble glass-like form, and assessment of the feasibility of using the basalt formations beneath the Hanford site as a repository for spent fuel and nuclear waste.

Rockwell Hanford Operations management expertise includes specialized application of research and engineering administration, quality assurance and safety, and production and waste management. Technical expertise includes chemical processing, solvent extraction, remote operation and maintenance decontamination, radiation monitoring, criticality engineering, and transportation of radioactive materials.

PROGRAM FUNDING

The fiscal 1978 operating budget for Hanford Production Operations follows:

	<u>\$ Millions</u>
Rockwell	79.5
UNI	<u>43.1</u>
Total	\$122.6

MAJOR FACILITIES

The authorized investment in plant and equipment was \$972.2 million, including the following major facilities:

- o One dual-purpose 3800 MWt reactor (N Reactor) is in operation for production of plutonium and by-product steam.
- o Five plants accomplish all phases of chemical separation, purification, and long-term production, and research.

- o Three chemical laboratories assist in waste management, environmental protection, and research.
- o The Waste Management Surveillance and Operations Facility completed in 1977, provides space for approximately 290 persons and the tank farm surveillance computer. The completed cost of this 48,000 square foot facility is \$4.6 million. Thirteen one-million gallon, double-shell underground radioactive waste storage tanks are also under construction in 200 East Area. The estimated cost of the new tanks is \$47.5 million. Six tanks will be completed in fiscal 1979 and seven in fiscal 1980.

WEAPONS TESTING AND FABRICATION COMPLEX

A major increment of the Department of Energy's (DOE's) annual operating budget supports the testing and production of nuclear weapons, and stockpile evaluation and maintenance activities. The fiscal 1978 operating budget for these activities was about \$0.7 billion, or roughly 10 percent of the total DOE budget.

The nuclear weapons design and development function is performed by three of DOE's major laboratories:

Los Alamos Scientific Laboratory
Lawrence Livermore Laboratory
Sandia Laboratories

Their specific program activities were described earlier in section IV on Multiprogram Laboratories.

Following the design and development of test devices, the weapons laboratories perform underground experiments at the Nevada Test Site (NTS) to verify performance, test safety features, and explore the physics of new design concepts. The NTS is located in the remote desert of Nye County, Nevada, to assure safety and security in test operations. Following successful completion and certification of a new weapons system by the developing laboratories, the production phase is begun and the weapon eventually enters the national defense (war reserve) stockpile. The DOE weapons production complex consists of seven major facilities with completed plant and equipment value of approximately \$1.4 billion. Related fiscal 1978 employment totals about \$20,200.

Program direction for the DOE weapons complex is centered in DOE's Office of Military Application.

NEVADA TEST SITE

INTRODUCTION

The Nevada Test Site (NTS), operated by the Nevada Operations Office (NV), is located about 65 miles northwest of Las Vegas, Nevada.

Established in December 1950 as a continental site for conducting atmospheric nuclear tests, NTS proved to be ideal from the geologic and hydrologic standpoints for the underground nuclear testing program which has been conducted since 1962.

Covering more than 800,000 acres and buffered on three sides by hundreds of thousands of acres of the Nellis Air Force Range, the NTS has extensive administrative, logistic, and technical support facilities in Mercury, the Control Point, Area 12 Camp, and the Nuclear Rocket Development Station (NRDS). These include housing, medical and feeding facilities. The NTS is served by a four-lane highway from Las Vegas and contains three airfields.

The Nevada Operations Office in Las Vegas was established in 1962 to administer the nuclear testing program, which has included nuclear test projects both on and off the NTS. NV is a project management organization that provides for the planning, preparation, execution, and post-execution phases of approved programs and projects at the NTS. Upon specific request of a project sponsor, NV will undertake the selection, negotiation, and execution of contracts to provide unique services at NTS and other locations which are not readily available at other operating locations.

PERSONNEL

The NV engages a group of contractors who perform site management, construction, technical, engineering, and other support activities at the Nevada Test Site. The contractors employ a wide range of construction craftsmen, including carpenters, electricians, iron workers, plumbers, teamsters, sheet metal workers, tunnel workers, drillers, operating engineers and laborers. In fiscal 1978, the NV contractor employment averaged approximately 5,200 people.

Nuclear rocket fuels stored at NRDS were removed for shipment to the Idaho National Engineering Laboratory where the uranium was extracted and recovered from the graphite fuel elements. E-MAD Building was built to handle the huge NERVA engine. The building is 80 feet high and has 100,000 square feet of floor space. A hot bay, with railroad car or truck access through a rolling concrete door, can receive and store radioactive materials. It is equipped with a sidewall manipulator at the end of a 35-foot arm and 10 master-slave manipulators.

NTS Major Contractors	Function	FY 1977 Average Personnel Level
Reynolds Electrical & Engineering Co., Inc.	Prime Support	2,585
EG&G, Inc.	Technical Support	1,415
Holmes & Narver (OCTD)	Architect and Engineering	205
Fenix & Scission, Inc.	Mining and Drilling Architect and Engineering	60
Computer Science Corporation	Computer Operation	61
Wackenhut Services, Inc.	Security	215

The NTS program also receives support from other federal agencies for services in which they have particular expertise. These include the Environmental Protection Agency, which is responsible for offsite safety, the National Weather Service, which provides meteorological services, and the U.S. Geological Survey, which provides geological and hydrologic studies.

CURRENT MISSION AND PROGRAM ACTIVITIES

The primary mission of the Nevada Test Site is to provide a remote secure facility for the safe conduct of underground nuclear testing in support of national defense programs. Over the years of operations at NTS, NV contractors have developed unique expertise in such fields as drilling, mining, and downhole diagnostics in support of the weapons development laboratories and the Department of Defense.

Much of the success of the testing program is due to the development of big-hole drilling techniques at NTS. Ordinary drilling for petroleum uses drill bit diameters of less than one foot. Nuclear weapons canisters containing diagnostic equipment require much larger holes. Nevada contractors Fenix and Scission, Inc., and Reynolds Electrical and Engineering Company, Inc., have developed drill bits that now can bore holes up to 12 feet in diameter and thousands of feet deep in one pass. There is considerable international industrial interest in big-hole drilling technology.

The need to evaluate accurately nuclear device performance deep underground led to the development of highly sophisticated electronic diagnostic equipment by the DOE weapons laboratories and contractors. This sophistication has aided in the development of radiation detection equipment such as that used in the EG&G-operated aerial measuring systems aircraft.

In addition to weapons testing, use of the site has been expanded to include many other programs and projects. Examples are various biological and medical experiments to study plant and animal life in a radiation environment; geological, hydrological, and seismic investigations; tests in the Plowshare program to develop applications of nuclear explosives in science and industry; and the development and testing of nuclear rocket engines at the Nuclear Rocket Development Station (NRDS) facilities on the Test Site.

As a result of studies supporting the underground nuclear testing program, the geology and hydrology of the test site are among the best known of any large region in the nation. Meteorological support is provided on a daily basis with a variety of recording systems available.

Eleena shale and granitic rock formations are under investigation as part of a nationwide program to locate a medium that has good heat flow characteristics for use in storing commercial radioactive waste material.

PROGRAM FUNDING

In fiscal 1978, NV's operating budget was about \$257.6 million, of which \$201.9 million was DOE funded; \$55.7 million is for work performed for other Federal agencies. Major operating programs in fiscal 1978 included:

	FY 1978 Operating Funds (In Millions)
Weapons Activities	\$151.0
Terminal Waste Storage	8.9
Gas Recovery	4.9
Biomedical	1.4
Decontamination & Decommissioning	.8
Environmental R&D	3.2
Program Direction	8.7
Geothermal	10.5
Spent Fuel Handling & Packaging Program	6.9
Other Federal Agencies	55.7
Miscellaneous Programs	5.6
Total	\$259.6

The authorized investment in plant and capital equipment through fiscal 1978 at NTS is approximately \$250.0 million.

FACILITIES

Facilities which may be used for energy projects include the Nuclear Rocket Development Station (NRDS) which encompasses office space, large cells for handling radioactive materials, shops hydrogen and oxygen storage tanks a photographic laboratory, and support facilities.

The principal NRDS facility, the \$50 million engine maintenance, assembly, and disassembly building (EMAD), has provisions for conventional assembly operations, including cranes, lift trucks, handtools, and technical support from machine shops, electric/electronic shops, welding shops, and instrumentation laboratories. Disassembly areas for post-test reactor disassembly and examination of components consist of "hot" bays and cells of various sizes with thick concrete walls and lead glass viewing windows to protect personnel against radiation during the remotely conducted operations. Remotely operated equipment includes bridge cranes, electro-mechanical manipulators, and master-slave manipulators, all of which are operated from outside the "hot" cells.

The NTS has a full range of telecommunications facilities, including secure voice and communications centers, diagnostic data acquisition systems linked by microwave, primary and satellite telephone switching systems, as well as HF, VHF, and UHF radio facilities. There is also an emergency reporting center to relay calls to medical, fire, police, etc.

The NTS is also the site of DOE's tallest structure, the 1,527-foot tower used by the Civil Effects Test Organization to approximate radiation exposures experienced by the survivors of Hiroshima and Nagasaki. More recently it has supported weather and sonic boom research.

WEAPONS PRODUCTION PLANTS

Responsibility for production of nuclear weapons is delegated by DOE to the Albuquerque Operations Office (AL). AL is responsible for overall management of the production system, including weapons production work done for AL at the Oak Ridge Operations Y-12 Plant and the Savannah River Plant. In managing this extensive operation, AL maintains Area Offices at seven of the plant locations. These offices are responsible for contract administration and quality assurance functions. AL is also responsible for the safe-secure domestic transport of nuclear weapons in DOE custody and strategic quantities of DOE-owned special nuclear materials, by highway, rail, and government and contractor-owned aircraft.

PERSONNEL

Weapons Production Plant Employment

<u>Weapons Production</u>	FY 1978 <u>Avg. Man-Years</u>
Bendix, Kansas City	5,561
Rockwell, Rocky Flats	2,986
Mason & Hangar-Pantex Plant	1,858
Monsanto, Mound	1,705
General Electric, Pinellas	1,233
Union Carbide, Y-12 ^{1/}	4,911
duPont, Savannah River ^{2/}	<u>355</u>
Total Weapons Production Plants	18,609
Other Weapons Production Support:	
Sandia Laboratories	537
DOE-ALQ ^{3/}	365
	<u>19,511^{4/}</u>

^{1/} Y-12 plant is 30 percent dedicated to non-weapons activities

^{2/} Weapons Program only

^{3/} Transportation safeguards system and onsite production surveillance

^{4/} Differs from end of year permanent full-time employees

Employees with Degrees

	<u>Ph.D. Degree</u>	<u>Masters Degree</u>	<u>Other Degree Holders</u>
Bendix, Kansas City	24	324	1,195
Rockwell, Rocky Flats	58	130	435
Monsanto, Mound	68	125	435
General Electric, Pinellas	7	37	194
M&H, Pantex Plant	11	59	345
Union Carbide, Y-12 <u>1/</u>	57	185	712
du Pont, Savannah River	<u>13</u>	<u>14</u>	<u>90</u>
Total	238	874	3,406

1/ 70 percent of Y-12 totals would yield 40 Ph.D., 130 Masters, and 498 other, applied to weapons production and surveillance.

CURRENT MISSION AND PROGRAM ACTIVITIES

Kansas City Plant

The Kansas City Plant, located in southeastern Kansas City, Missouri, was established in 1949, and is operated by the Bendix Corporation to produce nonnuclear weapon components. The plant is a highly diversified, technically oriented operation embracing the full spectrum of work on nonnuclear products--from research on new materials to the production of complex and reliable weapons components.

Production is directed toward relatively small quantities fabricated to meet the high quality, high reliability, and close tolerance requirements characteristic of weapons programs.

Production activities are directed toward three basic areas:

- o Electrical and electronics work is a major activity and includes components such as radars, timers, high energy power supplies, hybrid microcircuits, printed circuit boards, and telemetry and flight instrumentation units used in simulated weapons performance analysis.
- o Mechanical products are another major activity and include precision valves, coded locking devices, environmental sensing components, and machined support structures. Much of the major manufacturing equipment in the mechanical area is numerically controlled.

- o Plastic products include injection and compression molded polymers, filled elastomers, and molded- and machined-to-size syntactic, polyurethane, and polystyrene foam. The molding operation uses a computer-controlled mold heating and cooling system.

To support its primary production mission, the plant develops processes and materials. It engages indirectly in energy research and development by providing developmental hardware for research programs conducted at the DOE laboratories. Such hardware includes targets for laser-fusion and electron beam fusion, laser target chambers and laser amplifiers, insulating foam and energy collecting pipes for solar energy development, prototype metal Dewar bottles for particle accelerators, and devices for experiments with electron beam sources.

Weapons development activities range from plating 500-angstrom-thick films to modifying truck trailers in the Safeguards transportation safety program. Special technologies include organic coatings, metal deposition, etching of precision patterns into metal films, formulating polymers and adhesives, and designing and fabricating instrumentation for product testing. Prototype fabrication capabilities are available for metal machining, welding, assembly of complex telemetry systems, fabricating miniature electronic devices, and producing polymers.

Rocky Flats Plant

The Rocky Flats Plant is located on a 6,551 acre site between Golden and Boulder, Colorado. The plant was established in 1952 with Dow Chemical Company the initial operator. In 1975, Atomics International, a division of Rockwell International, replaced Dow as the operating contractor.

Rocky Flats' mission is to produce nuclear components along with some non-nuclear assemblies/hardware for weapons. The plant is primarily concerned with metal production and chemical processing with heavy emphasis on production-related research. Production activities include fabrication of plutonium and uranium alloy as well as conventional metal components and their assembly, foundries, plutonium recovery and research and development support for the weapons design laboratories in assigned mission areas. The plant is also responsible for the recovery of plutonium residues for the weapons complex. Also, extensive process development programs are carried out to support the weapons design laboratories with development models for concept feasibility studies.

The Rocky Flats Plant has led in research on the attributes and properties of various alloys of plutonium metals for both a fabrication and waste recovery standpoint. It has also pioneered the field of beryllium fabrication.

Special Purpose Valves. Bendix manufactures explosive-activated valves. A precision fit plunger is pressed into place before a disc is welded in place by an electron beam to provide a hermetic seal.

Pantex (Amarillo) Plant

The Pantex Plant is located approximately 23 miles northeast of Amarillo, Texas, and has been operated for DOE by Mason & Hanger-Silas Mason Company, Inc., since October 1, 1956. The plant site occupies more than 10,000 acres.

The Pantex Ordnance Plant was built in 1942 to produce conventional bombs and shells. The facility was deactivated following World War II and administration assumed by the U.S. Army Corps of Engineers who later turned Pantex over to the War Assets Administration. In 1951, following a survey of World War II Ordnance Plants, the U.S. Atomic Energy Commission (AEC) selected Pantex as the location for an explosives components plant and an Amarillo Area Office was activated. The AEC assumed complete administrative control of the plant including the real property on October 1, 1963, and the name of the facility was changed to Pantex Plant.

The principal programs at Pantex are related to the fabrication of high explosive and other components necessary to assemble, repair, and test nuclear weapons, participate in weapon retirement, and support plant maintenance. More specifically, the mission of the plant is to:

- o Fabricate high explosives and other components and, with components provided by other weapons complex plants, perform final assembly of nuclear weapons.
- o With provided components, perform final assembly testing of type units for DOE and DOD testing and training programs.
- o Perform new material and stockpile laboratory tests, weapon modifications and repair work necessary on all existing weapons within the U.S. nuclear stockpile.
- o Retire weapons which are surplus to stockpile requirements.
- o Provide technical support in the field of high explosives and fabricate explosive device components for the design agency laboratories.
- o Maintain active portions of the plant facilities for the above activities.

Pinellas Plant

The neutron devices department of the General Electric Company (GEND) operates the Pinellas Plant in St. Petersburg, Florida for DOE. The plant was built in 1956 for the purpose of development and production of neutron generators for nuclear weapons initiation.

Pinellas' facilities support process development, design laboratory and production activities. GEND technology and skills focus on the development and manufacture of highly complex, miniaturized neutron generators and electronic assemblies; medium power radioisotopic thermoelectric generators and thermoelectric converters, electrical connectors which arrest lightning discharges; and special neutron generation and neutron measurement devices for nuclear weapons testing. Some of the more interesting state-of-the-art advances in process technology have been the metal coating and high vacuum technology necessary to build a fusion reaction into a small vacuum envelope and the successful adaptation of laser energy in forming and sealing complex glass components. Pinellas also designs and fabricates sophisticated electronic test systems for use by DOE in product acceptance testing.

Mound Facility

The Mound Facility located in Miamisburg, Ohio, is operated by Monsanto Research Corporation, a wholly-owned subsidiary of Monsanto Company. The Mound Facility originated as a technical organization in 1943 in Dayton, Ohio, when Monsanto Chemical Company was requested to accept responsibility for determining the chemical and metallurgical properties of polonium as a project of the Manhattan Engineer District. Construction of a permanent facility for this activity was completed in nearby Miamisburg in 1948.

Mound is an integrated production and laboratory facility which performs a wide variety of weapons production and process development activities and conducts research and development for several other DOE programs. Based on specialized capabilities established during the last 30 years, its missions today emphasize work in explosives technology, tritium technology, plutonium-238 isotopic heat source development and assembly, isotope separation, and fossil energy technology.

The current major production activity is the fabrication of explosive components--such as detonators, explosive timers, explosive-actuated transducers and fire sets, and explosive pellets--for nuclear weapons. Assignments have recently been expanded to include development and production of electronically initiated pyrotechnic components and ceramic components. Other manufacturing activities include the fabrication of nuclear components and small isotopic heat sources for weapons systems. Closely related is an extensive reliability testing program on stockpile samples of explosive detonators and components containing radioactive materials. Design and construction of testing equipment is an important part of this quality assurance program.

Process development activities include a broad range of studies to develop materials, processes, and equipment for potential production applications in support of programs at several DOE laboratories. Mound also supplies one-of-a-kind components and specialized materials for DOE laboratories.

As an outgrowth of weapons production activities involving components containing tritium, Mound recovers and purifies tritium from all types of wastes. A leader in the application of energy from decay of radioisotopes, this facility also assembles heat sources fueled with plutonium-238 for space and terrestrial use. Mound has recently been assigned the management of plutonium-238 heat source production activities for DOE non-weapons programs. A worldwide program for sales of stable (nonradioactive) isotopes is conducted in conjunction with isotope separation and enrichment activities. Over 25 isotopes of the noble gases, carbon, nitrogen, oxygen and sulfur, are currently marketed. In addition, Mound separates the radioactive isotopes, thorium-229, thorium-230, protactinium-231, and uranium-234 for the isotope sales activities at Oak Ridge National Laboratory.

In association with all program activities, Mound conducts multidisciplinary research and development on materials and instrumentation. For example, a comprehensive program for the development of plastics, elastomers, adhesives, and ceramics is conducted in connection with production operations. Also, calorimetry research, a long-time specialty, often includes the construction of highly accurate calorimeters for other DOE sites.

Y-12 Plant

The Oak Ridge Y-12 Plant, operated by the nuclear division of Union Carbide Corporation, is located adjacent to the City of Oak Ridge, Tennessee. The plant, which was built in 1943 as part of the Manhattan Project, had as its initial mission the separation of uranium isotopes by the electromagnetic process. The electromagnetic process was discontinued in 1947 in favor of the gaseous diffusion process, and since that time the plant has evolved into a highly sophisticated development, engineering and manufacturing organization with major responsibilities in the nuclear weapons program. Extensive and highly diversified production capabilities and skills ranging from heavy industry activities to miniature assemblies involving a broad spectrum of materials in many forms and combinations are provided for the weapons program. Complementing the production resources are broad and advanced capabilities for evaluating and certifying product(s). All of the production and certification resources are supported by extensive applied research and development capabilities.

The basic mission of the Y-12 Plant is support of the nuclear weapons program through fabrication and certification of components for the weapons stockpile, development and fabrication of test hardware for the three weapons design laboratories, and conduct of related process development activities. Weapons production activities involve chemical processing, metal forming, machining, precision plating and coating, powder metallurgy, ceramic, manufacturing, and assembly. Process development activities parallel production missions and cover materials, metal forming, joining, precision machining and certification techniques. A major portion of the plant's fabrication and certification equipment utilizes numerical control or computer control.

In addition to support of the nuclear weapons program, other Y-12 Plant activities include the following:

- o Nuclear materials processing including enriched uranium, lithium metal and compounds, and deuterium gas.
- o Precision machining of optics for application in the laser fusion program.
- o Development work in support of the uranium vapor isotope separation concept. This effort involves use of Y-12 developed technologies in the areas of uranium melting and refractory metals.
- o Development work in support of energy conservation consisting of hot pressing of ceramic engine components and fabrication of high-performance composite flywheels.
- o Engineering and fabrication work for other UCC-ND plants. This work supports DOE programs in the areas of uranium isotope separation, magnetic fusion, and reactor development.
- o Work for other federal agencies involving use of carbon technology, standards calibration equipment, precision machining and powder metallurgy technology.

Savannah River Weapons Facility

The Savannah River Weapons Facility, located at the Savannah River Plant site, near Aiken, South Carolina, is operated by E. I. duPont de Nemours & Co. The facility consists of three major buildings having approximately 92 thousand square feet of area. The primary mission of this facility is the extraction, separation, and recovery of tritium. To support this mission, the plant has special capabilities for the tritium loading of special components, as well as the unloading and reclamation of such components. Savannah River also provides for surveillance and materials compatibility testing relative to such components.

PROGRAM FUNDING

The fiscal 1978 operating costs for the weapons production complex follow.

	FY Operating Budget (BO) \$ Million		
	<u>DOE^{1/}</u>	<u>Other</u>	<u>Total</u>
Pantex Plant	\$ 45.1	1.4	\$ 46.5
Kansas City Plant	157.5	37.2	194.7
Mound Facility	57.0	2.4	59.4
Pinellas Plant	39.7	2.5	42.2
Rocky Flats Plant	95.0	1.0	96.0
Savannah River Weapons Facility	19.4 ^{2/}	.0	19.4
Y-12 Plant	158.2	3.5	161.7
Total	\$571.9	\$48.0	\$619.9

1/ Includes work done for other DOE Facilities

2/ Includes only work for the Savannah River Weapons Facility

MAJOR FACILITIES

The September 30, 1978 investment in completed plant and equipment was approximately \$1.4 billion.

	Plant Site	Plant
	Acreage	and Equipment - FY78 (In Millions)
Pantex Plant	10,177	94.9
Kansas City Plant	122	163.2
Mound Facility	182	116.8
Pinellas Plant	99	37.1
Rocky Flats Plant	6,551	414.7
Savannah River Weapons Facility	15	23.1
Y-12 Plant	850	541.2
Total	17,951 Acres	1,394.0

KANSAS CITY PLANT

- o Controlled environment facilities for development, fabrication, and testing of miniature products (i.e., precision mechanisms, hybrid microcircuits, etc.).

- o Metal working facilities which include 275 major equipment items for machining various materials with sizes ranging from 8-foot dimensions to 0.050-inch wall thicknesses.
- o Plastic facilities equipped with 33 major items including compression presses, injection molders, and turning machines for manufacturing applications ranging from precision miniature panels to parts 4 feet in diameter and 30-inches long.
- o Materials and product development laboratories

ROCKY FLATS PLANT

- o Plutonium handling facilities including foundry, fabrication, and assembly equipment.
- o Metallurgical laboratories.
- o Nonradioactive materials electro-chemical milling facilities.

PANTEX PLANT

- o High explosives fabrication capabilities include pressing, machining and inspection. Pressing facilities include hydraulic isostatic and compacting capabilities up to 25-inch diameter and 30,000 psi. Machining facilities include numerical controlled multiaxis turning, boring, drilling, and milling capabilities. Inspection facilities include scanning electron microscopy, 8 and 12 million electron volt linear accelerator, numerical controlled gaging, optical measurement and mass spectrometry.
- o Six explosive test sites for quality evaluation of weapons explosives and to perform testing and evaluation of new explosive compounds.

PINELLAS PLANT

- o Ultra-high vacuum processes facility which is one-of-a-kind among the AL production plants.
- o Ceramics and glass assembly facility for fabrication of assemblies requiring ceramic to metal, ceramic to glass and glass to metal vacuum tight seals.

- o Material and Product Analysis Laboratory facility (which supports the development of GEND products) used extensively for production problem solving.
- o A production facility for thermoelectric materials and assembly and test of radioisotopic thermoelectric generators.
- o A development facility including a 1,000 sq. ft. dry room for production problem solving and development of process for thermal batteries.

MOUND FACILITY

- o Processing facility for plutonium-238 heat source encapsulation.
- o Facilities for tritium recovery, purification and effluent control, including basic studies on tritium components (a tritium technology facility).
- o Dimensional, electrical, and mass standards laboratories.
- o Environmental technology laboratories.
- o Specialized equipment (diffusion and chemical exchange cascades, separation equipment) associated with isotope separation and enrichment activities.
- o Facilities for development and testing of components containing explosive and pyrotechnic materials.
- o Materials development facilities, including ceramic development facilities, compatibility testing facilities, and precision machine shops.

Y-12 PLANT

- o High temperature autoclaves and pressure vessels
- o Large metal working equipment, including furnaces, rolling mills, and forming machines

- o High precision machining facilities, including inert atmosphere machining.
- o Enriched uranium chemical processing and casting equipment.
- o Filament winding facility.
- o Dimensional inspection, physical testing and analytical measuring equipment.
- o Physical, electrical, and dimensional standards laboratories.
- o Extensive materials and systems development facilities.

SAVANNAH RIVER WEAPONS FACILITY

- o Tritium extraction, separation, recovery and loading facilities.
- o Materials testing laboratory.
- o Component reclamation facility.

SECTION VI

POWER MARKETING ADMINISTRATIONS

NAVAL PETROLEUM AND OIL SHALE RESERVES

POWER MARKETING ADMINISTRATIONS
AND NAVAL PETROLEUM AND OIL SHALE RESERVES

INTRODUCTION

Surplus power not necessary to operate government-owned hydroelectric projects is marketed by the Power Marketing Administrations (PMA's) to help repay the Federal Government's investments in the projects. In addition, PMA's are authorized to construct or acquire transmission lines and related facilities which are necessary to generate the power and energy. This power is priced at the lowest possible rate consistent with sound business principles to recover the costs of producing the power.

The five Federal PMA's are the Alaska Power Administration, Bonneville Power Administration, Southeastern Power Administration, Southwestern Power Administration, and Western Area Power Administration.

The Assistant Secretary for Resource Applications is responsible for coordinating and overseeing the operations of the Federal PMA's within a framework which preserves them as separate and distinct organizational entities within the department, but ensures conformance to the National Energy Policy objectives.

The management of the Naval Petroleum and Oil Shale Reserves in California, Utah, and Wyoming is also the responsibility of the Assistant Secretary for Resource Applications.

More detail on the PMA's and Naval Petroleum and Oil Shale Reserves follows in this section.

11

EXECUTIVE SUMMARY

Alaska Power Administration

LOCATION: Juneau, Alaska

STATISTICS: (FY 1978)

NUMBER OF AREA OFFICES:	2
NUMBER OF GOVERNMENT EMPLOYEES:	38
ANNUAL OPERATING BUDGET:	\$2.2 million

MAJOR PROGRAM AND PROJECT ASSIGNMENTS:

- o Operation, maintenance, and marketing of power of Eklutna and Snettisham Hydroelectric Projects.
- o General investigations for developing and using Alaska's water, power, and related resources.

MAJOR PROJECTS ADMINISTERED:

- o Eklutna Project (30,000 kilowatts) near Anchorage, Alaska
- o Snettisham Project (47,160 kilowatts) near Juneau, Alaska

ALASKA POWER ADMINISTRATION

Juneau, Alaska

INTRODUCTION

The Alaska Power Administration (APA) is a unit of the Department of Energy reporting to the Assistant Secretary for Resource Applications.

APA was established as a separate bureau in the Interior Department in June 1967. The same functions were handled by the Bureau of Reclamation's Alaska District office between 1948 and 1967.

APA operates, maintains, and markets power from Alaska's two Federal hydroelectric projects. These projects are the 30,000 kilowatt (kW) Eklutna Project, serving the Anchorage-Palmer area, and the 47,160 kW Snettisham Project, serving the Juneau area.

PERSONNEL

APA has 38 full-time employees, including a staff of 19 for the two operating projects, and 19 at the headquarters office in Juneau.

CURRENT MISSION AND PROGRAM ACTIVITIES

Alaska now gets most of its power supplies from oil and natural gas. The state's population and economy are growing rapidly. Power demands are also increasing at rapid rates--12 percent per year is 1970's average rate of increase for Alaska's utilities.

APA investigates and plans for developing and utilizing Alaska's water, power, and related resources. Much of their planning work focuses on hydroelectric resources, transmission systems, and power market analyses. Alaska has some good options in abundant resources of coal and undeveloped hydroelectric power. Current Federal, state, and local efforts focus on developing these alternatives.

APA investigation programs involve engineering, economic, and environmental studies for future water and power developments in Alaska, including necessary evaluations of transmission systems, power market analyses, and estimates of future power requirements. All planning work is closely coordinated with local, state, and other federal entities.

Major areas of emphasis in the planning program include investigation of smaller hydroelectric projects to serve isolated coastal cities in Alaska. This group of cities has access to good local hydro resources, but otherwise depends on petroleum products for all their energy.

PROGRAM FUNDING

APA's fiscal 1978 operating budget is \$2.2 million, of which 55 percent is for operations, maintenance, and marketing, and 45 percent is for the investigations program and general administrative expenses. Estimated fiscal 1978 revenues from power sales are \$3.2 million.

The power is marketed at wholesale to five electric utilities. All costs associated with the projects are reimbursable from power sales revenues.

MAJOR FACILITIES

Eklutna Hydroelectric Project

The Eklutna Project has been in service since 1955, providing power to Anchorage, Palmer, and surrounding areas. It is 34 miles northeast of Anchorage, and about 8 miles south of Palmer. The powerhouse has two turbine-generators, each with a rated output of 15,000 kW. Transmission lines run from the plant to Anchorage and Palmer.

Eklutna Lake serves as the project's storage reservoir. Active capacity is 174,800 acre-feet. A low, earth-fill dam (replaced after the 1964 earthquake) retains the water. The power tunnel from the lake to the powerplant is 4.5 miles long.

Up through 1978, Eklutna had produced 3.5 billion kilowatt-hours (kWh) of energy, roughly equivalent to 250 million gallons of fuel oil used for power. The average production is over 150 million kWh a year.

Snettisham Hydroelectric Project

Detailed feasibility studies for the development of the Snettisham Project were undertaken in the late 1950's by the Bureau of Reclamation's Alaska District. Construction authorization was granted by Congress in 1962. Actual project construction started in 1967. The project was designed by the Corps of Engineers. APA is responsible for its operation and maintenance.

The first stage of the project was the development of the power potential of Long Lake. This stage was completed in 1975. The underground powerhouse, located at the head of Speel Arm, is 28 air miles southeast of Juneau. Two turbine generators are installed--each with a 23,580 kW capacity. Water is carried from the reservoir to the powerplant through an 8,000-foot tunnel. The reservoir provides 138,000 acre-feet of storage. This stage of the project has the capability of producing over 200 million kilowatt-hours of energy annually.

The first stage of development included a 44-mile, 138,000 volt transmission line, and a substation near Juneau.

The Juneau substation is the local area control center. Operators at the substation have supervisory control of the Snettisham Project and other utility powerplants in the Juneau system.

The second stage of the project will develop Alaska's Crater Lake near the Snettisham powerplant. This stage has been authorized; estimated power demands indicate it will be needed in the mid-to-late 1980's. It will consist of a tunnel from Crater Lake to the powerplant, and a 27,000 kW turbine generator unit.

As a major side benefit, the Alaska Department of Fish and Game has a fishery development program underway that may lead to a major salmon hatchery at Snettisham. Here, the water supply from the powerplant is well suited for fishery use because of its near-constant temperature and high quality.

This combination of power and fishery values, plus added benefits in recreational opportunities, make the Snettisham Project a true multi-purpose public facility.

Project details are shown on the sketches on the following pages. Each project has over 40 miles of transmission lines, plus switchyards and substations.

Water from Eklutna Lake is carried through Goat Mountain via tunnel to the Eklutna powerhouse.

Location Map - Eklutna Project

The Snettisham Project, located on the shore of Speel Arm southeast of Juneau, is accessible only by plane or boat. The underground powerplant entrance is to the left of the landing strip.

Location Map - Snettisham Project

EXECUTIVE SUMMARY

Bonneville Power AdministrationLOCATION: Portland, OregonSTATISTICS: (FY 1978)

NUMBER OF AREA OFFICES:	4
NUMBER OF DISTRICT OFFICES:	4
NUMBER OF GOVERNMENT EMPLOYEES:	3,083
ANNUAL OPERATING BUDGET (OBLIGATIONS):	\$376 million

MAJOR PROGRAM AND PROJECT ASSIGNMENTS

- o Markets electric power from Federal dams.
- o Wheels power for non-federal generating systems.
- o Constructs, operates, and maintains its transmission system.
- o Performs and participates in R&D to improve EHV and UHV technology.
- o Prepares wholesale rates and repayment schedules.
- o Participates in regional power planning.
- o Is developing a formula for power allocation.
- o Carries out an energy conservation program.

OTHER OFFICE LOCATIONS AND MAJOR FIELD OFFICES

<u>Office</u>	<u>Location</u>
Washington, D.C. Office	Washington, D.C.
Ross Complex	Vancouver, Washington
Portland Area Office	Portland, Oregon
Seattle Area Office	Seattle, Washington
Spokane Area Office	Spokane, Washington
Walla Walla Area Office	Walla Walla, Washington
Eugene District Office	Eugene, Oregon
Idaho Falls District Office	Idaho Falls, Idaho

OTHER OFFICE LOCATIONS AND MAJOR FIELD OFFICES (Continued)

<u>Office</u>	<u>Location</u>
Kalispell District Office	Kalispell, Montana
Wenatchee District Office	Wenatchee, Washington

BONNEVILLE POWER ADMINISTRATION

Portland, Oregon

INTRODUCTION

Bonneville Power Administration (BPA), created by the Bonneville Project Act of 1937 is responsible for the construction of transmission lines and the marketing of power from Federal hydroelectric projects in the Pacific Northwest.

BPA's service area essentially consists of the States of Washington, Oregon, Idaho, and the portion of Montana west of the Continental Divide. Within this area, it operates some 12,600 circuit miles of high-voltage transmission lines and 346 substations.

BPA markets power from 30 Federal hydroplants operated by the Army Corps of Engineers and the Bureau of Reclamation. It also markets the output of the Hanford Nuclear Generating Plant and part of the output of the coal-fired Centralia Thermal Project and the Trojan Nuclear Project.

BPA's 160 customers include both public and investor-owned utilities, cooperatives, large industrial installations, and state and Federal agencies. BPA sells surplus power and interchanges power with utilities in California and British Columbia.

PERSONNEL

The BPA permanent personnel complement is 3,083, plus some 400 temporary positions.

CURRENT MISSION AND PROGRAM ACTIVITIES

The BPA mission is to assure a reliable electric energy system in the Pacific Northwest while balancing economic, technical, and environmental considerations. Commensurate with this mission, BPA is the Federal Government Agency in the Pacific Northwest responsible for:

- (1) The marketing of power from the region's Federal hydrogenerating projects as well as power purchased or acquired from other sources;
- (2) Acting in cooperation with other entities in the region to integrate the operations of the region's generation and transmission systems and for achieving, as nearly as practicable, the economic and environmental benefits possible;

- (3) Constructing transmission facilities necessary to integrate and transmit the electric power from existing or additional Federal or non-Federal generating units, providing service to the Administrator's customers, providing interregional transmission facilities, and maintaining the electrical stability and electrical reliability of the Federal system.

As a result of earlier litigation, BPA embarked in late 1975 on the preparation of a programmatic environmental impact statement describing its participation in Phase 2 of the regional Hydro-Thermal Power Program. The draft document also explores a range of alternative roles which BPA might play in the future Northwest power system. During the fall and winter of 1977-78, BPA conducted 30 public hearings throughout the region to discuss the issues contained in the Role Environmental Impact Statement (EIS) and to solicit public comments. More than 300 persons gave valuable testimony, and some 500 written statements were subsequently received. All of these are being incorporated into the final EIS, which is scheduled for completion in mid-1979.

BPA has a statutory obligation to give preference and priority in the marketing of Federal power to public bodies and cooperatives. Unfortunately, electric energy resources are not keeping pace with growing demand, and there is increasing pressure for a broader distribution of the lower-cost Federal power. BPA is therefore undertaking a major review of future power allocation throughout the region. It will seek broad public involvement in the development of an allocation formula which is scheduled to be adopted in mid-1980.

The chief executive officer is the Bonneville Power Administrator. Under the administrator and his deputy are four major divisions and an office in Washington, D.C., each headed by an assistant administrator.

Under the direction of the assistant administrator--Washington, D.C., office, BPA maintains liaison with the DOE, the Congress, the Office of Management and Budget, and other Federal offices.

The Division of Engineering and Construction plans, designs, and builds transmission lines and substations. The division also directs research and development, including studies and pilot programs such as ultra-high voltage and underground transmission.

The Division of Operation and Maintenance operates and maintains the BPA transmission lines, substations, rights-of-way, protection and control equipment, and buildings and grounds. Power operation and maintenance in the Pacific Northwest are administered through area offices in Portland, Spokane, Seattle, and Walla Walla. Subsidiary district offices are located in Eugene, Oregon; Wenatchee, Washington; Idaho Falls, Idaho; and Kalispell, Montana.

The Division of Power Management develops power marketing proposals and markets power from Pacific Northwest Federal hydro projects. The

division also prepares load-resource forecasts, calculates generation needed to meet BPA loads and interchange requirements, develops whole-sale power rate schedules adequate to assure repayment of the Federal Government's investment in the Columbia River power system. It negotiates and coordinates contracts for the sale, interchange, and wheeling of power with utilities and industries, and with owners and users of interregional tielines.

The Division of Management Services administers management control and administrative services, including planning, budgeting, accounting, personnel, environmental protection, management analysis, safety, processing systems, and administrative support functions. The division prepares repayment plans and payout schedules for the Federal power system. An environmental office was established in 1971 to be responsible for all environmental protection procedures.

Under the direction of the Assistant Administrator for Operation and Maintenance, area offices have primary responsibility in their areas for operation and maintenance of the power system, power management, engineering, and administrative management functions.

PROGRAM FUNDING

Total obligations for fiscal 1978 are approximately \$376 million. About \$55 million of that total is devoted to operation and maintenance, \$119 million to purchase power and wheeling, \$6.2 million to interest expense, \$51 million to associated project costs, \$113 million to construction and \$31 million to reimbursable programs. BPA uses its revenues to support its operations, and no longer uses appropriations. It also has borrowing authority of up to \$1.25 billion to help finance its construction program. BPA has a statutory obligation to repay all Federal costs of the Columbia River power system, including generation and transmission facilities, plus accrued interest and an irrigation subsidy.

MAJOR FACILITIES

Generally, program planning and policy development are performed centrally from the headquarters located in Portland, Oregon.

The William A. Dittmer System Control Center is located in Ross Complex (Vancouver, Washington).

EXECUTIVE SUMMARY

Southeastern Power Administration

LOCATION: Elberton, Georgia

STATISTICS: (FY 1978)

NUMBER OF AREA OFFICES:	0
NUMBER OF GOVERNMENT EMPLOYEES:	39
ANNUAL OPERATING BUDGET:	\$1.4 million

MAJOR PROGRAM AND PROJECT ASSIGNMENTS:

- o Markets power from United States Army Corps of Engineers' Hydroelectric Projects.

SOUTHEASTERN POWER ADMINISTRATION

Elberton, Georgia

INTRODUCTION

The Southeastern Power Administration (SEPA), located in Elberton, Georgia, is responsible for the marketing of power from U.S. Army Corps of Engineers' hydroelectric projects located in 10 southeastern states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia). Southeastern has 199 wholesale customers located in those states (except West Virginia), plus Indiana and Illinois.

Receiving power are: 108 rural electric cooperatives; 86 municipalities; one state, one county, and one Federal organization; plus eight investor-owned utilities. As Southeastern owns no transmission lines, the power is "wheeled" to the preference customers over facilities owned by the utilities in the specific service area involved.

Section 5 of the Flood Control Act of 1944 provides statutory guidance for the marketing of power by Southeastern.

PERSONNEL

SEPA has 39 employees, all are at the Elberton office.

CURRENT MISSION AND PROGRAM ACTIVITIES

Marketing negotiations involving the new Laurel Project power are underway.

Procedures to be used in the formulation of power marketing policies are being developed. The views of interested individuals are being considered.

PROGRAM FUNDING

SEPA has an annual budget of \$1.4 million. Southeastern's overall repayment status is good. With a total investment of \$975 million, the cumulative repayment of capital investment is \$202 million. Annual operating expenses of \$238 million and \$295 million in interest, have been paid.

MAJOR FACILITIES

There are 21 hydroelectric projects in operation that have a nameplate capacity of 2,712 megawatts and an annual average energy of 6.8 billion kilowatt-hours. SEPA represents 2.5 percent of the total power capacity in the area. These projects, with the exception of the Laurel Project, are grouped into four systems. The following table and map (see next page) show the four systems and the projects in each:

Kerr-Philpott Projects

John H. Kerr
Philpott

Cumberland Projects

Barkley
Center Hill
Cheatham
Cordell Hull
Dale Hollow
Old Hickory
J. Percy Priest
Wolf Creek

Georgia-Alabama Projects

Allatoona
Buford
Carters
Clark Hill
Walter F. George
Hartwell
Jones Bluff
Millers Ferry
West Point

Jim Woodruff Project

There is one project under construction, the Richard B. Russell Project, that is currently authorized for a 300 megawatt conventional hydropower installation. The potential for adding 300 megawatts of pumped storage facilities is now being studied. Its target completion date is 1984.

**UNITED STATES
DEPARTMENT OF ENERGY**
SOUTHEASTERN POWER ADMINISTRATION
ELBERTON, GEORGIA
POWER PROJECT RESPONSIBILITIES

- Cumberland System
- Georgia-Alabama System
- Kerr-Philpott System
- Jim Woodruff System

EXECUTIVE SUMMARY

Southwestern Power Administration

LOCATION: Tulsa, Oklahoma

STATISTICS: (FY 1978)

NUMBER OF AREA OFFICES:	4
NUMBER OF GOVERNMENT EMPLOYEES:	165
ANNUAL OPERATING BUDGET:	\$25.6 million

MAJOR PROGRAM AND PROJECT ASSIGNMENTS:

- o Markets electric power and energy producted at southwestern multipurpose reservoir projects constructed by United States Army Corps of Engineers.

SOUTHWESTERN POWER ADMINISTRATION

Tulsa, Oklahoma

INTRODUCTION

Southwestern Power Administration (SWPA) was established by the Secretary of Interior in 1943, as a bureau of the Department of the Interior. It is under the direction of an Administrator with delegated authority to carry out the responsibilities of the Secretary under Section 5 of the Flood Control Act of 1944 to market the electric power and energy produced at certain multipurpose reservoir projects constructed by the Department of the Army, Corps of Engineers, in the southwest.

PERSONNEL

SWPA has 183 Federal employees; of these, 165 are full-time personnel and 18 are temporary employees. Of the total Federal employees, 80 are at the Tulsa headquarters and 103 are at the field offices located in Jonesboro, Arkansas; Springfield, Missouri; Muskogee, Oklahoma; and Ada, Oklahoma.

CURRENT MISSION AND PROGRAM ACTIVITIES

The Southwestern Federal Power System is the name applied to the facilities and operations of SWPA and the hydroelectric generating plants constructed and operated by the Corps of Engineers for which SWPA has been designated the marketing agent.

SWPA markets power from hydroelectric projects located in the States of Arkansas, Missouri, Oklahoma, and Texas. Power is marketed in those four states plus Kansas and Louisiana to 64 wholesale customers.

PROGRAM FUNDING

SWPA has an annual operating budget (FY 1978) of \$25.6 million. In its power marketing program, SWPA must secure revenue sufficient to meet the annual costs of operation and maintenance of the generating and transmission facilities and to repay with interest all of the investment in generation (\$610.4 million) and transmission (\$61.7 million) facilities over a reasonable period of time.

MAJOR FACILITIES

SWPA markets power from 21 hydroelectric generating plants (1,916,700 kilowatts) constructed and operated by the U.S. Army Corps of Engineers. Two additional plants are under construction.

The SWPA transmission system consists of 1,636 miles of line and 34 substations and switching stations. (See map on next page.)

EXECUTIVE SUMMARY

Western Area Power Administration

LOCATION: Golden, Colorado

STATISTICS: (FY 1978)

NUMBER OF AREA OFFICES:	5
NUMBER OF GOVERNMENT EMPLOYEES:	991
ANNUAL OPERATING BUDGET:	\$144.7 million

MAJOR PROGRAM AND PROJECT ASSIGNMENTS:

- o Markets power and energy.
- o Constructs transmission facilities.
- o Operates and maintains extensive high-voltage transmission facilities.

WESTERN AREA POWER ADMINISTRATION

Golden, Colorado

INTRODUCTION

The Western Area Power Administration (WAPA) markets the power and energy generated at Federal generating projects in 15 western states to wholesale power customers (426), constructs transmission facilities in selected areas, and operates and maintains an extensive high-voltage transmission system. WAPA will construct, operate, and maintain additional transmission facilities that may be needed and authorized in the future to assure reliable electric service.

WAPA serves a marketing area of 1,269,956 square miles in 15 western states (California, Nevada, Utah, Arizona, Montana, Wyoming, Colorado, New Mexico, western Texas, North Dakota, South Dakota, Nebraska, Kansas, western Minnesota, and western Iowa).

PERSONNEL

WAPA has 991 permanent employees, located in area offices in Billings, Montana; Denver, Colorado; Boulder City, Nevada; Salt Lake City, Utah; Sacramento, California; and in district offices in Phoenix, Arizona; Montrose, Colorado; Amarillo, Texas; Huron, South Dakota; Fort Peck, Montana; Bismarck, North Dakota; Watertown, South Dakota; Loveland, Colorado; and Casper, Wyoming.

CURRENT MISSION AND PROGRAM ACTIVITIES

In addition to marketing federally generated electric power, constructing, operating, and maintaining its transmission system, WAPA prepares wholesale rates and repayment schedules, participates in joint transmission planning and develops and administers formulas for power allocations.

PROGRAM FUNDING

WAPA has an annual operating budget of nearly \$144.7 million. Agency activities are financed principally from appropriated funds and revenues.

MAJOR FACILITIES

WAPA markets power and energy from the Bureau of Reclamation powerplants, U.S. Army Corps of Engineers powerplants, and the International Boundary and Water Commission's powerplant in Texas.

Installed generating capacity	7,668 MW
Circuit miles of transmission	15,939
Voltage ratings	69-VV to 500-VV
Number of substations	271 <u>1</u> /

1/210 WAPA substations and 61 Bureau of Reclamation switchyards.

EXECUTIVE SUMMARY

Naval Petroleum and Oil Shale ReservesLOCATION: Washington, D.C.STATISTICS: (FY 1978)

NUMBER OF AREA OFFICES:	2
NUMBER OF GOVERNMENT EMPLOYEES:	
Civilian	93
Military	17
NUMBER OF CONTRACTOR/SUBCONTRACTOR EMPLOYEES	1,025
ANNUAL OPERATING BUDGET:	\$152.2 million
EXPLORATION COSTS	5.6 million
DEVELOPMENT COSTS	31.2 million
CONSTRUCTION COSTS	91.6 million
OPERATION AND MAINTENANCE	22.4 million
NAVAL PETROLEUM AND OIL SHALE RESERVES	1.3 million

SIZE OF RESERVES:

	<u>Acres</u>	<u>Remaining Oil Reserves (Barrels)</u>
NAVAL PETROLEUM RESERVE NUMBER 1	46,095	1.2 billion*
NAVAL PETROLEUM RESERVE NUMBER 2	30,181	21.2 million*
NAVAL PETROLEUM RESERVE NUMBER 3	9,481	29.8 million*
NAVAL OIL SHALE RESERVES NUMBER 1 and NUMBER 3	54,893	22.0 billion**
NAVAL OIL SHALE RESERVE NUMBER 2	90,440	3.8 billion**

MAJOR PROGRAM AND PROJECT ASSIGNMENTS:

- o Evaluate the resources at the Naval Oil Shale Reserves.
- o Develop the Naval Petroleum Reserves and produce at the maximum efficient rate until April 4, 1982, unless extended. Production rates must be at a level so as to not reduce maximum ultimate recovery to hydrocarbons.

*Recoverable reserves.

**In-place reserves due to nature of resource. Estimated recoverable shale oil at Naval Oil Shale Reserve Number 1 is over 5 billion barrels; no estimate of recoverable resource at Naval Oil Shale Reserve Number 2 has been made.

- o Construct or acquire the capability to transport NPR production to refineries or sale points.
- o Explore and develop reserves underlying the Naval Petroleum Reserves not previously proven or known.
- o Sell the Federal Government's share of production from the Naval Petroleum Reserves at public sale to the highest qualified bidder.

FIELD OFFICES ADMINISTERED:

<u>Facility Name</u>	<u>Contractor/Operator</u>
Naval Petroleum Reserve Number 1 and Number 2 (California)	William Brothers Engineering
Naval Petroleum Reserve Number 3 (Wyoming)	Fenix and Scisson, Inc.
Naval Oil Shale Reserves* (Colorado and Utah)	TRW (Support Contractor)

These offices are administered by DOE personnel (onsite staff) and have their own office and staff as well, but work as directed by the DOE Field Office Staff.

*Field activity for the Naval Oil Shale Reserves is coordinated from the Casper, Wyoming Field Office.

NAVAL PETROLEUM AND OIL SHALE RESERVES

Naval Petroleum Reserve (NPR) Number 1 and Number 3	- California
Naval Petroleum Reserve (NPR) Number 3	- Wyoming
Naval Oil Shale Reserves (NOSR)	- Colorado and Utah

BACKGROUND AND MISSION

The Office of Naval Petroleum and Oil Shale Reserves (NPOSR) has cognizance over three petroleum and three oil shale reserves. The reserves were withdrawn during the period 1912 to 1924 for the purpose of providing a standby reserve of oil for purposes of national defense. By Public Law 94-258, enacted on April 6, 1976, the Petroleum Reserves were opened to full production on July 3, 1976, and are currently being developed to achieve their maximum efficient rate of production. By enactment of this law, the reserves will remain open until 1982, with the possibility of 3-year extensions if directed by the President and Congress.

MANAGEMENT PHILOSOPHY

The operations of the Naval Petroleum Reserves (NPR) are conducted through contract operators under the direction of Federal Government personnel. The work at the NOSR's is conducted by using the services of a management support and systems engineering contractor. This contractor also takes its direction from Government personnel.

PROGRAM WORKLOAD

The fiscal 1978 budget for the NPOSR program was approximately \$152.151 million. Allocation of this total was as follows:

Exploration	\$ 7.513 million
Development	56.313 million
Construction	66.805 million
Operation and Maintenance	20.860 million
NOSR Resource Assessment	1.3 million

The budget was distributed among the reserves as follows:

NPR Number 1 and Number 2	\$126,340
NPR Number 3	24,511
NOSR	1,300

MAJOR PROGRAM ASSIGNMENTS

Development of Petroleum Reserves to their MER of Production

Pursuant to Public Law No. 94-258 of April 5, 1976, NPR No. 1 and No. 3 began full production on July 3, 1976. Extensive exploratory and development programs have been implemented at each of the reserves in order to bring production up to the maximum efficient rate (MER). During fiscal 1978, 123 wells were drilled at NPR No. 1 and 154 wells were drilled at NPR No. 3.

It is estimated that NPR No. 1 contains approximately 1.2 billion barrels of recoverable oil and, when fully developed, its peak MER will be between 200,000 and 220,000 barrels of oil per day. Estimated reserves at NPR No. 3 are approximately 30 million barrels, with an anticipated peak MER of 5,700 barrels of oil per day. NPR No. 2 is almost entirely leased out to private entities and is substantially depleted.

The NOSR's contain an estimated 26 billion barrels of shale oil and it is estimated that using the technologies currently under development, that 5 billion barrels of this shale oil could be recovered.

In addition to the exploratory and development drilling programs, extensive construction programs have been initiated under the supervision of the Naval Facilities Engineering Command at NPR No. 1 and Fenix and Scission, Inc. at NPR No. 3. These programs provide for the construction of oil and gas collection systems, gas handling facilities, electrical distribution systems, and other production facilities.

The Naval Petroleum Reserves Production Act of 1976 (Public Law 94-258) requires the acquisition of sufficient pipeline capacity from Elk Hills to transport 350,000 barrels of oil per day. Identification of available spare pipeline capacity from Elk Hills now indicates that a Government-owned pipeline will not be required. The Department of Energy is preparing a proposal to amend the law to delete this requirement.

Evaluate the NOSR's

The NOSR's represent a significant potential for production of synthetic fuel. In order to fully evaluate this potential, a 6-year predevelopment (resource assessment) program is underway. This program provides for the evaluation of total resources available on the reserves including: oil shale; surface and ground water; and conventional oil and gas resources. In addition, the program provides for the investigation of assessment of the development potential of the reserves and the identification of the environmental and socioeconomic consequences of any development.

LOCATION MAP

Location of Naval Petroleum Reserve No. 3 in Natrona County,
 and Location of Natrona County in Wyoming.

- Naval Oil Shale Reserve—Entire area has potential for production of hydrocarbons or is needed for disposal of spent shale
 - Indian Reservation—Navy has mineral rights
 - Outleased for sheep grazing
 - Power site withdrawal
- NOTES: 1 Total Area = 90,440 acres (approximate, portions of reserve have not yet been surveyed)

NAVAL OIL SHALE RESERVE NO. 2

SCALE 1 in = 1 mi

APPENDICES

APPENDIX A-1

DOE R&D FACILITY EMPLOYEES BY OCCUPATIONAL FIELD

Facility	Scientists	Engineers	Other Professionals	Technicians	Others	Total Staff
<u>Multiprogram Laboratories</u>						
Ames Laboratory	206	39	-	46	159	450
Argonne National Laboratory	1,014	843	-	703	2,606	5,166
Brookhaven National Laboratory	658	281	79	668	1,774	3,460
Energy Technology Engineering Center	10	144	10	120	66	350
Hanford Engineering Development Laboratory	92	657	367	405	1,379	2,900
Idaho National Engineering Laboratory	76	302	-	356	1,477	2,211
Lawrence Berkeley Laboratory	1,000	370	90	520	1,390	3,370
Lawrence Livermore Laboratory	1,492	965	-	2,992	1,565	7,014
Los Alamos Scientific Laboratory	1,465	858	283	2,317	1,637	6,560
Oak Ridge National Laboratory	1,290	980	-	180	2,530	4,980
Pacific Northwest Laboratory	516	359	-	-	1,320	2,195
Sandia Laboratories	637	1,480	1,009	1,739	2,613	7,478
Savannah River Laboratory	179	114	26	-	649	968
<u>Program Dedicated Facilities</u>						
Bartlesville Energy Technology Center	50	32	-	52	73	207
Bates Linear Accelerator Facility	15	16	-	39	5	75
Bettis Atomic Power Laboratory	128	942	836	652	751	3,309
Carbondale Mining Operations Center	2	10	2	2	9	25
Center for Energy and Environment Research	118	24	-	-	60	202
Comparative Animal Research Laboratory	19	1	9	34	23	86
Environmental Measurements Laboratory	46	10	1	22	25	104
Fermi National Accelerator Laboratory	209	87	272	450	421	1,439
Grand Forks Energy Technology Center	30	18	4	5	33	90

A-1-1

APPENDIX A-1 (Cont'd)

Facility	Scientists	Engineers	Other Professionals	Technicians	Others	Total Staff
Inhalation Toxicology Research Institute	77	5	-	76	64	222
Knolls Atomic Power Laboratory	143	1,051	608	157	977	2,936
Laboratory for Energy-Related Health Research	20	1	2	47	24	94
Laboratory of Nuclear Medicine and Radiation Biology	41	5	5	51	82	184
Laboratory of Radiobiology--University of California, San Francisco	12	-	2	21	5	40
Laramie Energy Technology Center	47	40	2	46	73	208
MSU-DOE Plant Research Laboratory	54	-	-	12	14	80
Morgantown Energy Technology Center	39	54	2	124	31	250
New Brunswick Laboratory	41	3	-	7	5	56
Notre Dame Radiation Laboratory	52	2	-	14	11	79
Oak Ridge Associated Universities	85	11	-	16	241	353
Pittsburgh Energy Technology Center	82	78	-	140	79	379
Pittsburgh Mining Operations Center	42	4	-	31	9	86
Princeton Plasma Physics Laboratory	115	148	-	496	172	931
Radiobiology Laboratory-University of Utah	14	1	-	42	5	62
Savannah River Ecology Laboratory	16	1	-	26	25	68
Solar Energy Research Institute	199	31	36	-	84	350
Stanford Linear Accelerator Center	141	162	-	354	527	1,184
The Franklin McLean Memorial Research Institute	30	20	1	31	21	103
University of Rochester Biomedical Laboratory	77	-	7	69	56	209

APPENDIX A-1 (Cont'd)

Facility	Scientists	Engineers	Other Professionals	Technicians	Others	Total Staff
<u>Nuclear Materials Production Facilities</u>						
Ashtabula Extrusion Plant	-	2	-	7	53	62
Feed Materials Production Center	24	30	-	27	502	583
Oak Ridge Gaseous Diffusion Plant	257	475	-	570	4,233	5,535
Paducah Gaseous Diffusion Plant	34	133	-	182	2,026	2,375
Portsmouth Gaseous Diffusion Plant	105	236	-	156	2,499	2,996
Hanford Production Operations	238	421	20	337	2,955	3,971
Savannah River Plant	212	490	167	427	3,537	4,833
<u>Weapons Testing and Fabrication Complex</u>						
Kansas City Plant	700	-	28	787	4,391	5,906
Mound Facility	224	168	236	362	695	1,685
Nevada Test Site	-	-	-	-	-	5,200
Pantex Plant	43	175	-	305	1,330	1,853
Pinellas Plant	171	-	-	209	843	1,223
Rocky Flats	173	239	558	359	1,588	2,917
Y-12 Plant	239	398	33	543	3,612	4,825

APPENDIX A-2

DOE R&D FACILITY EMPLOYEES BY ACADEMIC DEGREE

Facility	Degrees			
	Ph.D.	M.S.	B.S.	Total
<u>Multiprogram Laboratories</u>				
Ames Laboratory	91	43	136	270
Argonne National Laboratory	911	458	667	2,036
Brookhaven National Laboratory	690	241	431	1,362
Energy Technology Engineering Center	4	51	109	164
Hanford Engineering Development Laboratory	123	304	798	1,225
Idaho National Engineering Laboratory	135	517	1,026	1,678
Lawrence Berkeley Laboratory	517	278	619	1,414
Lawrence Livermore Laboratory	919	683	800	2,402
Los Alamos Scientific Laboratory	1,254	569	673	2,496
Oak Ridge National Laboratory	930	530	990	2,450
Pacific Northwest Laboratory	276	313	495	1,084
Sandia Laboratories	782	765	643	2,190
Savannah River Laboratory	135	66	154	355
<u>Program Dedicated Facilities</u>				
Bartlesville Energy Technology Center	20	24	55	99
Bates Linear Accelerator Facility	15	5	11	31
Bettis Atomic Power Laboratory	155	345	845	1,345
Carbondale Mining Operations Center	1	11	9	21
Center for Energy and Environment Research	36	52	54	142
Comparative Animal Research Laboratory	19	11	12	42
Environmental Measurements Laboratory	7	17	29	53
Fermi National Accelerator Laboratory	161	75	185	421
Grand Forks Energy Technology Center	6	8	38	52
Inhalation Toxicology Research Institute	52	18	43	113
Knolls Atomic Power Laboratory	100	430	755	1,285
Laboratory for Energy-Related Health Research	17	9	23	49
Laboratory of Nuclear Medicine and Radiation Biology	46	21	49	116
Laboratory of Radiobiology--University of California, San Francisco	12	3	19	34
Laramie Energy Technology Center	27	20	78	125

APPENDIX A-2 (Cont'd)

Facility	Degrees			Total
	Ph.D.	M.S.	B.S.	
MSU-DOE Plant Research Laboratory	31	10	30	71
Morgantown Energy Technology Center	17	22	46	85
New Brunswick Laboratory	7	12	27	46
Notre Dame Radiation Laboratory	42	4	11	57
Oak Ridge Associated Universities	52	35	96	183
Pittsburgh Energy Technology Center	53	30	104	187
Pittsburgh Mining Operations Center	6	9	38	53
Princeton Plasma Physics Laboratory	119	65	79	263
Radiobiology Laboratory-University of Utah	12	2	17	31
Savannah River Ecology Laboratory	16	10	16	42
Solar Energy Research Institute	67	100	99	266
Stanford Linear Accelerator Center	134	84	217	435
The Franklin McLean Memorial Research Institute	30	7	14	51
University of Rochester Biomedical Laboratory	78	9	59	146
<u>Nuclear Materials Production Facilities</u>				
Ashtabula Extrusion Plant	-	9	6	15
Feed Materials Production Center	-	13	62	75
Oak Ridge Gaseous Diffusion Plant	53	265	1,054	1,372
Paducah Gaseous Diffusion Plant	3	45	328	376
Portsmouth Gaseous Diffusion Plant	9	71	511	591
Hanford Production Operations	49	154	695	898
Savannah River Plant	25	153	691	869
<u>Weapons Testing and Fabrication Complex</u>				
Kansas City Plant	24	324	1,195	1,543
Mound Facility	68	125	435	628
Nevada Test Site	-	-	-	-
Pantex Plant	11	59	345	415
Pinellas Plant	7	37	194	238
Rocky Flats	58	130	435	623
Savannah River Weapons Facility	13	14	90	117
Y-12 Plant	57	185	712	954

APPENDIX A-3

FY 1978 OPERATING EXPENSES AND CAPITAL INVESTMENT

Facility	Dollars in Millions			Capital Investment
	Operating Expenses			
	DOE	Other	Total	
<u>Multiprogram Laboratories</u>				
Ames Laboratory	\$ 11.6	\$ 0.7	\$ 12.3	\$ 29.3
Argonne National Laboratory	191.1	14.7	205.8	521.5
Brookhaven National Laboratory	93.7	24.7	118.4	391.7
Energy Technology Engineering Center	21.0	-	21.0	63.5
Hanford Engineering Development Laboratory	154.8	1.4	156.2	606.1
Idaho National Engineering Laboratory	144.4	51.1	195.5	536.1
Lawrence Berkeley Laboratory	74.5	29.5	104.0	185.0
Lawrence Livermore Laboratory	262.5	41.1	303.6	400.0
Los Alamos Scientific Laboratory	253.3	34.8	288.1	541.5
Oak Ridge National Laboratory	202.4	39.5	241.9	480.0
Pacific Northwest Laboratory	96.6	14.7	111.3	60.7
Sandia Laboratories	336.2	62.7	398.9	398.0
Savannah River Laboratory	54.2	2.0	56.3	90.4
<u>Program Dedicated Facilities</u>				
Bartlesville Energy Technology Center	24.7	0.5	25.2	7.5
Bates Linear Accelerator Facility	4.0	-	4.0	35.7
Bettis Atomic Power Laboratory	154.6	46.4	201.0	302.1
Carbondale Mining Operations Center	4.0	-	4.0	2.3
Center for Energy and Environment Research	2.6	0.5	3.1	10.9
Comparative Animal Research Laboratory	1.7	0.1	1.8	6.3
Environmental Measurements Laboratory	5.2	-	5.2	2.1
Fermi National Accelerator Laboratory	59.6	0.9	60.5	359.5
Grand Forks Energy Technology Center	5.0	-	5.0	4.1
Inhalation Toxicology Research Institute	4.9	2.2	7.1	14.2

APPENDIX A-3 (Cont'd)

Facility	Dollars in Millions			Capital Investment
	Operating Expenses			
	DOE	Other	Total	
Knolls Atomic Power Laboratory	\$ 99.0	\$ 62.3	\$161.3	\$357.3
Laboratory for Energy-Related Health Research	2.6	-	2.6	5.5
Laboratory of Nuclear Medicine and Radiation Biology	4.0	1.1	5.1	3.5
Laboratory of Radiobiology--University of California, San Francisco	1.6	0.1	1.7	2.2
Laramie Energy Technology Center	26.2	-	26.2	11.3
MSU-DOE Plant Research Laboratory	1.4	0.4	1.8	0.3
Morgantown Energy Technology Center	37.8	-	37.8	4.9
New Brunswick Laboratory	1.6	0.7	2.3	5.9
Notre Dame Radiation Laboratory	1.73	0.05	1.78	4.5
Oak Ridge Associated Universities	10.5	3.3	13.8	12.0
Pittsburgh Energy Technology Center	19.3	-	19.3	54.5
Pittsburgh Mining Operations Center	5.35	-	5.35	35.0
Princeton Plasma Physics Laboratory	40.0	-	40.0	379.8
Radiobiology Laboratory--University of Utah	1.6	-	1.6	5.0
Savannah River Ecology Laboratory	2.4	0.6	3.0	5.0
Solar Energy Research Institute	-	-	-	-
Stanford Linear Accelerator Center	32.7	0.3	33.0	191.4
The Franklin McLean Memorial Research Institute	2.5	0.05	2.6	4.7
University of Rochester Biomedical Laboratory	3.4	3.1	6.5	5.6
<u>Nuclear Materials Production Facilities</u>				
Ashtabula Extrusion Plant	1.6	-	1.6	2.1
Feed Materials Production Center	18.1	-	18.1	121.2
Oak Ridge Gaseous Diffusion Plant	167.4	-	167.4	3.5*
Paducah Gaseous Diffusion Plant	257.1	-	257.1	3.5*
Portsmouth Gaseous Diffusion Plant	234.9	-	234.9	3.5*

*Total Capital Investment for Oak Ridge, Paducah and Portsmouth Gaseous Diffusion Plants.

APPENDIX A-3 (Cont'd)

Facility	Dollars in Millions			Capital Investment
	Operating Expenses			
	DOE	Other	Total	
Hanford Production Operations	122.6	-	122.6	972.2
Savannah River Plant	282.8	-	282.8	1.5
<u>Weapons Testing and Fabrication Complex</u>				
Kansas City Plant	157.5	37.2	194.7	163.2
Mound Facility	57.0	2.4	59.4	116.8
Nevada Test Site	201.9	55.7	257.6	250.0
Pantex Plant	45.1	1.4	46.5	97.9
Pinellas Plant	39.7	2.5	42.2	37.1
Rocky Flats	95.0	1.0	96.0	414.7
Savannah River Weapons Facility	19.4	0.0	19.4	23.1
Y-12 Plant	158.2	3.5	161.7	541.2

APPENDIX B

ORGANIZATION CHARTS

FOR

FIELD AND PROJECT OFFICES

ALBUQUERQUE OPERATIONS OFFICE

CHICAGO OPERATIONS AND REGIONAL OFFICE

IDAHO OPERATIONS OFFICE

NEVADA OPERATIONS OFFICE

OAK RIDGE OPERATIONS OFFICE

RICHLAND OPERATIONS OFFICE

SAN FRANCISCO OPERATIONS OFFICE

SAVANNAH RIVER OPERATIONS OFFICE

GRAND JUNCTION OFFICE

PITTSBURGH NAVAL REACTORS OFFICE

SCHENECTADY NAVAL REACTORS OFFICE

FAST FLUX TEST FACILITY PROJECT OFFICE

Clinch River Breeder Reactor Plant Project Office

APPENDIX C-1

DOE FIELD AND PROJECT OFFICES/R&D FIELD FACILITIES
BY STATE/TERRITORY, CITY AND COUNTY/TERRITORY

<u>State/Territory</u>	<u>City</u>	<u>County/ Territory</u>
<u>CALIFORNIA</u>		
San Francisco Operations Office	Oakland	Alameda
Energy Technology Engineering Center	Santa Susana	Ventura
Laboratory for Energy-Related Health Research	Davis	Solano
Laboratory of Nuclear Medicine and Radiation Biology, University of California	Los Angeles	Los Angeles
Laboratory of Radiobiology, University of California	San Francisco	San Francisco
Lawrence Berkeley Laboratory	Berkeley	Alameda
Lawrence Livermore Laboratory	Livermore	Alameda
Sandia Laboratories	Livermore	Alameda
Stanford Linear Accelerator Center	Menlo Park	San Mateo
<u>COLORADO</u>		
Grand Junction Office	Grand Junction	Mesa
Rocky Flats Plant	Golden	Jefferson
Solar Energy Research Institute	Golden	Jefferson
<u>FLORIDA</u>		
Pinellas Plant	Clearwater	Pinellas
<u>IDAHO</u>		
Idaho Operations Office	Idaho Falls	Bonneville
Idaho Chemical Processing Plant	Idaho Falls	Butte
Idaho National Engineering Laboratory	Idaho Falls	Butte/ Jefferson/ Bingham
<u>ILLINOIS</u>		
Chicago Operations and Regional Office	Argonne	DuPage
Argonne National Laboratory	Argonne	DuPage
Carbondale Mining Operations Center	Centerville	Williamson
Fermi National Accelerator Laboratory	Batavia	DuPage/Kane
New Brunswick Laboratory	Darien	DuPage
The Franklin McLean Memorial Research Institute	Chicago	Cook

APPENDIX C-1 (Cont'd)

<u>State/Territory</u>	<u>City</u>	<u>County/ Territory</u>
<u>INDIANA</u>		
Notre Dame Radiation Laboratory	South Bend	St. Joseph
<u>IOWA</u>		
Ames Laboratory	Ames	Story
<u>KENTUCKY</u>		
Paducah Gaseous Diffusion Plant	Paducah	McCracken
<u>MASSACHUSETTS</u>		
Bates Linear Accelerator Facility	Middleton	Essex
<u>MICHIGAN</u>		
MSU-DOE Plant Research Laboratory	East Lansing	Ingham
<u>MISSOURI</u>		
Kansas City Plant	Kansas City	Jackson
<u>NEVADA</u>		
Nevada Operations Office	Las Vegas	Clark
Nevada Test Site	Mercury	Nye
<u>NEW JERSEY</u>		
Princeton Plasma Physics Laboratory	Plainsboro	Middlesex
<u>NEW MEXICO</u>		
Albuquerque Operations Office	Albuquerque	Bernalillo
Inhalation Toxicology Research		
Institute	Albuquerque	Bernalillo
Los Alamos Scientific Laboratory	Los Alamos	Los Alamos
Sandia Laboratories	Albuquerque	Bernalillo

APPENDIX C-1 (Cont'd)

<u>State/Territory</u>	<u>City</u>	<u>County/ Territory</u>
<u>NEW YORK</u>		
Brookhaven National Laboratory	Islip	Suffolk
Environmental Measurements Laboratory	New York	New York
Knolls Atomic Power Laboratory	Schenectady	Schenectady
Schenectady Naval Reactors Office	Schenectady	Schenectady
University of Rochester Biomedical Laboratory	Rochester	Monroe
<u>NORTH DAKOTA</u>		
Grand Forks Energy Technology Center	Grand Forks	Grand Forks
<u>OHIO</u>		
Ashtabula Extrusion Plant	Ashtabula	Ashtabula
Feed Materials Production Center	Fernald	Hamilton
Mound Facility	Miamisburg	Montgomery
Portsmouth Gaseous Diffusion Plant	Piketon	Pike
<u>OKLAHOMA</u>		
Bartlesville Energy Technology Center	Bartlesville	Washington
<u>PENNSYLVANIA</u>		
Bettis Atomic Power Laboratory	West Mifflin	Allegheny
Pittsburgh Energy Technology Center	Pittsburgh	Allegheny
Pittsburgh Mining Operations Center	Bruceton	Allegheny
Pittsburgh Naval Reactors Office	West Mifflin	Allegheny
Shippingport Atomic Power Station	West Mifflin	Allegheny
<u>PUERTO RICO</u>		
Center for Energy and Environment Research	San Juan	Puerto Rico
<u>SOUTH CAROLINA</u>		
Savannah River Operations office	Aiken	Aiken/ Barnwell/ Allendale
Savannah River Ecology Laboratory	Aiken	Aiken/ Barnwell/ Allendale

APPENDIX C-1 (Cont'd)

<u>State/Territory</u>	<u>City</u>	<u>County/ Territory</u>
Savannah River Laboratory	Aiken	Aiken/ Barnwell/ Allendale
Savannah River Plant	Aiken	Aiken/ Barnwell/ Allendale
<u>TENNESSEE</u>		
Oak Ridge Operations Office	Oak Ridge	Anderson
Comparative Animal Research Laboratory	Oak Ridge	Anderson
Clinch River Breeder Reactor Plant		
Project Office	Oak Ridge	Anderson
Oak Ridge Associated University	Oak Ridge	Anderson
Oak Ridge Gaseous Diffusion Plant	Oak Ridge	Roane
Oak Ridge National Laboratory	Oak Ridge	Roane
Y-12 Plant	Oak Ridge	Anderson
<u>TEXAS</u>		
Pantex Plant	Amarillo	Potter
<u>UTAH</u>		
Radiobiology Laboratory, University of Utah	Salt Lake City	Salt Lake
<u>WASHINGTON</u>		
Richland Operations Office	Richland	Benton
Fast Flux Test Facility Project Office	Richland	Benton
Hanford Engineering Development Laboratory	Richland	Benton
Hanford Production Operations	Richland	Benton
Pacific Northwest Laboratory	Richland	Benton
<u>WEST VIRGINIA</u>		
Morgantown Energy Technology Center	Morgantown	Monogalia
<u>WYOMING</u>		
Laramie Energy Technology Center	Laramie	Albany

APPENDIX C-2

DOE FIELD AND PROJECT OFFICES

Names and Mailing Addresses

ALBUQUERQUE OPERATIONS OFFICE
P.O. Box 5400
Albuquerque, New Mexico 87115
Herman E. Roser, Manager

NEVADA OPERATIONS OFFICE
P. O. Box 14100
Las Vegas, Nevada 89114
Mahlon E. Gates, Manager

CHICAGO OPERATIONS AND REGIONAL
OFFICE
9800 South Cass Avenue
Argonne, Illinois 60439
Robert H. Bauer, Manager/
Regional Representative

OAK RIDGE OPERATIONS OFFICE
P. O. Box E
Oak Ridge, Tennessee 37830
Robert J. Hart, Manager

CLINCH RIVER BREEDER REACTOR
PLANT PROJECT OFFICE
P.O. Box V
Oak Ridge, Tennessee 37836
Lochlin W. Caffey, Director

RICHLAND OPERATIONS OFFICE
P. O. Box 550
Richland, Washington 99352
Alex G. Fremling, Manager

FAST FLUX TEST FACILITY PROJECT
OFFICE
P.O. Box 550
Richland, Washington 99352
Charles S. Carlisle, Director

SAN FRANCISCO OPERATIONS OFFICE
1333 Broadway, Wells Fargo Bldg.
Oakland, California 94616
Joe La Grone, Manager

GRAND JUNCTION OFFICE
P.O. Box 2567
Grand Junction, Colorado 81501
Donald L. Everhart, Manager

SAVANNAH RIVER OPERATIONS OFFICE
P. O. Box A
Aiken, South Carolina 29801
N. Stetson, Manager

IDAHO OPERATIONS OFFICE
550 Second Street
Idaho Falls, Idaho 83401
Charles E. Williams, Manager

APPENDIX C-2 (Cont'd)

DOE R&D FIELD FACILITIES

Locations by State or Territory, Names and Mailing AddressesCALIFORNIA

ENERGY TECHNOLOGY ENGINEERING
CENTER
P.O. Box 1449
Canoga Park, California 91304
J. C. Cochran, Director

LAWRENCE BERKELEY LABORATORY
University of California
Berkeley, California 94720
Andrew M. Sessler, Director

LAWRENCE LIVERMORE LABORATORY
University of California
P.O. Box 808
Livermore, California 94520
Roger E. Batzel, Director

SANDIA LABORATORIES
P.O. Box 969
Livermore, California 94550
T. B. Cook, Jr., Vice President

STANFORD LINEAR ACCELERATOR FACILITY
Stanford University
P.O. Box 4349
Stanford, California 94305
W. K. H. Panofsky, Director

LABORATORY FOR ENERGY-RELATED
HEALTH RESEARCH
University of California
Davis, California 95616
Marvin Goldman, Director

LABORATORY OF RADIOBIOLOGY--
UNIVERSITY OF CALIFORNIA,
SAN FRANCISCO
School of Medicine
University of California
San Francisco, California 94143
Harvey M. Patt, Director

LABORATORY OF NUCLEAR MEDICINE
AND RADIATION BIOLOGY
University of California
900 Veteran Avenue
Los Angeles, California 90024
Owen R. Lunt, Director

COLORADO

GRAND JUNCTION OPERATIONS
Bendix Field Engineering Corp.
P.O. Box 1569
Grand Junction, Colorado 81501
C. L. Greenslit, Manager

ROCKY FLATS (ROCKWELL) PLANT
P.O. Box 464
Golden, Colorado 80401
R. O. Williams, Jr.
Vice President, General Manager

SOLAR ENERGY RESEARCH INSTITUTE
1536 Cole Boulevard
Golden, Colorado 80401
Paul Rappaport, Director

FLORIDA

PINELLAS (GENERAL ELECTRIC)
PLANT
P.O. Box 11508
St. Petersburg, Florida 33733
L. A. Kiley, General Manager

IDAHO

IDAHO NATIONAL ENGINEERING
LABORATORY
Idaho Falls, Idaho 83401
Charles E. Williams, Director

APPENDIX C-2 (Cont'd)

ILLINOIS

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, Illinois 60439
E. Gale Pewitt, Acting Director

CARBONDALE MINING OPERATIONS
CENTER
P.O. Box 2587
Carbondale, Illinois 62901
Alphonse C. Van Besien, Manager

FERMI NATIONAL ACCELERATOR
LABORATORY
P. O. Box 500
Batavia, Illinois 60510
Robert R. Wilson, Director

FRANKLIN McLEAN MEMORIAL RESEARCH
INSTITUTE
University of Chicago
950 East 59th Street
Chicago, Illinois 60637
Robert N. Beck, Director

NEW BRUNSWICK LABORATORY
9800 South Cass Avenue
Argonne, Illinois 60439
Carlton D. Bingham, Director

INDIANA

NOTRE DAME RADIATION LABORATORY
University of Notre Dame
Notre Dame, Indiana 45556
Robert H. Shuler, Director

IOWA

AMES LABORATORY
Iowa State University
Ames, Iowa 50011
Robert S. Hansen, Director

KENTUCKY

PADUCAH GASEOUS DIFFUSION PLANT
P.O. Box 1410
Paducah, Kentucky 42001
C. D. Zerby, Plant Manager

MASSACHUSETTS

BATES LINEAR ACCELERATOR
FACILITY
Massachusetts Institute of
Technology
P.O. Box 95
Middleton, Massachusetts 01949
P. Demos, Director

MICHIGAN

MICHIGAN STATE UNIVERISTY--DOE
PLANT RESEARCH LABORATORY
East Lansing, Michigan 48824
Hans Kende, Director

MISSOURI

KANSAS CITY (BENDIX) PLANT
P.O. Box 1159
Kansas City, Missouri 64141
R. J. Quirk, Vice President
and General Manager

NEVADA

NEVADA TEST SITE
P.O. Box 14400
Las Vegas, Nevada 89114
B. C. Moore, Manager

APPENDIX C-2 (Cont'd)

NEW JERSEY

PRINCETON PLASMA PHYSICS
LABORATORY
Princeton University
P.O. Box 451
Princeton, New Jersey 08540
Melvin B. Gottlieb, Director

NEW MEXICO

LOS ALAMOS SCIENTIFIC LABORATORY
University of California
P.O. Box 1663
Los Alamos, New Mexico 87545
Robert N. Thorn, Acting Director

SANDIA LABORATORIES
P.O. Box 5800
Albuquerque, New Mexico 87115
Morgan Sparks, President

INHALATION TOXICOLOGY RESEARCH
INSTITUTE
Lovelace Biomedical and
Environmental Research Institute
P.O. Box 5890
Albuquerque, New Mexico 87115
Roger O. McClellan, Director

NEW YORK

BROOKHAVEN NATIONAL LABORATORY
Upton, Long Island, New York 11973
George H. Vineyard, Director

ENVIRONMENTAL MEASUREMENTS
LABORATORY
376 Hudson Street
New York, New York 10014
John H. Harley, Director

KNOLLS ATOMIC POWER LABORATORY
P.O. Box 1072
Schenectady, New York 12301
A. E. Kakretz, General Manager

SCHENECTADY NAVAL REACTORS
OFFICE
P.O. Box 1069
Schenectady, New York 12301
Barry M. Erickson, Manager

UNIVERSITY OF ROCHESTER
BIOMEDICAL LABORATORY
School of Medicine and Dentistry
Rochester, New York 14642
Paul L. LaCelle, Director

NORTH DAKOTA

GRAND FORKS ENERGY TECHNOLOGY
CENTER
P.O. Box 8213
University Station
Grand Forks, North Dakota 58202
Gordon H. Gronhovd, Director

OHIO

ASHTABULA EXTRUSION PLANT
P.O. Box 579
Ashtabula, Ohio 44004
R. D. Heiser, Manager

FEED MATERIALS PRODUCTION CENTER
P.O. Box 39158
Cincinnati, Ohio 45239
S. F. Audia, Manager

MOUND FACILITY
P.O. Box 32
Miamisburg, Ohio 45342
J. R. McClain, Director

PORTSMOUTH GASEOUS DIFFUSION
PLANT
P.O. Box 628
Piketon, Ohio 45661
C. D. Tabor, General Manager

APPENDIX C-2 (Cont'd)

OKLAHOMA

BARTLESVILLE ENERGY TECHNOLOGY
CENTER
P.O. Box 1398
Bartlesville, Oklahoma 74003
Harry R. Johnson, Director

PENNSYLVANIA

BETTIS ATOMIC POWER LABORATORY
P.O. Box 79
West Mifflin, Pennsylvania 15122
W. H. Hamilton, General Manager

PITTSBURGH ENERGY TECHNOLOGY CENTER
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213
Sun W. Chun, Acting Director

PITTSBURGH MINING OPERATIONS CENTER
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213
Eugene R. Palowitch, Acting Director

PITTSBURGH NAVAL REACTORS OFFICE
P.O. Box 109
West Mifflin, Pennsylvania 15122
Carl K. Gaddis, Manager

PUERTO RICO

CENTER FOR ENERGY AND ENVIRONMENT
RESEARCH
University of Puerto Rico
Caparra Heights Station
San Juan, Puerto Rico 00935
Juan A. Bonnet, Jr., Director

SOUTH CAROLINA

SAVANNAH RIVER ECOLOGY
LABORATORY
Drawer E
Aiken, South Carolina 29801
Michael H. Smith, Director

SAVANNAH RIVER LABORATORY
Aiken, South Carolina 29801
A. H. Peters, Manager

SAVANNAH RIVER PLANT
Aiken, South Carolina 29801
W. J. Mottel, Manager

TENNESSEE

COMPARATIVE ANIMAL RESEARCH
LABORATORY
1299 Bethel Valley Road
Oak Ridge, Tennessee 37830
H. E. Walburg, Director

OAK RIDGE ASSOCIATED
UNIVERSITIES
P.O. Box 117
Oak Ridge, Tennessee 37630
Philip L. Johnson, Executive
Director

OAK RIDGE GASEOUS DIFFUSION
PLANT
P.O. Box P
Oak Ridge, Tennessee 37830
R. A. Winkel, Plant Manager

OAK RIDGE NATIONAL LABORATORY
P.O. Box X
Oak Ridge, Tennessee 37830
Herman Postma, Director

Y-12 PLANT
P.O. Box Y
Oak Ridge, Tennessee 37830
J. M. Case, Plant Manager

APPENDIX C-2 (Cont'd)

TEXAS

PANTEX PLANT
P.O. Box 647
Amarillo, Texas 79177
D. R. Dunham, Plant Manager

WEST VIRGINIA

MORGANTOWN ENERGY RESEARCH CENTER
P.O. Box 880
Morgantown, West Virginia 26505
Augustine A. Pitrolo, Director

UTAH

RADIOBIOLOGY LABORATORY
University of Utah
Building 522
Salt Lake City, Utah 84112
Webster Jee, Director

WYOMING

LARAMIE ENERGY TECHNOLOGY CENTER
P.O. Box 3395
University Station
Laramie, Wyoming 82071
Andrew W. Decora, Director

WASHINGTON

HANFORD ENGINEERING DEVELOPMENT
LABORATORY
P.O. Box 1970
Richland, Washington 99352
John B. Yasinsky, Director

HANFORD PRODUCTION OPERATIONS
UNITED NUCLEAR INDUSTRIES, INC.
Hanford Operations
P.O. Box 490
Richland, Washington 99352
R. K. Robinson, President

ROCKWELL HANFORD OPERATIONS
P.O. Box 800
Richland, Washington 99352
D. K. Cockeram, Vice President
and General Manager

PACIFIC NORTHWEST LABORATORY
Battelle
P.O. Box 999
Richland, Washington 99352
T. W. Ambrose, Director

APPENDIX D

NAMES AND TELEPHONE NUMBERS FOR DOE R&D FIELD FACILITIES

<u>Facility/Organization Name</u>	<u>Contractor Name</u>	<u>Director/Manager</u>	<u>Telephone Number</u>
<u>Field and Project Offices</u>			
Albuquerque Operations Office		H. E. Roser	(505) 264-7231
Chicago Operations and Regional Office		R. H. Bauer	(312) 972-2001
Clinch River Breeder Reactor Plant Project Office		L. M. Caffey	(615) 576-6008
Fast Flux Test Facility Project Office		C. S. Carlisle	(509) 942-5481
Grand Junction Office		D. L. Everhart	(303) 242-8621 X201
Idaho Operations Office		C. E. Williams	(208) 526-1322
Nevada Operations Office		M. E. Gates	(702) 734-3211
Oak Ridge Operations Office		R. J. Hart	(615) 576-4444
Pittsburgh Naval Reactors Office		C. K. Gaddis	(412) 462-5000 X0240
Richland Operations Office		A. G. Fremling	(509) 942-7395
San Francisco Operations Office		J. La Grone	(415) 536-7111
Savannah River Operations Office		N. Stetson	(803) 725-6211 X2277
Schenectady Naval Reactors Office		B. M. Erickson	(518) 393-6611 X4441
<u>Multiprogram Laboratories</u>			
Ames Laboratory	Iowa State University	R. S. Hansen	(515) 294-2770
Argonne National Laboratory	University of California/Argonne Universities Association	E. G. Pewitt (Acting)	(312) 972-5555

APPENDIX D (Cont'd)

Facility/Organization Name	Contractor Name	Director/Manager	Telephone Number
Brookhaven National Laboratory	Associated Universites, Inc.	G. H. Vineyard	(516) 345-3335
Energy Technology Engineering Center	Rockwell International Corporation	J. C. Cochran	(213) 341-1000 X6185
Hanford Engineering Development Laboratory	Westinghouse Hanford Company	J. B. Yasinsky	(509) 942-3915
Idaho National Engineering Laboratory	Allied Chemical Corp. and EG&G Idaho, Inc.	F. H. Anderson R. W. Kiehn	(208) 526-1476 (208) 526-1905
Lawrence Berkeley Laboratory	University of California	A. M. Sessler	(415) 843-2740 X5111
Lawrence Livermore Laboratory	University of California	R. E. Batzel	(415) 422-7401
Los Alamos Scientific Laboratory	University of California	R. N. Thorn (Acting)	(505) 667-5101
Oak Ridge National Laboratory	Nuclear Division of Union Carbide Corp.	H. Postma	(615) 574-4846
Pacific Northwest Laboratory	Battelle Memorial Institute	T. W. Ambrose	(509) 946-2201
Sandia Laboratories	Western Electric Company	M. Sparks	(505) 264-7261
Savannah River Laboratory	E. I. duPont de Nemours & Co., Inc.	A. H. Peters	(803) 725-6211 X3183

Program Dedicated Facilities

Bartlesville Energy Technology Center		H. R. Johnson	(918) 336-2400 X200
Bates Linear Accelerator Facility	Massachusetts Institute of Technology	P. Demos	(617) 245-6600
Bettis Atomic Power Laboratory	Westinghouse Electric Corporation	W. H. Hamilton	(412) 462-5000 X0200
Carbondale Mining Operations Center		A. C. Van Besien	(618) 985-3771

APPENDIX D (Cont'd)

Facility/Organization Name	Contractor Name	Director/Manager	Telephone Number
Center for Energy and Environment Research	University of Puerto Rico	J. A. Bonnet, Jr.	(809) 765-7210
Comparative Animal Research Laboratory	University of Tennessee	H. E. Walburg	(615) 576-4008
Environmental Measurements Laboratory		J. H. Harley	(212) 620-3616
Fermi National Accelerator Laboratory	University Research Association, Inc.	R. R. Wilson	(312) 840-3000 X3211
Grand Forks Energy Technology Center		G. H. Gronhovd	(701) 795-8131
Inhalation Toxicology Research Institute	Lovelace Biomedical and Environmental Research Institute	R. R. Wilson	(312) 840-3000 X3211
Knolls Atomic Power Laboratory	General Electric Corporation	A. E. Kakretz	(518) 393-6611 X4200
Laboratory for Energy-Related Health Research	University of California at Davis	M. Goldman	(916) 752-1341
Laboratory of Nuclear Medicine and Radiation Biology	University of California	O. R. Lunt	(213) 825-9431
Laboratory of Radiobiology	University of California at San Francisco	H. M. Patt	(415) 666-1636
Laramie Energy Technology Center		A. W. Decora	(307) 721-2115 X4212
MSU-DOE Plant Research Laboratory	Michigan State University	H. Kende	(517) 353-2270
Morgantown Energy Technology Center		A. A. Pitrolo	(304) 599-7511
New Brunswick Laboratory		C. D. Bingham	(312) 972-2446

APPENDIX D (Cont'd)

Facility/Organization Name	Contractor Name	Director/Manager	Telephone Number
Notre Dame Radiation Laboratory	University of Notre Dame	R. H. Schuler	(219) 283-7502
Oak Ridge Associated Universities	Oak Ridge Associated Universities	P. L. Johnson	(615) 843-8411 X201
Pittsburgh Energy Technology Center		S. W. Chun (Acting)	(412) 892-2400 X2395
Pittsburgh Mining Operations Center		E. R. Palowitch	(412) 892-2400 X705
Princeton Plasma Physics Laboratory	Princeton University	M. B. Gottlieb	(609) 452-5600
Radiobiology Laboratory	University of Utah	W. S. S. Jee	(801) 581-6600
Savannah River Ecology Laboratory	University of Georgia	M. H. Smith	(803) 824-6331 X2472
Solar Energy Research Institute	Midwest Research Institute	P. Rappaport	(303) 231-1000
Stanford Linear Accelerator Center	Stanford University	W. K. H. Panofsky	(415) 854-3300 X2601
The Franklin McLean Memorial Research Institute	University of Chicago	R. N. Beck	(312) 947-5007
University of Rochester Biomedical Laboratory	University of Rochester	P. L. LaCelle	(716) 275-3723

Nuclear Materials Production FacilitiesExtrusion Plants

Ashtabula Feed Materials Plant	Reactive Metals, Inc.	R. D. Heiser	(216) 997-5141 X280
Feed Materials Production Center	National Lead Company of Ohio	S. F. Audia	(513) 738-1151 X8444

APPENDIX D (Cont'd)

Facility/Organization Name	Contractor Name	Director/Manager	Telephone Number
<u>Gaseous Diffusion Plants</u>			
Oak Ridge Gaseous Diffusion Plant	Union Carbide Corporation	R. A. Winkel	(615) 574-7911
Paducah Gaseous Diffusion Plant	Union Carbide Corporation	C. D. Zerby	(502) 444-6311 X301
Portsmouth Gaseous Diffusion Plant	Goodyear Atomic Corporation	N. H. Hunt, Jr.	(614) 289-2331 X2101
Hanford Production Operations	Rockwell Hanford Operations and United Nuclear Industries	D. J. Cockeram	(509) 942-1277
		R. K. Robinson	(509) 942-7258
Idaho Chemical Processing Plant	Allied Chemical Corp.	F. H. Anderson	(208) 526-1476
Savannah River Plant	E. I. duPont de Nemours & Company, Inc.	W. J. Mottel	(803) 725-6211 X2701
<u>Weapons Testing and Fabrication Complex</u>			
Kansas City Plant	Bendix Corporation	R. J. Quirk	(816) 997-2000 X3212
Mound Facility	Monsanto Research Corporation	J. R. McClain	(513) 866-7444 X3222
Nevada Test Site	Reynolds Electrical and Engineering Co., Inc.	B. C. Moore	(702) 986-9060
Pantex Plant	Mason & Hanger-Silas Mason Co., Inc.	D. R. Dunham	(806) 335-1581 X2111
Pinellas Plant	General Electric Co.	S. W. Suci	(813) 544-2511 X173
Rocky Flats	Rockwell International	R. O. Williams	(303) 497-7000 X4361
Y-12 Plant	Nuclear Division of Union Carbide Corp.	J. M. Case	(615) 483-8611 X7353

APPENDIX E

DOE FACILITY/MISSION MATRIX

(\$ IN MILLIONS, FY 1978 OPERATING EXPENSES¹)

Facility	Energy Supply Research and Development	Energy Conservation	Fossil Energy Research and Development	General Sciences and Research	Uranium Enrichment	Atomic Energy Defense Activities	Departmental Administration	Energy Information Administration	Total 2
<u>Multiprogram Laboratories</u>									
Ames Laboratory	10.9	—	.8	.7	—	—	.1	—	12.5
Argonne National Laboratory	142.2	12.7	11.7	24.0	—	1.8	4.1	—	196.5
Brookhaven National Laboratory	41.4	3.1	1.6	44.5	.2	1.9	3.0	.3	96.0
Energy Technology Engineering Center	20.7	—	—	—	—	—	—	—	20.7
Hanford Engineering Development Laboratory	144.4	—	—	—	—	.8	—	—	145.2
Idaho National Engineering Laboratory	47.5	.5	.09	.04	—	41.4	—	—	89.5
Lawrence Berkeley Laboratory	39.7	5.8	.9	32.1	—	.9	.5	1.1	81.0
Lawrence Livermore Laboratory	72.2	.9	5.9	1.6	3.8	190.3	.4	—	275.1
Los Alamos Scientific Laboratory	73.1	.5	2.0	26.7	.1	159.0	—	.08	216.5
Oak Ridge National Laboratory	166.9	6.5	8.2	13.2	.6	6.9	.5	1.6	204.4
Pacific Northwest Laboratory	79.2	.9	2.8	.3	—	3.5	—	—	86.7
Sandia Laboratories	54.8	—	11.5	.06	.7	283.0	.02	—	350.1
Savannah River Laboratory	6.4	—	—	.04	4.2	31.2	.1	—	41.9

¹Budget Obligations

²Excludes Reimbursable Work

NOTE: Totals may differ from figures in row due to rounding errors.

Facility	Energy Supply Research and Development	Energy Conservation	Fossil Energy Research and Development	General Sciences and Research	Uranium Enrichment	Atomic Energy Defense Activities	Departmental Administration	Energy Information Administration	Total
									2
<u>Program-Dedicated Facilities</u>									
Bartlesville Energy Technology Center	.2	—	27.6	—	—	—	—	—	27.8
Bates Linear Accelerator Facility	—	—	—	4.1	—	—	—	—	4.1
Bettis Atomic Power Laboratory	30.4	—	—	—	—	85.3	—	—	115.7
Carbondale Mining Operations Center	—	—	.2	—	—	—	—	—	.2
Center for Energy and Environment Research	1.1	—	—	—	—	—	—	—	1.1
Comparative Animal Research Laboratory	1.0	—	—	—	—	—	—	—	1.0
Environmental Measurements Laboratory	5.4	—	—	—	—	—	—	—	5.4
Fermi National Accelerator Laboratory	.05	—	—	61.0	—	—	—	—	61.1
Grand Forks Energy Technology Center	—	—	5.9	—	—	—	—	—	5.9
Inhalation Toxicology Research Institute	5.0	—	—	—	—	—	—	—	5.0
Knolls Atomic Power Laboratory	.5	—	—	—	—	91.5	—	—	92.0
Laboratory for Energy-Related Health Research	2.7	—	—	—	—	—	—	—	2.7
Laboratory for Nuclear Medicine and Radiation Biology	1.3	—	—	.8	—	—	—	—	2.1
Laboratory of Radiobiology (University of California, San Francisco)	1.5	—	—	.05	—	—	—	—	1.6

Facility	Energy Supply Research and Development	Energy Conservation	Fossil Energy, Research and Development	General Sciences and Research	Uranium Enrichment	Atomic Energy Defense Activities	Departmental Administration	Energy Information Administration	Total
									2
Laramie Energy Technology Center	.5	—	24.5	—	—	—	—	—	25.0
MSU-DOE Plant Research Laboratory	.06	—	—	.2	—	—	—	—	.3
Morgantown Energy Technology Center	.5	—	32.2	—	—	—	—	—	32.7
New Brunswick Laboratory	—	—	—	—	—	1.5	—	—	1.5
Notre Dame Radiation Laboratory	1.8	—	—	—	—	—	—	—	1.8
Oak Ridge Associated Universities	2.2	—	—	1.6	—	—	2.1	—	5.9
Pittsburgh Energy Technology Center	.2	.2	19.5	—	—	—	—	—	19.9
Pittsburgh Mining Operations Center	—	—	.2	—	—	—	—	—	.2
Princeton Plasma Physics Laboratory	37.3	—	—	—	—	—	—	—	37.3
Radiobiology Laboratory (University of Utah)	1.6	—	—	—	—	—	—	—	1.6
Savannah River Ecology Laboratory	1.4	—	—	—	—	—	.06	—	1.5
Solar Energy Research Institute	12.8	—	—	—	—	—	—	—	12.8
Stanford Linear Accelerator Center	—	—	—	33.0	—	—	—	—	33.0
The Franklin McLean Memorial Research Institute	.1	—	—	1.1	—	—	—	—	1.2
University of Rochester Biomedical Laboratory	2.5	—	—	1.3	—	—	—	—	3.8

Facility	Energy Supply Research and Development	Energy Conservation	Fossil Energy Research and Development	General Sciences and Research	Uranium Enrichment	Atomic Energy Defense Activities	Departmental Administration	Energy Information Administration	Total
<u>Nuclear Materials Production Facilities</u>									
Ashtabula Extrusion Plant	1.7	—	—	—	—	—	—	—	1.7
Feed Materials Production Center	—	—	—	—	1.3	15.8	—	—	17.1
Oak Ridge Gaseous Diffusion Plant	2.1	—	—	—	219.0	—	—	—	221.1
Paducah Gaseous Diffusion Plant	.1	—	—	—	258.3	—	—	—	258.4
Portsmouth Gaseous Diffusion Plant	—	—	—	—	242.9	—	—	—	242.9
Hanford Production Operations*	37.9	—	—	—	—	131.3	—	—	169.2
Savannah River Plant	3.4	—	—	—	.7	219.4	—	—	223.5
<u>Weapons Testing and Fabrication Complex</u>									
Kansas City Plant	—	—	—	—	—	150.5	—	—	150.5
Mound Facility	9.1	—	—	.7	—	43.6	.03	—	53.4
Nevada Test Site	12.3	—	—	—	—	160.8	—	—	173.1
Pantex Plant	—	—	—	—	—	33.5	—	—	33.5
Pinellas Plant	—	—	—	—	—	40.0	—	—	40.0
Rocky Flats Plant	6.9	—	—	—	—	77.5	—	—	84.4
Y-12 Plant	2.8	—	—	—	.4	105.2	—	—	108.4

*Includes data for United Nuclear Industries, Inc., and Rockwell Hanford Operations.

Energy Supply Research and Development includes Basic Energy Sciences, Biomass, Electric Energy Systems and Storage, Environment, Geothermal, Hydropower, Magnetic Fusion, Nuclear, Solar Applications, and Solar Technology.

Energy Conservation includes Buildings and Community Systems, Industrial, Transportation, State and Local, State Energy Management and Planning and Multi-Sector.

Fossil Energy Research and Development includes Coal, Gas and Petroleum.

General Sciences and Research includes Life Sciences Research and Biomedical Application, High Energy Physics, and Nuclear Physics.

Uranium Enrichment includes Uranium Enrichment Activities and Uranium Resource Assessment.

Atomic Energy Defense Activities includes Defense Waste Management, Inertial Confinement Fusion, Materials Production, Naval Reactors, Nuclear Materials Security and Safeguards, Verification and Control Technology and Weapons Activities.

Departmental Administration includes Policy and Management (Policy Analysis and Systems Studies, International Affairs, Intergovernmental and Institutional Relations and In-House Energy Management.

Energy Information Administration includes Energy Information (Energy Applied Analysis; Collection, Production, and Dissemination; Data Validation; and Data Information Services).

APPENDIX F

DOE FACILITIES BY PROGRAM

(FY 1978 \$ in Millions)¹

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

Basic Energy Sciences

Ames Laboratory.....	\$ 9.5
Argonne National Laboratory.....	24.9
Brookhaven National Laboratory.....	19.0
Bartlesville Energy Technology Center...	.1
Idaho National Engineering Laboratory...	.5
Lawrence Berkeley Laboratory.....	12.7
Lawrence Livermore Laboratory.....	2.2
Los Alamos Scientific Laboratory.....	4.6
Morgantown Energy Technology Center.....	.1
Oak Ridge National Laboratory.....	33.4
Pacific Northwest Laboratory.....	3.7
Pittsburgh Energy Technology Center.....	.04
Sandia Laboratories.....	2.5
Solar Energy Research Institute.....	.002
Notre Dame Radiation Laboratory.....	1.8
Mound Facility.....	1.2

Biomass

Lawrence Berkeley Laboratory.....	.4
Oak Ridge National Laboratory.....	.2
Pacific Northwest Laboratory.....	.6
Solar Energy Research Institute.....	1.2

Electric Energy Systems and Storage

Argonne National Laboratory.....	10.4
Brookhaven National Laboratory.....	5.7

Lawrence Berkeley Laboratory.....	\$.3
Lawrence Livermore Laboratory.....	2.3
Los Alamos Scientific Laboratory.....	2.8
Oak Ridge National Laboratory.....	5.4
Pacific Northwest Laboratory.....	2.2
Sandia Laboratories.....	3.8

Environment

Ames Laboratory.....	.9
Argonne National Laboratory.....	19.7
Brookhaven National Laboratory.....	12.2
Bartlesville Energy Technology Center...	.05
Hanford Engineering Development Laboratory.....	.2
Idaho National Engineering Laboratory...	2.3
Laramie Energy Technology Center.....	.5
Lawrence Berkeley Laboratory.....	6.4
Lawrence Livermore Laboratory.....	11.9
Los Alamos Scientific Laboratory.....	8.1
Morgantown Energy Technology Center.....	.3
Oak Ridge National Laboratory.....	23.7
Pacific Northwest Laboratory.....	20.1
Pittsburgh Energy Technology Center.....	.2
Sandia Laboratories.....	6.6
Savannah River Laboratory.....	1.6
Notre Dame Radiation Laboratory.....	.03
Mound Facility.....	.07
Oak Ridge Associated Universities.....	2.2
Center for Energy and Environment Research.....	1.0

Comparative Animal Research Laboratory..	\$ 1.0
Environmental Measurements Laboratory...	5.4
Inhalation Toxicology Research Institute.....	5.0
Laboratory of Energy-Related Health Research.....	2.7
Laboratory of Nuclear Medicine and Radiation Biology.....	1.3
Laboratory of Radiobiology.....	1.5
MSU-DOE Plant Research Laboratory.....	.6
Radiobiology Laboratory (University of Utah).....	1.6
Savannah River Ecology Laboratory.....	1.4
The Franklin McLean Memorial Research Institute.....	.1
Hanford Production Operations.....	.7
University of Rochester Biomedical Laboratory.....	2.5

Geothermal

Argonne National Laboratory.....	.08
Lawrence Berkeley Laboratory.....	7.0
Lawrence Livermore Laboratory.....	3.8
Los Alamos Scientific Laboratory.....	7.4
Oak Ridge National Laboratory.....	1.0
Pacific Northwest Laboratory.....	2.0
Sandia Laboratories.....	3.2

¹Budget Obligations

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

Hydropower

Idaho National Engineering Laboratory...\$ 1.0
Oak Ridge National Laboratory..... .1

Magnetic Fusion

Ames Laboratory..... .05
Argonne National Laboratory..... 2.3
Brookhaven National Laboratory..... 1.8
Hanford Engineering Development
Laboratory..... 4.0
Lawrence Berkeley Laboratory..... 10.8
Lawrence Livermore Laboratory..... 37.7
Los Alamos Scientific Laboratory..... 14.7
Oak Ridge National Laboratory..... 35.9
Pacific Northwest Laboratory..... .4
Sandia Laboratories..... 1.1
Princeton Plasma Physics Laboratory..... 37.3
Mound Facility..... .01

Nuclear

Ames Laboratory..... .2
Argonne National Laboratory..... 79.5
Brookhaven National Laboratory..... 1.3
Hanford Engineering Development
Laboratory..... 140.2
Idaho National Engineering Laboratory... 43.7
Lawrence Berkeley Laboratory..... .2
Lawrence Livermore Laboratory..... 12.9
Los Alamos Scientific Laboratory..... 33.5
Oak Ridge National Laboratory..... 64.9
Pacific Northwest Laboratory..... 46.4
Sandia Laboratories..... 3.9
Savannah River Laboratory..... 4.7

Energy Technology Engineering Center....\$20.1
Bettis Atomic Power Laboratory..... 30.4
Knolls Atomis Power Laboratory..... .5
Mound Facility..... 7.7
Oak Ridge Gaseous Diffusion Plant..... 2.1
Savannah River Plant..... 3.4
Hanford Production Operations..... 37.2
Idaho Chemical Processing Plant..... .6
Nevada Test Site..... 12.3
Rocky Flats Plant..... .8
Y-12 Plant..... 2.8

Solar Applications¹

Ames Laboratory..... .2
Argonne National Laboratory..... 2.6
Brookhaven National Laboratory..... 1.3
Lawrence Berkeley Laboratory..... 1.3
Lawrence Livermore Laboratory..... .7
Los Alamos Scientific Laboratory..... 1.6
Oak Ridge National Laboratory..... .7
Pittsburgh Energy Technology Center.... .01
Sandia Laboratories..... .5
Fermi National Accelerator Laboratory... .06
Mound Facility..... .1

Solar Technology²

Ames Laboratory..... .03
Argonne National Laboratory..... 2.7
Brookhaven National Laboratory..... .2
Lawrence Berkeley Laboratory..... .7
Lawrence Livermore Laboratory..... .6
Los Alamos Scientific Laboratory..... .2

Oak Ridge National Laboratory.....\$ 1.7
Pacific Northwest Laboratory..... 3.7
Sandia Laboratories..... 33.2
Solar Energy Research Institute..... 11.6
Energy Technology Engineering Center.... .6
Rocky Plants Plant..... 6.1

Conservation

Argonne National Laboratory..... 12.7
Brookhaven National Laboratory..... 3.1
Idaho National Engineering Laboratory... .5
Lawrence Berkeley Laboratory..... 5.8
Lawrence Livermore Laboratory..... .9
Los Alamos Scientific Laboratory..... .5
Oak Ridge National Laboratory..... 6.5
Pacific Northwest Laboratory..... .9
Pittsburgh Energy Technology Center.... .2

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

Coal

Ames Laboratory..... .8
Argonne National Laboratory..... 11.7
Brookhaven National Laboratory..... 1.6
Bartlesville Energy Technology Center... .8
Grand Forks Energy Technology Center.... 5.9
Idaho National Engineering Laboratory... .09
Laramie Energy Technology Center..... 3.8
Lawrence Berkeley Laboratory..... .6
Lawrence Livermore Laboratory..... 2.5
Los Alamos Scientific Laboratory..... .6
Morgantown Energy Technology Center.... 16.1

¹Solar Applications includes Systems Development, Demonstration in Buildings, Agriculture and Process Heat and Federal Photovoltaics.

²Solar Technology includes Thermal Electric Power Systems, Photovoltaics, Wind and Ocean Systems.

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

Coal (continued)

Oak Ridge National Laboratory.....	\$ 7.8
Pacific Northwest Laboratory.....	2.7
Pittsburgh Energy Technology Center.....	19.5
Sandia Laboratories.....	2.7

Gas

Bartlesville Energy Technology Center...	1.0
Lawrence Livermore Laboratory.....	.7
Los Alamos Scientific Laboratory.....	.6
Morgantown Energy Technology Center.....	1.3
Sandia Laboratories.....	2.4

Petroleum

Argonne National Laboratory.....	.006
Bartlesville Energy Technology Center...	25.8
Laramie Energy Technology Center.....	20.7
Lawrence Berkeley Laboratory.....	.3
Lawrence Livermore Laboratory.....	2.6
Los Alamos Scientific Laboratory.....	.8
Morgantown Energy Technology Center.....	14.8
Oak Ridge National Laboratory.....	.5
Sandia Laboratories.....	6.3

GENERAL SCIENCE AND RESEARCH

Life Sciences Research and Biomedical

Application

Argonne National Laboratory.....	1.6
Brookhaven National Laboratory.....	6.1
Lawrence Berkeley Laboratory.....	5.6
Lawrence Livermore Laboratory.....	1.5
Los Alamos Scientific Laboratory.....	3.2
Oak Ridge National Laboratory.....	7.2

Pacific Northwest Laboratory.....	\$.3
Savannah River Laboratory.....	.04
Laboratory of Nuclear Medicine and Radiation Biology.....	.8
Laboratory of Radiobiology.....	.05
MSU-DOE Plant Research Laboratory.....	.2
Mound Facility.....	.7
Oak Ridge Associated Universities.....	1.3
The Franklin McLean Memorial Research Institute.....	1.1
University of Rochester Biomedical Laboratory.....	1.3

High Energy Physics

Ames Laboratory.....	.6
Argonne National Laboratory.....	18.3
Brookhaven National Laboratory.....	34.0
Lawrence Berkeley Laboratory.....	10.3
Los Alamos Scientific Laboratory.....	.1
Oak Ridge National Laboratory.....	.4
Fermi National Accelerator Laboratory..	61.0
Stanford Linear Accelerator Center.....	33.0

Nuclear Physics

Ames Laboratory.....	.1
Argonne National Laboratory.....	4.2
Brookhaven National Laboratory.....	4.3
Idaho National Engineering Laboratory..	.04
Lawrence Berkeley Laboratory.....	16.2
Lawrence Livermore Laboratory.....	0.6
Los Alamos Scientific Laboratory.....	23.4
Oak Ridge National Laboratory.....	5.5
Sandia Laboratories.....	.06
Bates Linear Accelerator Facility.....	4.1
Mound Facility.....	.2

URANIUM ENRICHMENT

Ames Laboratory.....	\$.8
Brookhaven National Laboratory.....	.2
Lawrence Livermore Laboratory.....	3.8
Sandia Laboratories.....	.7
Savannah River Laboratory.....	4.2
Oak Ridge Gaseous Diffusion Plant.....	219.0
Paducah Gaseous Diffusion Plant.....	258.3
Portsmouth Gaseous Diffusion Plant....	242.9
Fernald Feed Materials Production Center.....	1.3
Savannah River Plant.....	.7
Y-12 Plant.....	.4

ATOMIC ENERGY DEFENSE ACTIVITIES

Defense Waste Management

Argonne National Laboratory.....	.2
Brookhaven National Laboratory.....	.3
Hanford Engineering Development Laboratory.....	.8
Idaho National Engineering Laboratory.	4.3
Lawrence Livermore Laboratory.....	.3
Los Alamos Scientific Laboratory.....	3.2
Oak Ridge National Laboratory.....	4.7
Pacific Northwest Laboratory.....	.5
Sandia Laboratories.....	10.7
Savannah River Laboratory.....	1.4
Mound Facility.....	1.1
Savannah River Plant.....	32.5
Hanford Production Operations.....	49.8
Idaho Chemical Processing Plant.....	11.5
Nevada Test Site.....	.4
Rocky Flats Plant.....	1.5

ATOMIC ENERGY DEFENSE ACTIVITIES

Inertial Confinement Fusion

Argonne National Laboratory.....	\$.8
Brookhaven National Laboratory.....	.5
Lawrence Berkeley Laboratory.....	.9
Lawrence Livermore Laboratory.....	44.0
Los Alamos Scientific Laboratory.....	26.1
Pacific Northwest Laboratory.....	.4
Sandia Laboratories.....	12.0

Materials Production

Oak Ridge National Laboratory.....	1.7
Savannah River Laboratory.....	7.7
Paducah Gaseous Diffusion Plant.....	.1
Fernald Feed Materials Production Center.....	15.8
Ashtabula Extrusion Plant.....	1.7
Savannah River Plant.....	165.0
Hanford Production Operations.....	82.0
Idaho Chemical Processing Plant.....	18.3
Y-12 Plant.....	5.6

Naval Reactors

Idaho National Engineering Laboratory..	37.1
Bettis Atomic Power Laboratory.....	85.3
Knolls Atomic Power Laboratory.....	90.7

Nuclear Materials Security and Safeguards

Argonne National Laboratory.....	.1
Brookhaven National Laboratory.....	1.1
Lawrence Livermore Laboratory.....	.4
Los Alamos Scientific Laboratory.....	8.6
Oak Ridge National Laboratory.....	.5
Pacific Northwest Laboratory.....	.2
Sandia Laboratories.....	20.8
Mound Facility.....	.7

New Brunswick Laboratory.....	\$ 1.5
Idaho Chemical Processing Plant.....	1.1
Nevada Test Site.....	.4

Verification and Control Technology

Argonne National Laboratory.....	.6
Lawrence Livermore Laboratory.....	4.4
Los Alamos Scientific Laboratory.....	4.1
Oak Ridge National Laboratory.....	.05
Pacific Northwest Laboratory.....	.6
Sandia Laboratories.....	9.8
Knolls Atomic Power Laboratory.....	.7
Nevada Test Site.....	.7

Weapons Activities

Lawrence Livermore Laboratory.....	141.2
Los Alamos Scientific Laboratory.....	117.0
Pacific Northwest Laboratory.....	1.9
Sandia Laboratories.....	229.7
Mound Facility.....	41.9
Savannah River Plant.....	22.0
Nevada Test Site.....	159.6
Kansas City Plant.....	150.5
Rocky Flats Plant.....	70.6
Pantex Plant.....	33.5
Pinellas Plant.....	40.0
Y-12 Plant.....	99.6
Savannah River Laboratory.....	22.0

DEPARTMENTAL ADMINISTRATION

Ames Laboratory.....	.1
Argonne National Laboratory.....	4.1
Brookhaven National Laboratory.....	3.0

Lawrence Berkeley Laboratory.....	\$.5
Lawrence Livermore Laboratory.....	.4
Oak Ridge National Laboratory.....	.5
Sandia Laboratories.....	.02
Savannah River Laboratory.....	.1
Mound Facility.....	.03
Oak Ridge Associated Universities.....	2.1
Savannah River Ecology Laboratory.....	.06

ENERGY INFORMATION ADMINISTRATION

Brookhaven National Laboratory.....	.3
Los Alamos Scientific Laboratory.....	.08
Oak Ridge National Laboratory.....	1.6