ORNL/PPA-81/8

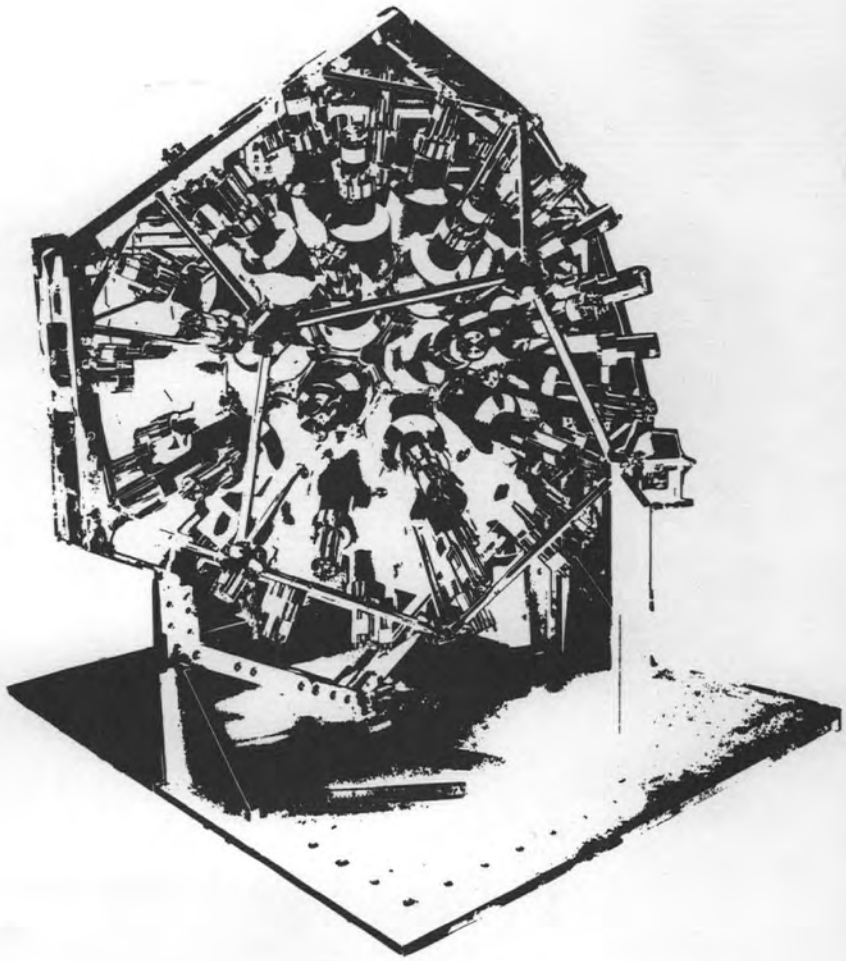
ornl

OAK
RIDGE
NATIONAL
LABORATORY

UNION
CARBIDE

OAK RIDGE NATIONAL LABORATORY INSTITUTIONAL PLAN FY 1982 - FY 1987

December 1981



OPERATED BY
UNION CARBIDE CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

The information in this Plan was obtained with the cooperation of the professional staff of the Oak Ridge National Laboratory. Additional copies of the *Institutional Plan FY 1982 – FY 1987* may be obtained from the Program Planning and Analysis Office, Building 4500N, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37830. Telephone (615)574-4170 (FTS 624-574-4170).

Cover design: A high-contrast line print of the spin spectrometer, a special device recently installed at the Holifield Heavy Ion Research Facility.

ORNL/PPA-81/8

Oak Ridge National Laboratory Institutional Plan FY 1982 - FY 1987

DATE PUBLISHED—DECEMBER 1981

Senior Planning Group

H. Postma
C. C. Hopkins
C. R. Richmond
M. W. Rosenthal
D. B. Trauger
A. Zucker

Planning Staff

S. R. McNeany
T. D. Anderson
J. E. Christian
B. R. Clark
H. A. Pfuderer
J. D. White

Contract No. W-7405-eng-26

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
THE UNION CARBIDE CORPORATION FOR THE DEPARTMENT OF ENERGY

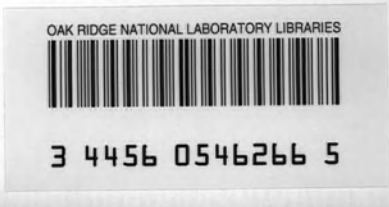


TABLE OF CONTENTS

DIRECTOR'S OVERVIEW

DIRECTOR'S OVERVIEW

This overview is written during a time of unusual turmoil and significant change. This condition is fostered by extensive modifications in energy research philosophy accompanied by large program modifications and budget cuts. Added to these changes is the Administration's decision to dismantle the Department of Energy (DOE), to establish a new set of research and development (R&D) priorities under the DOE Energy Research and Advisory Board (ERAB), and to examine roles of DOE laboratories by both ERAB and the Presidential Science Advisor.

Though each year's institutional plan has been formulated during a time of change (i.e., changes in philosophy by an incumbent Administration, transitions from one agency to another, and/or program shifts as new DOE appointees come in), the changes we are now facing seem unusual in both their intensity and breadth.

Institutional plans serve many purposes. The ways in which they serve best are by bringing up issues, highlighting areas in which new initiatives are important, underscoring the roles of Oak Ridge National Laboratory (ORNL), and bringing about site planning for such needs as facilities and utility restorations. In most respects, however, the current institutional planning process does not allow for detailed planning beyond one year. Budget guidance normally fluctuates erratically as a result of interactions—sometimes conflicts—betweeen the Administration and the Congress, with little of the early guidance holding true during the period of the plan. Thus, readers of this document are directed to look primarily at those areas involving program objectives, goals, and milestones. Specific budgets and manpower projections should, at best, be viewed with some skepticism.

Throughout the plan, we have tried to point out where ORNL's strengths can contribute to many programs and where the sciences and technologies mesh and combine in unique ways to enable ORNL to efficiently solve complex problems for DOE. Certain core R&D areas are evident in the technologies: the nuclear fuel cycle, magnetic fusion (toroidal), residential energy conservation, and coal conversion and combustion; and in the supporting sciences: separation sciences, biotechnology, nuclear physics, heavy-ion physics, and materials research and process development. For R&D efforts throughout the plan, we emphasize generic research areas that strongly affect the technology base support.

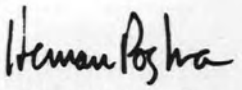
Though not a specific part of this plan, several ORNL philosophies have served DOE well during past fluctuations and should continue to do so for the successor agencies. Those philosophies are as follows:

- to retain maximum flexibility through subcontracting substantial R&D tasks;
- to utilize facilities fully by establishing user centers involving university and industrial groups;
- to establish a close liasion with collaborators in industry and universities to optimize government resources;
- to choose well the areas of research, with the full understanding that there will be change; and

- to look constantly for new initiatives within generic research areas that can make important additions to a broad technology base.

It is not possible for the budget numbers and programmatic areas in this plan to conform to the range of exercises to which we are currently asked to respond simultaneously; ranges go from a minimum of zero and close-out funding to a maximum funding at FY 1981 levels for the out years. Guidance relating to line items causes frequent removal and restoration of projects. We must assume from the rhetoric that DOE will be dismantled during this planning period, and that much of what is now DOE funding will shift to the category of "work for other agencies." Until those agencies establish their own research priorities, there are likely to be more EPA-type transfers, particularly in the health area.

Only a brief summary is possible. We expect a decline in programs, in breadth of research, in personnel, and in funding. Perhaps in the FY 1984 and 1985 time period, the budget pressures causing these contractions will ease, and we will see a revival of the research vigor and comprehensiveness that have served the nation so well since ORNL was created.



Herman Postma, Director

LABORATORY TRENDS AND FUTURE DEVELOPMENT

LABORATORY TRENDS AND FUTURE DEVELOPMENT

Laboratory Role

The primary objective of the Oak Ridge National Laboratory (ORNL) is to support national fission and fusion energy goals through scientific research and technology development. Emphasis is on long-term, high-risk, high-payoff technology development and on generating scientific and technical data (e.g., energy-related health, safety, and environmental) that are of national importance but that lack the incentives necessary for the private sector to develop and that are unsuitable for universities because of project size or because of the need for a multidisciplinary approach requiring long-term continuity. In support of this objective, the Laboratory carries out strong base technology research programs in engineering and in the physical, environmental, and biological sciences.

Energy technology development at ORNL emphasizes the fission nuclear fuel cycle and magnetic fusion and includes important other efforts in residential and commercial energy conservation and in some areas of coal conversion and utilization. The technology areas in which ORNL participates involve high risks and long-term commitments that industry finds unacceptable. In addition to ORNL's participation in the development of major energy technologies, the Laboratory maintains occasional and lesser involvement in other technologies [e.g., geothermal, ocean thermal energy conversion (OTEC), energy storage, etc.] in which existing facilities and expertise offer unique capabilities to the Department of Energy (DOE). ORNL also serves as a technical program manager for DOE in specialized areas of technology development in which we have special competence.

Another primary role of ORNL is to identify and provide solutions to generic research problems in energy-base technologies such as materials, separation techniques, chemical processes, biological screening, and biotechnology. In carrying out this role, ORNL conducts basic research in physical and life sciences in order to provide a solid basis on which to make decisions about the various energy technology options.

The philosophy of reinforcing fundamental thrusts of a few, well-chosen technologies (multiprogram) with broad, long-term, and more basic research in a variety of pertinent disciplines (multidiscipline) characterizes ORNL in the role of a multiprogram laboratory. This role is broadened by including a few areas of more basic research in which ORNL generates, analyzes, and systematizes new fundamental knowledge by virtue of the Laboratory's stewardship of unique or rare national facilities and resources such as reactors, the National Environmental Research Park, animal research facilities, and heavy-ion facilities.

The only non-R&D role for ORNL is in the manufacture, production, and sale of radioactive and

stable isotopes to the medical, industrial, and research communities. This is a function that U.S. private industry does not have the capability to provide.

The Laboratory also does work for the Nuclear Regulatory Commission (NRC) and, in areas where DOE has a program interest and facilities exist, undertakes work for other federal agencies such as the U.S. Department of Health and Human Services (DHHS) and the Environmental Protection Agency (EPA). This work for others amounts to about 20% of the Laboratory's program.

ORNL expends special effort to transfer technology to the private sector; to involve industry, where appropriate, in ORNL programs; and to encourage cooperative uses of facilities, both formally in users' groups and informally through professional contacts and participation. Similarly, the Laboratory provides universities with ready access to major research facilities and programs. At ORNL, users have access to state-of-the-art research capabilities, training facilities for faculty and students, and an opportunity for collaborative research in areas in which these facilities and techniques are not available to universities.

Finally, ORNL plays a special regional role for energy-related activities in the southeastern United States by providing universities access to its facilities, engaging in energy technologies that are of interest in the Southeast, and supporting and collaborating with other institutions—state and local governments and organizations such as the Tennessee Valley Authority (TVA)—that are primary R&D influences in the area. In addition, ORNL is linked to other DOE-sponsored development activities in the Oak Ridge area, such as the Clinch River Breeder Reactor (CRBR), the uranium enrichment programs, and support to the Operations Office.

Capabilities and Directions

ORNL has some special capabilities and facilities which promote contributions to energy development and to the growth of basic knowledge through research in most science and engineering areas. ORNL has traditionally tackled large-scale R&D problems with a high success rate made possible by maintaining within the divisions an unexcelled multidisciplinary capability. This traditional stance continues. Extensive and/or often unique facilities are located close together at the Laboratory as a result of ORNL's carrying out large, multifaceted research programs over the years. The breadth in types of physical facilities and the breadth and depth of personnel training make the Laboratory an invaluable national resource.

While current research programs are not so exclusively focused on nuclear energy as they were in the past, the multidisciplinary character of the Laboratory accommodates other major problems of national importance. Some examples are the technology-specific assessments in fossil energy development and the ongoing nuclear waste disposal/storage research. A recent result in nuclear waste storage research points very favorably to the incorporation of wastes in natural minerals, for example, in monazites. Another example of the advantage of a multidisciplinary problem-solving capability is the development of new or improved materials for specialized applications, namely, high-temperature materials for developing energy technologies.

Materials research is of such central importance to advanced technology development that a high-temperature materials program has been established at ORNL. The high level of DOE support for construction of a high-temperature materials laboratory (HTML) underscores the importance of this multidiscipline research program. In addition, and complementary to the HTML, an engineering science center has been proposed to help advance our knowledge of basic engineering data pertaining to heat and mass transfer, fluid dynamics, and solid mechanics. The Life Sciences Synthetic Fuels Program exemplifies the high degree of successs obtainable through mission-oriented research in a multidisciplined laboratory.

Many of the research facilities at the Laboratory are mutually supportive because of their being located close to one another. For example, the fusion energy program requires data that are supplied by basic measurements in the nuclear physics facilities. Materials research depends heavily on the neutron-scattering and irradiation facilities available at the research reactors and accelerators. Fuel-reprocessing development requires the expertise of chemists and chemical technologists as well as the availability of many materials-handling facilities not found nearby or in many other locations.

A specialized collection of equipment and unique facilities continues to make possible some research and service activities that are not carried out elsewhere in the nation. Some examples are (1) the Holifield Heavy Ion Research Facility (HHIRF) for studies of heavy-ion nuclear reactions, (2) the High Flux Isotope Reactor and the transuranium processing facilities for transuranium element processing production and research, (3) large-scale facilities for stable isotopes production, (4) a laboratory for producing and studying surface modifications of solids, and (5) an environmental research park.

Research Directions

Research will take advantage of the special capabilities and facilities discussed previously. In particular, there will be continuing and increasing interaction with university personnel and industrial research users groups.

University participation has steadily increased and presently accounts for a major portion of some research programs, for example, transuranium chemistry research. About 1300 university guests from about 500 colleges and universities participated in DOE-sponsored programs last year. Some 90 research proposals for experiments at the HHIRF have been accepted for implementation now. Special programs have been established to facilitate university research cooperation in neutron scattering [small-angle neutron scattering (SANS)], materials research (SHaRE), synchrotron studies of materials properties (NSLS), separation and investigation of short-lived isotopes (UNISOR), determination of properties of transuranium elements (TRL), environmental studies [Oak Ridge National Environmental Research Park (NERP)], and several more.

Industrial participation in the usage of specialized facilities and staff talents is expected to increase. Research may proceed through either contractual or collaborative arrangements. Some examples of current or recent industrial participation are studies of polymer structures by SANS (DuPont), coal structure studies by specialized electron spin resonance apparatus (Exxon), studies of low-level alpha emitters in high-purity silicon [International Business Machines (IBM)], and radionuclide measurements in solving problems with the cleanup operation at Three Mile Island (General Public Utilities).

Resources

Personnel levels at the Laboratory began declining rapidly in 1968. Following the reversal of this trend in 1974 (Fig. 1), the population grew strongly through 1978 when it leveled off. Current projections show a drop in personnel for FY 1982 and beyond. For the most part, the decreases in manpower will be in the Laboratory's Fossil Energy and Conservation programs, with other decreases expected in our assistance to federal regulatory activities.

The trend of ORNL's operating funds (in constant dollars) parallels that of personnel. Figure 2 shows total Laboratory funding levels from FY 1980

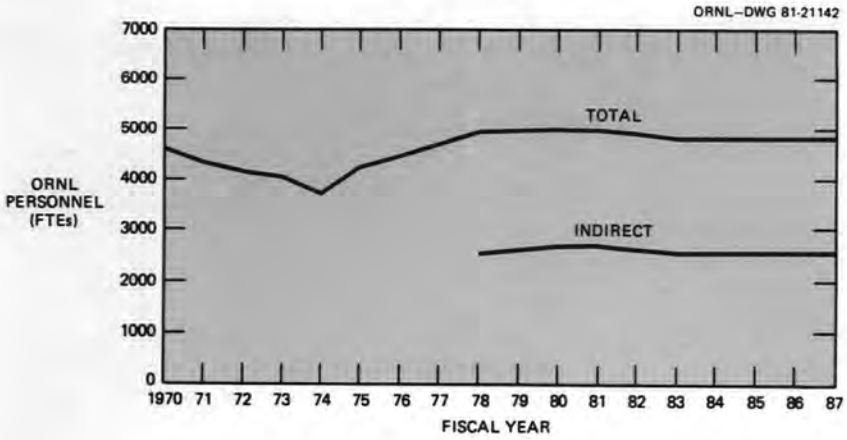


Fig. 1. Personnel projections show a drop in FY 1982 and FY 1983.

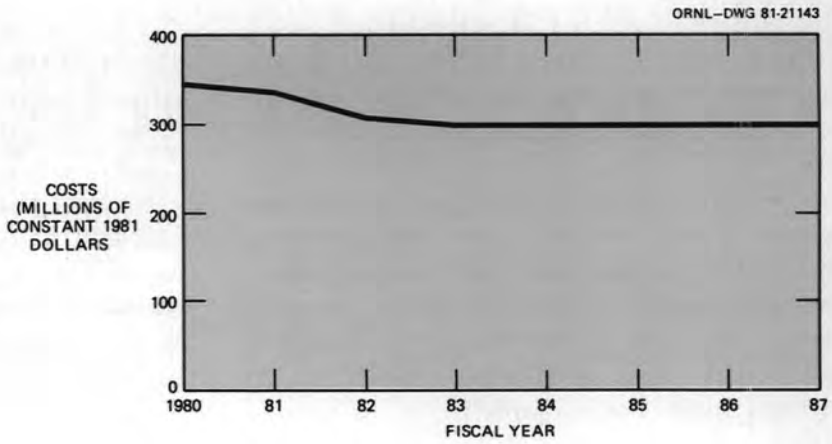


Fig. 2. Total Laboratory operating funds are projected to decrease in FY 1982 and FY 1983.

through the end of the planning period. The projected drop in funding is reflected in the manpower reductions projected for the period.

Overall Programs

The major areas of work at ORNL are related to fission energy, basic physical sciences, biomedical and environmental sciences, fusion energy, fossil energy, and conservation (Fig. 3). Most of these areas receive support from several sources. For example, in 1981, the fission area received funding from the Assistant Secretary for Nuclear Energy (ASNE) directly, from ASNE through other laboratories and operations offices, and from NRC, the Electric Power Research Institute (EPRI), and several other organizations.

The past decade has seen a major increase in the proportion of funds allocated for the Laboratory's major technology-oriented programs (fission, fusion,

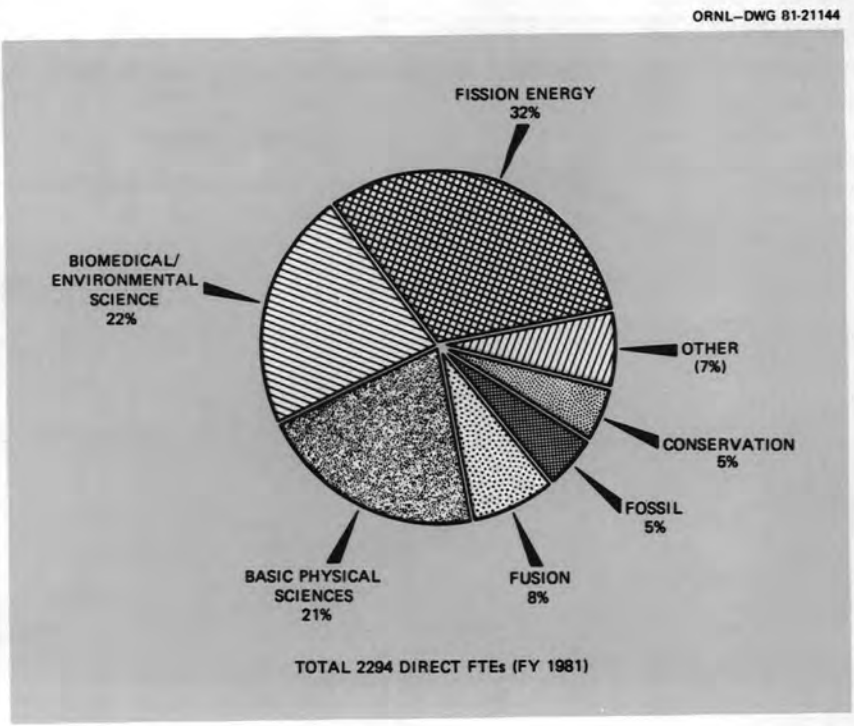


Fig. 3. The largest area of activity at ORNL, as a percentage of direct FTEs for FY 1981, is still fission energy, but work is also carried out in many other program areas.

fossil, and conservation) and a strong decline in the precentage of Laboratory funding devoted to programs in the basic physical and life sciences (Fig. 4). During the next 5 years the technology-oriented programs are projected to decline, and the sciences are expected to remain roughly constant or undergo small declines.

To help the Laboratory evaluate the very long-range future of energy research, we have recently completed an in-house study aimed at assessing the possible energy futures for the United States well into the next century and the R&D needs appropriate to these long-range supply and conservation options. To help set future goals for the distribution of our research, we are currently attempting to determine which R&D needs are best suited for development at ORNL and what priorities should be attached.

DOE Programs

The Office of Energy Research (OER) became our major supporter in 1979 when responsibility for the fusion program was transferred to that office and when the fission energy and fossil energy programs became the responsibility of separate secretarial offices. Since that time, its director has had overall responsibility for the Laboratory. After DOE's latest reorganization, which occurred during the early part of this calendar year, OER has acquired responsibility for a large part of ORNL's research in the life sciences. Now that office is by far the largest sponsor of research at ORNL (Fig. 5).

The Assistant Secretary for Nuclear Energy is the Laboratory's second-largest sponsor. Other programs are conducted for the Assistant Secretary for Defense Programs, the Assistant Secretary for Conservation and Renewable Energy, and the Assistant Secretary for Fossil Energy.

Another important program that accounted for almost 3% of our effort in 1980 is the production and distribution of stable and radioactive isotopes. The program is supported by DOE and is the sole U.S. distributor of isotopes to many federal, nonfederal, and foreign customers.

Non-DOE Programs

About 20% of the Laboratory's direct full-time equivalents (FTEs) are currently engaged in work for non-DOE sponsors. About half of them are involved in NRC programs (Fig. 6), and most of the remainder are working in various life sciences projects, which are funded primarily by the EPA and the National Cancer Institute (NCI) of DHHS.

This non-DOE work often has been the vehicle for entering or developing new areas of research and will

ORNL–DWG 81-21145

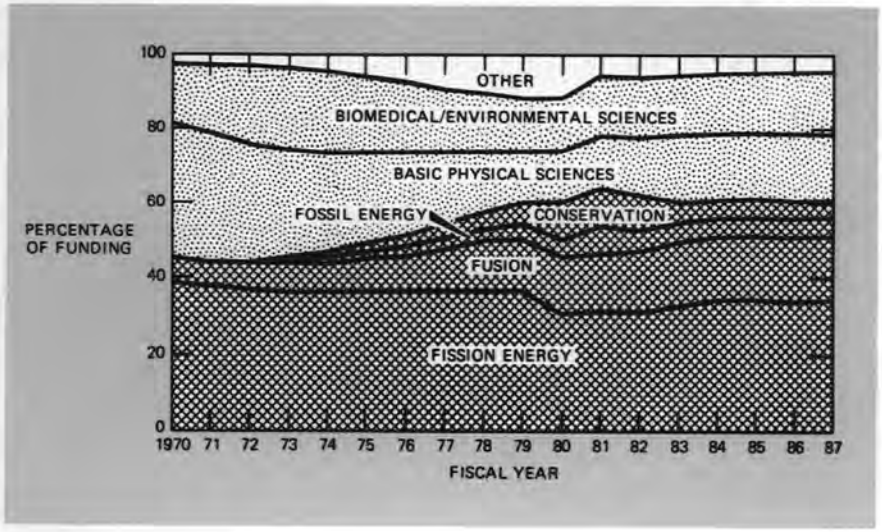


Fig. 4. ORNL's major technology programs (Conservation, Fossil Energy, Fusion, and Fission Energy) currently represent more than 60% of the Laboratory's effort, but support for the Conservation and Fossil Energy programs is expected to decline.

ORNL–DWG 81-21146

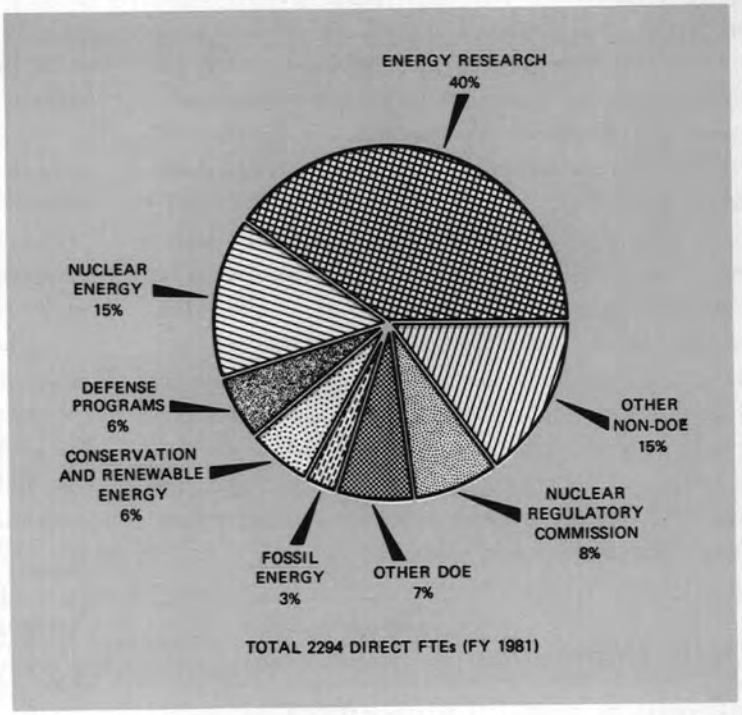


Fig. 5. The Director of Energy Research is the largest single supporter of ORNL programs.

ORNL–DWG 81-21147

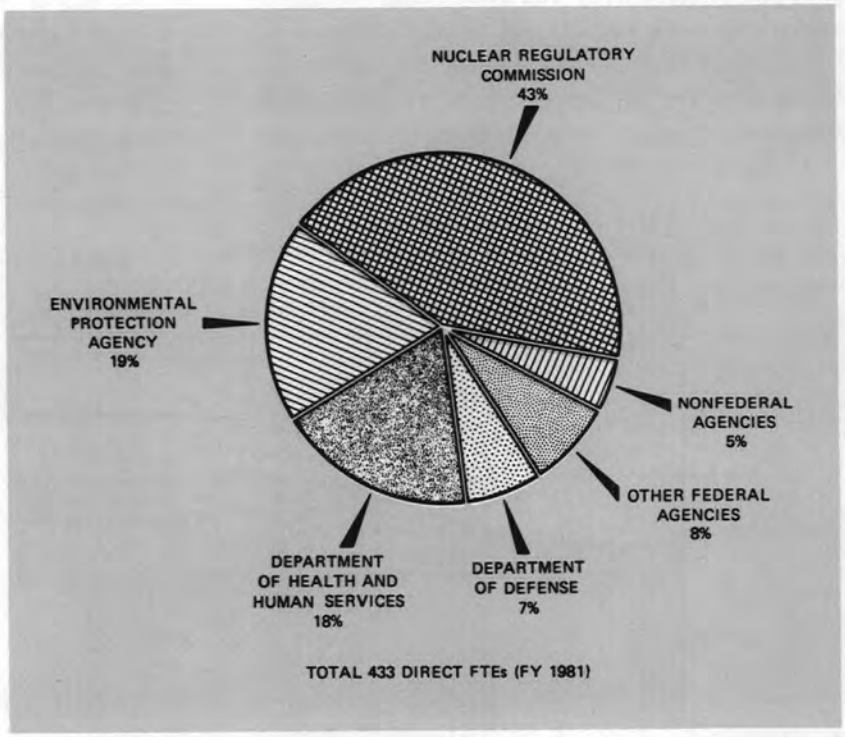


Fig. 6. The Nuclear Regulatory Commission is the largest sponsor of the Laboratory's non-DOE work.

continue to be extremely important to DOE in many ways. Recently, it has been invaluable in augmenting declining DOE support in our life sciences program. Several decisions in the past few years have transferred program responsibilities from DOE to EPA. Thus, in 1978, the responsibility for certain ORNL programs (funded at $1.3 million) was transferred from the former Assistant Secretary for the Environment (ASEV) to EPA as part of a larger ($14 million) program shift. In FY 1980, EPA transfer monies to ORNL were $2.4 million. In addition, more than $2 million have been made available to ORNL annually as part of a Federal Interagency Pass-Through Program, for which EPA has management responsibility. Generally, these sponsors have proved to be stable, reliable sources of funding. The work undertaken for other non-DOE sponsors complements DOE programs and consequently offers significant benefit to DOE as well as institutional and programmatic flexibility to the Laboratory as a whole. Of course, each such program must be approved directly by DOE as being an appropriate activity for the Laboratory to undertake. Overall, planning projections for non-DOE-sponsored work show research remaining near 20% of direct manpower over the entire planning period.

Subcontracting and Procurement

One of the two major extramural expenditures is subcontracting; the other is procurement. As Fig. 7 shows, a very substantial growth in extramural expenditure has occurred since DOE authorized the Laboratory to increase subcontracting in 1974. Some future decrease in extramural expenditures is projected as a result of expected declines in several programmatic areas.

Lead Missions

Over the last several years, the Oak Ridge Operations (ORO) and ORNL have been given major technical management roles in a number of DOE programs. These lead missions (Table 1) utilize ORNL's special technical and managerial skills in execution of these important program areas.

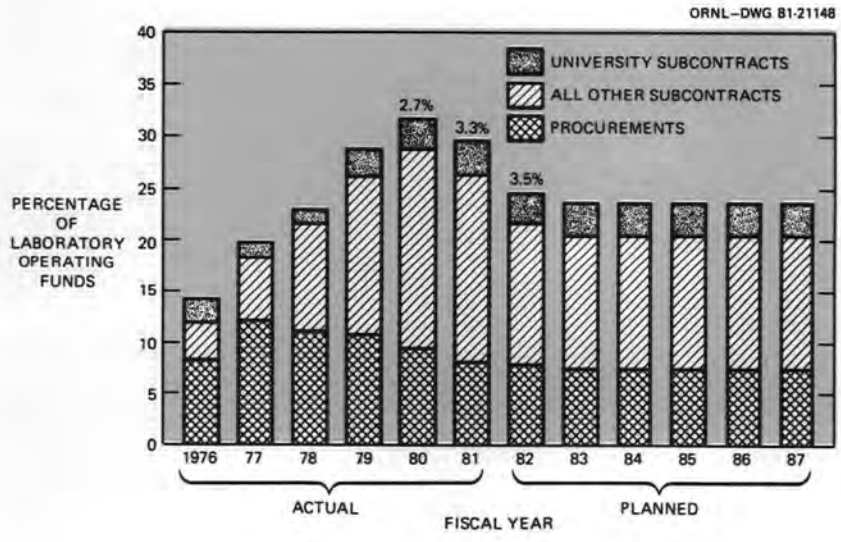


Fig. 7. Percentages of Laboratory operating funds used for subcontracting and procurement. The numerical values given above the bars indicate the percentage of total expenditure that was, or is projected to be, provided to minority or disadvantaged contractors.

Table 1. ORNL lead mission assignments

Title	ORNL principal investigator	DOE program management		
		ORO program manager	HQ program manager	Secretarial office
Annual Cycle Energy Systems	R. E. Minturn	S. S. Waddle	J. R. Ryan	Conservation and Renewable Energy
Building Thermal Envelope Systems and Insulating Materials	T. S. Lundy	S. S. Waddle	J. H. Cable	Conservation and Renewable Energy
Energy Conversion Utilization Technology (ECUT) Material Research	J. A. Carpenter	S. S. Waddle	J. J. Eberhardt	Conservation and Renewable Energy
Electric Energy Use Management and New Technology Integration Management	T. W. Reddoch	J. R. Gracia	J. C. Smith	Conservation and Renewable Energy
Heat Rejection from Geothermal Power Plants	H. G. Arnold	J. W. Rushing	R. La Salla	Conservation and Renewable Energy
High Voltage Technology	T. W. Reddoch	J. R. Gracia	K. W. Klein	Conservation and Renewable Energy
National Heat Pump R&D Program	F. A. Creswick	S. S. Waddle	J. R. Ryan	Conservation and Renewable Energy
National Residential and Commercial Appliances Program	V. O. Haynes	S. S. Waddle	R. Siskum	Conservation and Renewable Energy
Residential Conservation Service	A. C. Schaffhauser	S. S. Waddle	M. D. Friedrichs	Conservation and Renewable Energy
Thermal and Mechanical Storage Systems	J. F. Martin	S. S. Waddle	S. Ruby	Conservation and Renewable Energy
Woody Biomass Program	R. I. Van Hook	J. W. Rushing	B. J. Berger	Conservation and Renewable Energy
Consolidated Fuel Reprocessing	W. D. Burch	R. L. Philippone	W. W. Ballard	Nuclear Energy
Integrated Data Base	K. J. Notz	D. E. Large	E. F. Mastal	Nuclear Energy
Liquid Metal Fast Breeder Reactor Materials and Structures	W. O. Harms	E. E. Hoffman	J. A. Ford	Nuclear Energy
Nuclear Standards Management Center	W. L. Cooper, Jr.	J. Pidkowicz	M. E. Langston	Nuclear Energy
Technology for Low-Level Waste Program	R. S. Lowrie	D. E. Large	B. Jordan	Nuclear Energy
Elmo Bumpy Torus Development	L. A. Berry	L. K. Price	J. M. Turner	Energy Research
National Gyrotron Development Program	C. M. Loring	L. K. Price	G. M. Haas	Energy Research
Environmental Research for Gasifiers in Industry, H-Coal, and Coal Liquids	K. E. Cowser	C. L. Yarbro	A. P. Duhamel	Energy Research
Regional Ecological Analysis and Modeling	M. I. Dyer	C. L. Yarbro	W. S. Osburn	Energy Research
Fossil Energy Technology and Consumption Data Systems and Model Validation	A. S. Loebl	W. W. Parker	A. Daniels	Energy Information Administration
Fossil Energy Materials	R. A. Bradley	E. E. Hoffman	S. J. Dapkunas	Fossil Energy

SCIENTIFIC AND TECHNICAL ACTIVITIES

SCIENTIFIC AND TECHNICAL ACTIVITIES

DOE Effort

Director of Energy Research

Basic Physical Sciences (KA, KB, KC)

Nine ORNL divisions conduct research in the basic physical sciences. Support for this research comes from the Office of Energy Research (OER) and is administered through the OER programs in nuclear physics and basic energy sciences.

Technical Progress and Current Activities

Progress being made in current programs and comments on future directions are summarized below for nuclear physics and the broad areas of basic energy sciences research (materials, nuclear, and chemical). The major thrust of the nuclear physics program at ORNL is centered on research using heavy ion beams produced by the newly completed 25-MV tandem electrostatic accelerator of the Holifield Heavy Ion Research Facility, (HHIRF). Construction of the HHIRF Phase I project has now been completed, with the exception of final tests, at the full 25-MV rating. The accelerator vendor must make certain modifications to the accelerator before running these tests. In the interim, the experimental program at the facility has been initiated; the tandem is operating at potentials of up to 22 MV. A program advisory committee selects experiments from among proposals submitted by members of the users' organization, which currently numbers about 390 scientists. To date, some 90 experimental proposals have been reviewed, and some time has been recommended for about half of these. Experiments are being performed using the tandem accelerator operating alone and with the Oak Ridge Isochronous Cyclotron (ORIC) serving as a booster accelerator for beams injected from the tandem. To provide for future increases of facility capabilities, a study has been performed on upgrading of the ORIC through the addition of superconducting main field coils.

The Joint Institute for Heavy Ion Research, a users' building, has been completed and is being used. The state of Tennessee has made an unusual commitment and provided $350,000 for the addition of a second building to this complex for completion in 1983.

Materials science research resides mainly in the Solid State and Metals and Ceramics divisions. The excellent neutron-scattering facilities at the High Flux Isotope Reactor (HFIR) and the Oak Ridge Reactor (ORR) make possible the compilation of neutron-scattering data, used extensively to study the physical properties of condensed matter. Among the properties studied are electric and magnetic interactions between atoms, size distribution of voids in energy-related materials; the structure of polymers,

and the structure and dynamics of superconductors, defects, and alloys. The Crawford Committee commended this program at ORNL and urged larger support.

Synchrotron radiation is rapidly becoming another major tool in materials studies. ORNL uses synchrotron sources for static lattice studies as well as time-resolved studies of transient phenomena such as the surface structure of an ion-implanted solid surface during laser annealing. The Laboratory is designing and constructing equipment to be installed at the Brookhaven National Synchrotron Light Source (NSLS), namely, a flexible x-ray scattering facility with a very efficient focusing device and a multipurpose facility for surface studies on the vacuum uv ring.

Very important basic research is also being performed on diverse energy-related materials problems such as radiation effects in fission and fusion reactor materials, photovoltaic conversion in solar cells, storage of nuclear waste in minerals, and fast-ion conduction in solid electrolytes for batteries and fuel cells. The newly developed techniques of ion implantation doping and pulsed-laser annealing are being used to modify the near-surface properties of many types of materials. These surface modifications significantly affect such phenomena as friction, wear, corrosion, catalysis, and superconductivity, as well as the electronic properties of semiconductors.

Major nuclear sciences activities are investigating the chemical properties, producing, and separating, actinides; measuring neutron cross sections that are related to fusion; and preparing special isotopes.

There are several new trends in the long, continuing program of measuring neutron cross sections. Relations with the fusion-energy community have been closely coupled. This type of direct feedback from the users has recently been extended to the DOE fission-reactor programs. Thus, while the measurement emphasis is still on obtaining high-quality results of basic physical interest, the choices of particular measurements are influenced by long-range (and occasionally short-range) needs of the energy production program at DOE.

To strengthen the connections with nuclear theory, the Oak Ridge Electron Linear Accelerator (ORELA) program now sponsors workshops for theorists as well as short- and long-term assignments of theorists to the experimental facility. These interactions will permit the choice and design of experiments that can contribute most to the further development of nuclear theory.

Although ORELA has been the world's leading facility for time-of-flight measurements using intermediate-energy neutrons, improvements in two European facilities have brought them essentially to parity with ORELA. A broad study is now under way that examines the many advances in accelerator development to determine whether major increases in the pulsed-neutron source strength can be achieved at reasonable cost. The study includes the best possible projections of future measurements and their implications for the practical development of advanced energy sources and for nuclear physics theory.

The Stable Isotope Enrichment Program, which is carried out using the electromagnetic Calutron separators, has recently been integrated with the other isotope-related programs at the Laboratory. This program continues to suffer from depleted inventories caused by chronically insufficient funding. Maintaining a viable inventory, through isotope production efforts, of at least the 25 high-market-demand isotopes is a goal, as are developing and demonstrating low capital investment isotope enrichment technologies and extending and encouraging the use of separated products and improving their distribution and marketing.

The chemical sciences continue to focus on complex problems generic to several energy areas. Structural and reaction aspects of coal chemistry important to direct liquefaction are being studied through combined chemical and instrumental approaches. Also, molten salt catalysts for organic reactions are being examined to develop an understanding of their low-temperature hydrogen transfer and cracking capabilities.

The ability to study aqueous electrolyte solutions at high temperatures (400 to 800°C) and at high pressures (15 to 400 MPa) offers an unequaled opportunity to develop thermodynamic and kinetic data on aqueous electrolyte systems and reactions important in steam generator and geothermal systems. The reactions of iodine and amorphous silica solubilities are two important studies recently conducted.

Our Geosciences Program will continue to serve, as it began, as an interface to our high-temperature/high-pressure aqueous chemistry group. In addition, programs based on the hydrothermal geochemistry of natural materials and on phenomena associated with the melting and crystallization of rocks and minerals are taking shape. For the latter studies, we have constructed an apparatus capable of going to 1500°C and 400 MPa under 1 atm of hydrogen. These new capabilities will allow the generation of chemical and thermodynamic data useful in several areas, including waste disposal and ore formation.

Analytical instrumentation development is included in chemical sciences research. New, laser-based, spectroscopic measurement techniques constitute the main thrust of this work, although several highly innovative and promising new techniques in optical acoustic and microwave spectroscopy are being pursued.

Technology Assessment Projects (KD)

ORNL has initiated a program that will assess selected energy technologies and research programs. The objective of this work is to identify research goals and the underlying scientific issues associated with the research. The program includes technical and economic analyses of energy supply and conservation options, the development of data bases required by DOE to carry out their assessment of research programs, and administrative support. The assessment projects respond to needs of the Energy Research Office of Program Analysis and the Energy Research Advisory Board.

Fusion Energy (AT)

Since 1969, ORNL's fusion program has emphasized tokamaks and the technologies supporting them. Now the emphasis of the confinement program is shifting toward the study of improved closed-flux surface toroidal confinement schemes, through the Advanced Toroidal Facility (ATF, formerly ISX-C), and toward more extensive studies of the ELMO Bumpy Torus (EBT) confinement scheme through the EBT-P proof-of-principle device. Both devices should be completed in 1985–1986.

The broad-based technology program that has made significant contributions in, for example, the areas of heating, pellet fueling, superconductivity, and materials studies will continue providing support for experiments at ORNL and other laboratories. During the next five-year period emphasis on the development of radio-frequency heating will increase. The ORNL fusion budget is expected to expand largely because of the EBT-P and subcontracts, but the growth in staff numbers will be small. A strong effort will be made to obtain further involvement of industries and universities, particularly the University of Tennessee, in ORNL programs.

Elmo Bumpy Torus (AT 10 20). Because the EBT concept is to advance to the next stage of development, the present experimental program on EBT-S has been expanded. Higher-power electron cyclotron heating, using a 200-kW, cw 28-GHz Varian gyrotron, has been applied, and confinement scaling has been studied. The overall diagnostic capability is being increased. A successful collaborative program with McDonnell Douglas Astronautics Company has demonstrated the feasibility of ion cyclotron resonance heating. Studies of the integration of limiters with the EBT plasma are being undertaken with McDonnell Douglas to support the EBT-P project. Efforts to design an aspect ratio enhancement system that can be retrofitted onto the EBT-S device are continuing. A divertor has been designed by Westinghouse Corporation. The EBT-S program will continue studies in these areas until shutdown, which is anticipated to be a year prior to EBT-P operation. McDonnell Douglas has been selected to design, construct, and check out the EBT-P. The firm will also collaborate in the facility's experimental operations. In parallel development activities, a pulsed 200-kW, 60-GHz gyrotron has been operated by Varian, and a developmental superconducting magnet for EBT-P has been built and tested to full field by the ORNL superconductivity section.

Applied Plasma Physics (AT 05). The theoretical plasma physics program will continue to develop and apply theories and models of plasma behavior in both the tokamak and EBT configurations. In the tokamak area, increased emphasis will be given to refining our understanding of high-beta

tokamak stability in collaboration with the Impurity Study Experiment (ISX-B) program. In the EBT area, the efforts to model confinement will continue, and, in particular, the effects of high-core plasma beta will be studied. Efforts are increasing in the area of advanced toroidal concepts; emphasis is on the effects of externally applied helical fields.

Work continues in an applied plasma physics effort to develop advanced laser diagnostics. For example, a multichord Faraday rotation system that measures the plasma current profile on ISX-B has been developed and should begin providing data in FY 1982.

Activities pertaining to atomic physics data will continue analyzing and disseminating important data for the fusion community and, where needed, will measure cross sections of multicharged ions.

Tokamak Systems (AT 10 10). The ISX-B device continues to produce critical information for the tokamak program. High-beta studies of circular and noncircular plasmas continue, as well as parallel programs in pellet fueling, impurity studies, electron cyclotron heating, magnetic ripple effects, and diagnostic development. In FY 1982 a bundle divertor and improved diagnostics will be installed. We expect the ISX-B program to continue into 1984.

As a result of broadened interest shown by other laboratories and DOE in improving the tokamak concept, the ISX-C program and device are being modified and renamed ATF to emphasize the study of improved toroidal confinement features. Included will be studies of the effects of helical coils on stability and confinement and of the principles of steady-state operation. The ATF operation should start in 1985.

Development and Technology (AT 15). The major development activities in this area are superconducting magnets and neutral beams. The delivery of the first three coils for the Large Coil Program (two from the United States and one from Japan) is expected in mid FY 1982, and testing should begin early in FY 1983. The remaining U.S. coil and the two other international coils (from Euratom and Switzerland) should be delivered in FY 1983 and should lead to full-scale tests in FY 1984. Development work on high-field conductor and magnet designs suitable for high-field tokamak magnets will continue.

The Poloidal Divertor Experiment (PDX)/ISX-B neutral-beam development activity has been completely successful. Development in the area of long-pulse beams, in support of the MFTF-B device at Lawrence Livermore National Laboratory and ATF, has begun and will continue through 1984. Efforts in the areas of radiofrequency heating technology and negative ion-based neutral beams are expected to increase. In addition, significant work is in progress on (1) developing materials for fusion reactors, (2) developing accelerators that use solid hydrogen pellets to fuel plasma devices, (3) characterizing the plasma-wall interaction, and (4) developing techniques for calculating neutron transport in complex geometries and for checking the calculations against experimental results.

The Fusion Engineering Design Center (FEDC) has completed a preliminary design of the Fusion Engineering Device (FED) and is preparing to collaborate in expanded studies during FY 1982 and 1983. The FEDC's future role is being discussed. Design studies of the FED and of the tokamak and EBT demonstration reactors serve as a focus for the plasma physics experiments and for technology development.

Finally, a first draft of a generic environmental impact statement for magnetic fusion power systems has been prepared and will continue to be refined.

Biomedical and Environmental Research (HA 02)

This activity encompasses a broad effort to understand the interaction of energy-related pollutants with living organisms, including their transport, chemical evolution, and ultimate fate in the environment. The similarity of the environmental processes controlling the fates of many different pollutants makes a broad approach especially productive. Sedimentation and sediment transport are studied to define the principal reservoirs and vectors of pollutants; this information is being used in ongoing DOE activities to ensure that they are conducted safely and effectively and that potential hazards to humans and ecological systems can be identified, evaluated, and anticipated. One

example is the work being carried out in support of coal conversion technologies. This work is coordinated by the Life Sciences Synthetic Fuels Program (LSSFP), in which information developed in the life sciences research programs is integrated with site-specific information to assist in developing and assessing coal liquefaction and gasification technologies.

The major life sciences research programs involve (1) biological studies of carcinogenic, mutagenic, heritable, teratogenic, and toxicologic effects of physical and chemical agents associated with energy production; (2) ecological studies of the effects of energy technologies on particular ecosystems and assessments of the present and future effects of energy-related pollutants on the environment; and (3) studies of the physical, chemical, and environmental engineering aspects of problems related to the effects of hazardous wastes, including their transport and chemical evolution, and the quantitative measurement of such pollutants in biological and environmental systems.

Biological studies investigate the damage to organ systems from toxic chemicals and ionizing radiation associated with energy production, including the organic and metallic constituents of products, effluents, and their wastes. Results of these investigations will aid in estimating risks to workers in the energy industry, to other human populations, and to ecological systems exposed to materials released to the environment as a consequence of existing and developing energy production processes. This information is needed for making choices among various energy alternatives; for making decisions about modifications in the design, siting, and operation of energy technologies; and for setting exposure standards.

Physical and technological studies are relevant to problems in atmospheric chemistry and physics, to concerns about the transport and ultimate fate of energy-related pollutants, to radiation chemistry, and to the development of new principles for advanced analytical instrumentation.

A broadly based research program is needed to understand the global carbon cycle, man's influence on this cycle, and the ecological consequences of elevated atmospheric CO_2 to climate change. Key issues include the role of terrestrial vegetation in the global carbon cycle, the influence of increased atmospheric CO_2 on climate (as interpreted by past bioclimatic records), the effects of elevated CO_2 on aquatic and terrestrial ecosystems, and the need for improved global carbon cycle models. Our research program on ecobiological effects, with its assessment of acid deposition, studies the effects of these on agricultural crops and soils, freshwater ecosystems, and vegetation canopies and includes regional environmental assessments and risk analyses.

Research and inventory work on all biotic communities on the ORNL National Environmental Research Park (NERP) lands provides the basis for a computer catalog of all components with a resolution of 0.5 ha. This data base, coupled with long-term studies on the NERP, gives a unique resource from which fundamental, as well as management-related, problems in ecology can be examined. The ORNL NERP activities are coordinated within a network of five DOE-funded NERP sites.

The effects of energy technologies on water quality and the constraints of water resource on siting are key issues in our reservoir and stream freshwater ecology projects. Research includes studies on nutrient and carbon dynamics; transport, fate, and effects of toxic substances; and resource partitioning as affected by environmental stresses.

Life Sciences Research and Biomedical Applications (HB). Research at ORNL provides a foundation for understanding how various chemical and physical agents associated with energy production cause biological damage. The extent of that damage can then be measured by studying sensitive reproducible assays of it. In addition, the mechanisms by which biological damage is repaired are being investigated. A strong, fundamental biophysics research program emphasizes the mechanisms that play important roles in the interactions of pollutants in the biosphere.

The damage that chemicals and radiation cause to DNA and the mechanisms by which and extent to which this damage is repaired are also being studied. Knowledge of these processes contributes to a more thorough understanding of the molecular events that occur when carcinogens transform cells and when toxic agents (e.g., products of fossil fuel and nuclear energy technologies) damage them. Based on such understanding, we can establish broader concepts of health effects that can be more easily generalized to a wide variety of noxious agents.

Other projects seek to define the mechanisms that control the active transport of biologically important materials among cells and their environments; the regulation of various physiologic processes; the three-dimensional structure of biologically active molecules; the use of bioprocesses for energy production, waste treatment, or resource recovery; and the synthesis of structurally modified organic compounds needed for various investigations of mutagenesis and carcinogenesis. Basic research projects in ecology that investigate the mathematical and theoretical explanations of how natural systems are structured and behave when they are perturbed emphasize the uncertainty analyses, system aggregation, and hierarchy theory applied to natural systems.

The physics research program consists primarily of studies involving such basic processes as the structure and properties of materials of biological importance, the physical mechanisms that help transport pollutants through the atmosphere, and the interactions of pollutants with biological materials. The recently developed, high-powered tunable lasers are being used extensively. The scope of work includes unique applications of optical techniques to atomic and molecular physics studies and solid state and surface physics studies, to investigations of fast chemical reaction rates, and to development of advanced instrumentation for detecting a wide variety of chemical species.

The Nuclear Medicine Applications Program consists of integrated tasks that function in response to the role of DOE in promoting the beneficial applications of nuclear technology. Principal areas of interest include new radiopharmaceuticals for diagnostic procedures, which include agents for adrenal, myocardial, and brain applications. Currently the major objective is to investigate the properties of a unique class of radiolabeled, long-chain, fatty acids that have been "trapped" in the myocardium. Other areas of interest include the development and evaluation of radiolabeled, organometallic compounds for cancer therapy research. The R&D projects are complemented by active extramural collaborative efforts through the Medical Cooperative programs.

Assistant Secretary for Nuclear Energy (AE, HF, AG, AH, AP, AS, CD)

The Liquid Metal Fast Breeder Reactor

This program is adjusting to the current national trend of promoting the demonstration and commercialization of the Liquid Metal Fast Breeder Reactor (LMFBR) concept as part of a general revitalization of the nuclear industry. During this planning period, ORNL will continue its efforts in the traditional base-technology areas of materials and structures, safety, physics, and measurements and controls, but will increase its emphasis on the needs of the Clinch River Breeder Reactor Plant (CRBRP) and the Large Developmental Plant (LDP). ORNL personnel are expected to become inceasingly involved in foreign exchange arrangements in several base technology areas.

In the materials and structures area, we will continue efforts to enhance our understanding of the behavior of reference materials in LMFBR environments, to develop improved inelastic design methods, and to develop and qualify advanced materials so that they meet code standards for full and timely industrial use. Management of the Materials and Structures Technology Management Center under DOE assignment will continue, with ORNL acting as lead laboratory for the national Material and Structures Program. The physics work will concentrate on confirming and validating of shielding design methods as well as on providing and evaluating basic physics data (e.g., neutron cross sections) for specific reactor applications. In the reactor-safety area, thermal hydraulics data pertinent to the understanding and management of shutdown heat removal will be derived, using full-size simulations of portions of the LDP, and the development of safety and reliability data bases will continue. The limited measurements-and-controls effort will continue to be geared exclusively to responding to specific project needs.

This effort will also ensure that the national plan identifies all the development requirements for the total LMFBR Program. The Nuclear Standards Management Center, which is included as part of the LMFBR Program, will continue to promote the development of consensus industrial standards, augmented by special program standards as required, to ensure that the information and experience gained in all nuclear programs is documented appropriately and made available to the private sector.

Applied work in direct support of the CRBRP is expected to continue to increase in areas in which ORNL has special expertise. This direct support is in addition to the base technology efforts previously described that are relevant to the CRBRP. The category includes such tasks as developing special instrumentation, such as high-sensitivity neutron detectors; determing the properties of special materials, such as the particular concrete to be used in the CRBRP; and providing design reviews, shielding calculations, and in-residence technical support.

ORNL is also engaging in CRBR direct project support by providing hardware specification, procurement, and acceptance in selected areas. Current budget austerity, combined with the trend toward giving top priority to the CRBRP, is likely to reduce the ORNL LMFBR base and applied technology programs.

Consolidated Fuel Reprocessing

Two important areas of concern for reprocessing are the Administration's decision on civilian fuel reprocessing and the fate of the Barnwell plant. A decision to allow civilian fuel reprocessing would lend even more importance to the ORNL reprocessing program, because much of the technology being developed at the Laboratory applies to the light water reactor (LWR) reprocessing. Initial studies have indicated the possibility of modifying Barnwell to demonstrate LMFBR reprocessing with a smaller investment cost than would be required for a separate facility. The directions taken by the Administration will strongly influence the ORNL program.

Fuel reprocessing focuses mainly on uranium-plutonium fuel from the LMFBR but also includes some generic work applicable to the LWR and high-temperature gas-cooled reactor (HTGR) fuel cycles. Although much of the work is performed by the Fuel Recycle Division, recently created to provide a central repository for ORNL's experience in this area, a number of the Laboratory's R&D divisions and the UCC-ND Engineering Division participate in the program. As lead laboratory in DOE's Consolidated Fuel Reprocessing Program (CFRP), ORNL manages related efforts being conducted elsewhere in the country through the Consolidated Fuel Reprocessing Technical Management Center. Industrial participation is obtained through numerous subcontracts for systems studies and for design and fabrication of prototypical hardware systems.

Three major items currently in the prototype design and fabrication stage are a disassembly system, a fuel shearing system, and a voloxidizer system; all of these are designed for remote operation and maintenance. Completion of the first phase of the Integrated Equipment Test Facility, scheduled for late FY 1981, will permit installation of the remote operation and maintenance demonstration equipment. It is expected that following a testing period for the individual components, these systems—along with a rotary dissolver system—will begin integrated operation in FY 1984.

In a continuing cooperative effort with Hanford Engineering Development Laboratory (HEDL), ORNL is producing sol-gel particles and thermally denitrated $UPuO_2$ for the evaluation and comparison of these two candidate feed materials for advanced pellet-type fuels. The preparation of this material is an integral part of ORNL's development work for the conversion of purified uranium and plutonium solutions to oxide, a necessary step in fuel recycle. Cooperation with HEDL and Battelle Pacific Northwest Laboratories also includes systematically evaluating the various conversion processes and comparing the overall costs and benefits of each in a reprocessing plant.

The conceptual design of the Hot Experimental Facility (HEF) was completed in FY 1981. The HEF

is intended as a demonstration of the breeder reprocessing technology that can be scaled to commercial size. The design is a stand-alone 0.5-t/d reprocessing plant capable of handling LWR fuel as well as existing designs of breeder fuel. Further studies have indicated that significant cost savings may be realized by designing the demonstration plant as an add-on to an LWR reprocessing plant. Significant portions of the process would be shared, resulting in reduced overall cost. The add-on concept is now being developed in greater detail to determine its full potential prior to an actual conceptual design.

The technology to be developed and incorporated into such a design includes (1) overall mechanical and chemical flowsheets for processing advanced reactor fuels while providing high-fissile and fertile material recoveries and effective decontamination from fission products; (2) confinement techniques for positive control of routine emissions of gaseous fission products; (3) flowsheets that emphasize maximum liquid and chemical recycle and minimize waste volumes; (4) ventilation and containment systems that drastically reduce off-gas rates, thus simplifying cleanup systems and minimizing the potential for release of radionuclides in accident situations; (5) remote operating and maintenance techniques as required to adequately demonstrate facility concepts and containment systems; and (6) reliable process equipment that can be remotely operated, maintained, and scaled to commercial-plant size.

The plant design will also incorporate a multifaceted operation-maintenance concept termed *Remotex*. Remotex, currently being developed in the CFRP, is aimed at zero personnel access to the reprocessing cells. Advanced servomanipulators and television viewing equipment will be used for remote maintenance and replacement of failed process equipment. Sampling of process streams will be done by a remote automatic sample collection and delivery device. The Remotex concept will reduce personnel exposure to radiation and will increase plant availability by minimizing the time required for maintenance operations.

High-Temperature Gas-Cooled Reactor Program

For the past several years, congressional support has facilitated a continuing HTGR program in a spite of lack of administrative support. Based on this continuing program, emphasis will be on developing the cogeneration HTGR, followed by advanced systems operating at outlet coolant temperatures of up to 950°C. We will continue R&D in areas such as fuels, fission product behavior, materials, and reactor physics to provide base technology information. Where appropriate, the program will gradually be redirected toward obtaining more integral, engineering data pertinent to the HTGR licensing process and to understanding HTGR safety relative to other reactor concepts and the commercial risks. Further, we will increase our emphasis on component development and testing, centering around the component flow test loop (CFTL), but including a model test of the reference prestressed concrete reactor vessel (PCRV) and integral shielding experiments. The ORNL program will continue to provide technical guidance to the national program in specific areas and to supply unique facilities that permit the acquisition of needed technical data. Also, though the current effort is relatively small, we will continue to study the economic and technical performance of HTGRs as they apply to fossil conversion processes.

Commercial Nuclear Waste Management

The ORNL commercial nuclear waste management effort comprises a wide variety of activities under categories AP, AH, and AS. These activities include developing technology for immobilizing high-level wastes (HLW), treating uranium mill tailings, determining how best to dispose of formerly used sites, and determining the best means of transporting spent fuel. Personnel dedicated to this effort for FY 1981 total 35 FTEs, and, if funding permits, the Laboratory plans to increase this number to 45 FTEs in FY 1982 and 55 FTEs thereafter.

The Savannah River programs for developing methods of solidifying HLW (sol-gel process, coated particles, and FUETAP concrete) are expected to decrease to close-out funds in FY 1982 because only one process will be selected in the national program for large-scale engineering development in addition to vitrification. A number of programs have been identified as being possible replacements for those terminated, including development of treatments for Three Mile Island (TMI) wastes.

ORNL provides technical expertise for both the Uranium Mill Tailings Remedial Action Program (UMTRAP) and the Formerly-Utilized Sites Remedial Action Program (FUSRAP) in such areas as liner technology and waste stabilization. Though these are remedial action programs with applied orientation, in many cases, basic R&D must be undertaken to obtain practical solutions to problems.

Light Water Reactor Safety and Technology

Present DOE funding for this effort at ORNL is small. It is possible, however, that, in response to Public Law 96-567, there will be increases, starting in FY 1983, for long-range, high-risk studies not likely to be supported by industry or the Nuclear Regulatory Commission (NRC). Key elements of the DOE program would be conceptual design studies aimed at safety and operational improvements for next-generation and existing plants. It is considered that substantial reductions in risk, both real and perceived, must be achieved in both current and future plants if the important role of LWRs is to be realized.

Space Nuclear Systems

In this program, materials are developed and fabricated for use in current and future space missions and for terrestrial applications. Fabrication activities include both isotope fuel cladding, using an improved iridium alloy, and thermal insulation, using a low-density carbon composite material. In addition, this program has management responsibility for DOE's inventory of iridium at all Space Nuclear Systems Program contractor sites. Future efforts will be aimed at improving the efficiency of the fabrication processes and providing materials support as needed for the conceptual design and evaluation of future space energy systems, including fission power reactor concepts. The program will slow down after FY 1984 because there are no new planned missions.

Advanced Nuclear Systems

Nuclear Energy Assessment. Tasks in this area include economic, technical, and environmental assessments of the ability of nuclear power plants and their alternatives to supply electricity and heat. A continuing data base has been developed that characterizes the various nuclear power plant options and their fuel cycles. It is anticipated that continuing studies will focus on intermediate-term problems of LWRs. Topics to be investigated include the economics of nuclear power versus coal and the relative risks from electricity-generating plants.

Advanced Systems. In this area, for which ORNL is lead laboratory, activities in the field of cogeneration/district heating and programs on energy centers will be completed. Continuing studies will focus on small reactors for utility or cogeneration use and on siting concepts.

Assistant Secretary for Conservation and Renewable Energy

Conservation (AK, AL, EC, ED, EE, EF, EG)

The emphasis in conservation research at ORNL underwent major changes in FY 1981, to comply with programmatic guidance from DOE. Despite funding reductions, we remain convinced that efficiency is an essential element in solving energy problems. Our analysis also indicates that government research can make a unique contribution to accelerating the adoption of energy-efficient technologies. To ensure

optimal utilization of funds, we have reevaluated the need for government support in each program element. Consequently, we are proposing to initiate new work in a few areas.

The staff level for the ORNL conservation program now stands at 112 FTEs, and the expenditure rate is $34 million per year. Our projections indicate a decrease in staff size and spending rates during FY 1982 and FY 1983. In subsequent years the levels may be further decreased.

Several major conservation program areas will reach a point of logical conclusion during the next one to two years. The Annual Cycle Energy System has been developed at ORNL and has been demonstrated to be an exceptionally energy-conserving concept for the production of space-heating, space-cooling, and domestic hot water. The remaining task is to prepare and disseminate suitable technical documentation of the system design and characteristics. A number of near-commercial projects will be cancelled, thus reducing in scope both the Residential and Commercial Heat Pump Program and the Residential and Commercial Appliance Program. Future emphasis will be given to long-term projects that show promise of major improvements in efficiency.

The 50,000-gpd ANFLOW (anaerobic packed-bed bioreactor) pilot plant is in initial operation in Knoxville, Tennessee. Fifteen months of plant operation, together with supporting research at ORNL, should permit municipalities to assess the advantages of this energy-conserving concept. We hope also to find support for investigating the application of the ANFLOW concept to industrial waste streams.

Technical support to cities interested in installing district heating systems will be brought to an orderly conclusion in FY 1982. Technical assistance to states and utilities in home retrofit programs (the Residential Conservation Service) will be concluded in FY 1982. The related program on retrofit of commercial and apartment buildings, as well as the research effort known as the Innovative Retrofit Project, may continue through FY 1984. A substantial program in Buildings Energy Science (the BTESIM program) will continue at near-current levels for the next several years. This program provides the basic data needed for consensus standards and recommended building practices.

Data analysis modeling and forecasting for the Office of Vehicle and Engines R&D are expected to continue at less than half the current level. However, we will propose an additional research project to this office for the development of high-temperature materials for advanced heat engines.

Energy demand modeling and program evaluation are activities in which ORNL has taken a leading role for a number of years. We will continue to support the Office of Program Planning and Evaluation with diverse analyses of energy demand trends and evaluation of conservation and solar impacts. In addition, we will seek continued support from conservation program offices, including the Office of State and Local Programs, for evaluation of specific programs.

ORNL manages a substantial portion of the programs of the Division of Electric Energy Systems. We will continue this assignment during the planning period. However, we expect the funding to decrease somewhat during the next two years. Further development of load management systems will be left to the private sector. Research will continue on selected projects for the integration of new technologies into the power transmission grid, and R&D will also be needed on gaseous dielectrics, high-voltage ac and dc transmission, and substation equipment for the electric utility industry to meet growth projections efficiently.

Our lead mission assignment in thermal energy storage will continue as will the bulk of the long-term development projects in this area. Research will concentrate on concepts such as phase-change materials, configurations leading to thermal stratification in liquid storage systems, and characterization of domestically available ceramic materials for heat storage. We are completing arrangements with Headquarters regarding assignment to ORNL of an additional lead mission in mechanical energy storage.

In FY 1981, ORNL was given responsibility for the Materials Program in the Energy Conversion and Utilization Technology (ECUT) Program. The initial year has been largely devoted to assessment of materials technology needs for advanced conservation systems. Because the efficiencies of most energy-using processes are limited by materials considerations, there are numerous examples of urgent needs in generic materials research. If funding permits, we will develop this project into one of major importance for

the Office of the Assistant Secretary for Conservation and Renewable Energy. ORNL work on the ECUT Materials Program will complement the work we are doing for the Office of Industrial Programs on Materials for Waste Heat Utilization in industrial processes, as well as that for Buildings Energy Sciences for the Office of Buildings and Community Systems, Building Systems Division.

Solar Energy (EB)

The solar energy program at ORNL focuses primarily on laboratory and field studies on biomass production and harvesting, biotechnology, and photovoltaics. Additionally, we conduct research efforts on wind energy, passive solar structures, ocean thermal energy conversion (OTEC), and community planning for alternate energy use. Our effort in the solar energy program is expected to decline in future years as DOE cuts its funding support for solar research.

Last year under the sponsorship of the Solar Energy Research Institute (SERI), we initiated process application studies in (1) the use of lasers and ion implantation in photovoltaic (PV) cell manufacture and (2) the light-induced splitting of water using extracted green plant matter (chloroplasts). A companion study on water splitting using live algae is sponsored by the Gas Research Institute (GRI).

The Short Rotation Woody Crops Program, managed for the Biomass Energy Technology Division of DOE, consists of basic R&D in the areas of production and harvesting techniques. Nineteen universities, two USDA laboratories, a public utility, and three consulting organizations currently participate under ORNL coordination. The major activities under the program include species screening; stand establishment; cultural treatment and harvest; and collection, transport, and storage of woody materials.

We hope to continue our research on the potential use of biomass as a chemical source and to continue our role with the USDA on-farm applications program. The OTEC Program combines contract management and in-house work on the development of alternate (sea water-based) cycle concepts and evaluates heat exchanger designs for direct cycle concepts. Passive solar building studies include data collection for analysis of an earth-sheltered, passively heated structure; use of foliage in cooling structures; and the development of reflective insulating blinds.

ORNL continues to assist DOE in the technical monitoring and evaluation of PV demonstration projects. These now include facilities at Georgetown University (in the design stage); Northwest Mississippi Junior College (under construction); and Mississippi County Community College (undergoing shakedown tests). The new ORNL facility for studying atmospheric contamination effects on PVs is nearly complete; studies will begin in FY 1982, if DOE funds are available.

Geothermal Energy (AM)

Our concentrations in geothermal energy have been the development of high-efficiency heat exchangers, the problems of heat rejection from power plants, and the preparation of environmental statements and analyses. We anticipate that the activities in this program will be decreasing in future years.

Engineering R&D (AM 10). Currently, we are studying heat transfer and power conversion systems, placing emphasis on experimental and analytical work on heat rejection systems as the work relates to geothermal power plants and the direct use of geothermal heat. The thrust of our work is toward scale-up and field demonstration of enhanced condensation heat-transfer technologies developed at ORNL and analysis of the problem of water resources and cooling. This will be followed by work focused on the technology assessment and research required for selecting advanced heat rejection system components.

Environmental Control and Institutional Studies (AM 05, AM 15). Work in the Environmental Assessments Project focuses on preparing environmental assessments, environmental impact statements (EISs), and other environmental documentation for specific projects and facilities and assisting in developing and evaluating agency environmental policies associated with the DOE Geothermal programs. This effort requires ORNL to issue and manage subcontracts with industry and consulting firms.

Assistant Secretary for Fossil Energy

Fossil Energy Overview (AA, AC, CA, CH)

The Laboratory has given coal-related work a high priority, and its Fossil Energy Program offers the opportunity to integrate some elements of the work being carried out for the various parts of DOE as well as for other federal organizations. About 3.5% of the Laboratory's effort is conducted on behalf of the Assistant Secretary for Fossil Energy. Although our work in the fossil energy area grew from the beginning of the program in 1974 through 1981 (as is shown in the table below), a decrease in the range of 10 to 15% is anticipated in FY 1982.* Recovery from this decrease appears unlikely. Some specific areas in which work is being conducted are environmental control technology, materials, components, process technology, liquefaction, combustion, heat recovery, in situ coal gasification, coal preparation, process instrumentation, surface coal gasification, enhanced oil recovery, oil shale, and fossil energy information.

The staff level associated with the programs carried out for the Assistant Secretary for Fossil Energy is expected to decrease gradually after an initial drop in FY 1982, unless the Fossil Energy effort moves toward developing more basic technology. The major thrust in the ORNL Fossil Energy Program is aimed at solving fundamental problems that private industry is not motivated to invest in, though a subsequent R&D payoff for the country can be perceived. Emphasis is on materials, components, and environmental control technologies for advanced coal processing.

Our role in the fossil energy area has involved extensive contacts with industry and offers the opportunity for substantial cooperative efforts with individual companies working in the field.

Advanced Environmental Control Technology (AA 05). This area involves the development and evaluation of technology for dealing with gaseous, liquid, and solid effluents from the direct utilization of fossil fuels and from fossil fuel conversion processes. Current efforts are in flue-gas desulfurization and disposal of coal-derived solid wastes, while new work will include the chemistry and treatment of waste liquids.

Environmental acceptability and water availability are two fundamental, long-term problems faced by the expanding coal industry. Working with Morgantown Energy Technology Center, we have performed some initial research in this area, but we believe that additional advanced environmental control research is needed. The Laboratory has proposed a new initiative on this subject.

Advanced Research and Technology Development (AR&TD) (AA 15). The AR&TD program for DOE encompasses a broad spectrum of long-range activities including R&D in chemistry, materials, components, and process technology for gasification, liquefaction, and direct utilization concepts, as well as engineering and systems analysis

*The decrease caused by inflation is in addition to this anticipated reduction in funding.

Spending by ORNL for the DOE Office of Fossil Energy[a]

	'74	'75	'76	'77	'78	'79	'80	'81
Process technology	0.4	0.7	1.3	1.9	1.6	1.5	1.9	2.8
Studies and evaluations	0.1	0.4	1.3	2.8	3.8	3.7	3.5	5.1
Combustion	0	0	1.0	1.7	1.1	1.2	1.4	2.9
Environmental impacts	0	0	0	0.8	1.0	1.6	2.3	2.9
Materials	0	0	0.2	0.6	0.6	1.2	4.9[b]	7.3[b]
Total funding	0.5	1.1	3.8	7.7[c]	8.1	9.2	14.1	21.0

[a] Funding levels in millions of dollars are given by fiscal year and activity area. They include funding received indirectly through operations offices and the Energy Technology Centers as well as through funding in ORNL's own financial plan.

[b] Includes major subcontract costs for the national Fossil Energy Materials Program.

[c] Total does not equal sum of activity areas because of rounding errors.

work. Also included is modeling of fossil fuel supply sources. Current major components of this work are the management by ORNL/ORO of the AR&TD materials program as a lead lab assignment and the comprehensive comparative analyses of liquefaction technologies.

ORNL hopes to expand its components work and to continue to establish interrelationships between component design, analysis, and materials development. Also, the Laboratory expects to carry out fundamental research important to coal conversion and utilization, including heat transfer, non-Newtonian flow, and indirect pumping. In the area of coal chemistry, plans are to continue exploration of novel direct-liquefaction concepts aimed at maximizing the utilization of the hydrogen inherent in coal.

Liquefaction (AA 25). ORNL activities in the coal liquefaction area emphasize direct liquefaction through studies on coal conversion chemistry and measurement of physical properties of characteristic coal-derived liquids and slurries under process conditions. ORNL plans to sustain a significant program of research, development, and evaluation in direct and indirect liquefaction involving chemistry, process engineering, equipment, materials, and environmental and health aspects.

Combustion Systems (AA 35). Efforts in combustion systems are focused on fluidized-bed combustion (FBC) processes for coal [both atmospheric (AFBC) and pressurized (PFBC)] and on the study of systems utilizing the unique advantages of FBCs in an optimal fashion, including the assessment of equipment. These efforts include industrial and utility applications and synthetic fuel processes.

In the utility area, we are providing substantial technical support to the Tennessee Valley Authority (TVA) on the design and operation of a 20-MW(e) AFBC pilot plant and a 200-MW(e) AFBC demonstration plant. In the industrial area, a cogeneration-based AFBC system is being developed, although future funding for this facility remains in jeopardy.

Heat Engines and Heat Recovery (AA 55). Work in this area addresses the recovery and utilization of heat energy at low and high temperatures. The objective of the low-temperature heat utilization project is to explore methods and develop equipment and processes for converting heat below 93°C to productive use. Activities are grouped into five areas: conversion technology development, thermodynamic analyses, heat engines, industrial heat pumps, and thermally activated space cooling.

In Situ Coal Gasification (AA 65). ORNL provides technical assistance to DOE in the review and assessment of underground coal gasification (UCG) technology and commercial potential. We would hope to resume Laboratory R&D support activities which were previously terminated.

Mines R&D (AA 75). Coal preparation activities concentrate on the magnetic beneficiation of fine coal and the process modeling of conventional coal preparation plants. Experimental development on magnetic beneficiation of dry coal has been carried out using high-gradient magnetic separation (HGMS) and open-gradient magnetic separation (OGMS). Although there is an indication that work in this area will be discontinued by DOE, it remains an area where substantial economic and resource conservation gains could eventually result from R&D activities and is an area of interest to TVA. Development and design efforts supported by TVA will continue and will be directed toward an HGMS pilot plant for the TVA Paradise, Kentucky, site.

Some modeling of coal preparation plants was carried out with TVA funding during the past year, and expanded work is planned to complete and verify the model and then to apply it to specific problems.

A program on coal preparation plant automation was initiated during FY 1980 and terminated by DOE in FY 1981 after the completion of a state-of-the-art assessment and a preliminary study of potential economic benefits.

Surface Coal Gasification (AA 85). Historically, ORNL's involvement in this area has emphasized environmental considerations and evaluation of gasification in indirect liquefaction processes, but major efforts are being developed in regard to both materials and components for gasification systems. It is expected that ORNL will continue to provide technical management for the materials work under the ORO/ORNL lead role in Fossil Energy Materials and will contribute to the assessment and development of component technology. Research will emphasize pressure vessel materials; pressure vessel fabrication; nondestructive testing; slurry pumps; and dirty gas heat exchangers, expanders, and compressors.

The EIS effort, as such, has been concluded; but additional work in the area of environmental effects is expected.

Enhanced Oil Recovery (AC 15). Most of our efforts are directed toward the micellar flood approach to oil recovery and involve work to produce chemicals, to determine ion exchange characteristics for typical formations, and to select multiple tracers. We anticipate that a small effort will be maintained in this area.

Oil Shale (AC 20). ORNL's involvement in an eastern shale program is consistent with current expertise and regional interests. No activities are currently funded by DOE/Fossil Energy, but work has been proposed for developing new technology for oil recovery, metal resource recovery, environmental impact assessment and control, and waste management.

Assistant Secretary for Defense Programs

Defense Nuclear Waste Management (AR)

The ORNL defense nuclear waste management effort includes two categories of work: management of wastes generated at ORNL and development of technology in areas of ORNL expertise. The total FY 1981 effort under category AR is 100 FTEs.

The ORNL Waste Management Operations Program supports the operations, process development, and engineering efforts required for successful management of ORNL-produced radioactive wastes—both those currently generated wastes and those generated by previous programs, dating back to 1943. The program's long-term objective is to ensure that new technology and improved facilities will enable compliance with future regulations. Many of ORNL's waste management facilities were constructed in the 1940s and early 1950s and are now being extensively improved. Projects that have been completed—costing a total of $20 million—include the Process Waste Treatment Plant, Intermediate-Level Waste (ILW) Facility Modifications, and the New Hydrofracture Facility. A funded project of major expense currently under way is the removal and disposal of sludge from the Gunite tanks. Other projects in various stages of design, with a combined estimated cost of about $60 million, include the Radioactive Waste Facilities Improvement Project, a metal smelting facility, and a waste tanks project. Plans also include the expenditure of considerable general plant project (GPP) funds for facility improvements. A long-range plan to help guide the development of a strategy for ORNL radioactive waste management over the next ten years will be completed late in FY 1981. Decontamination and decommissioning will become an increasingly important part of the future effort.

In the category of waste management technology, ORNL has been designated as the associate lead laboratory in support of ORO in the execution of the National Low-Level Waste Management Program. Although ORNL is involved in almost all of the various program components for the Office of Nuclear Waste Management, its work focuses on technological activities, especially in the areas of waste processing and disposal of low-level wastes. One such activity is the demonstration of an instrumentation system for assaying transuranic wastes. ORNL also has a lead role for preparation of an integrated data base on which national waste management planning and analysis can be done by DOE Headquarters and lead field offices.

^{233}U Program (GE 03)

The ORNL ^{233}U Program encompasses two tasks. The first is routine operation of the ^{233}U National Repository in order to supply various experimenters in the United States and abroad with ^{233}U (as directed by DOE through ORO) and to recover ^{233}U from scrap generated by these experimenters. The effort for repository operation is expected to remain steady during the next five years. The second task is the design and fabrication or procurement of equipment for the installation and operation of a facility capable of converting 1000 kg of uranium from a liquid to an inert solid, which would ameliorate a potentially hazardous situation. This work is being carried out under the auspices of the Consolidated Edison Uranium Solidification Program (CEUSP).

The specific objective of CEUSP is to design and install in an existing process cell equipment that will enable conversion of the uranium to a solid, beginning in FY 1984. The program schedule proposes a peak

in the engineering effort in FY 1981, a sizable fabrication effort in FY 1982, installation of equipment in FY 1983, and completion of facility operation in FY 1986.

Nuclear Materials Security and Safeguards (GD 01)

In the Laboratory's single task included in this activity, we are developing improved methodology for isotopic analysis, which is the foundation of nuclear safeguards. Ongoing R&D is being carried out to improve the mass spectrometric isotopic analyses of elements of interest to safeguards (i.e., uranium, plutonium, and thorium). Applications of various analytical techniques are being explored to verify inventories of nuclear materials by employing improved mass measurements that can furnish tank volume calibrations as well as total fissile inventory. A quadrupole mass spectrometer and associated equipment for use as an onsite analytical system have been procured and are currently undergoing field trials. Transfer of the technology to other installations will be effected at the request of the Office of Safeguards and Security. We will continue to evaluate the micro techniques as an archival storage device and to explore the application of resin-bead technology to the full fuel cycle.

Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness

Overview and Assessment (HA 01)

ORNL provides technical support to DOE environmental assessments and assistance in DOE compliance with the National Environmental Policy Act (NEPA) and other environmental statutes and regulations. To promote accurate, complete, and timely compliance of DOE programs, ORNL is (1) preparing additional technology-specific guidance documents to supplement previously prepared environmental report guidelines and procurement guidelines; (2) revising and updating previously prepared environmental guidelines as experience indicates is necessary; (3) providing technical assistance to DOE on environmental matters related to DOE's role in cooperative interagency responsibilities; (4) providing technical assistance to DOE in the preparation of environmental guidelines or regulations which implement new legislation or executive orders; and (5) conducting the Remedial Action Survey and Certification Activities (RASCA) program in support of three DOE remedial action programs. ORNL research involves (1) data analysis with recommendations for immediate improvements in existing economic, energy, and environmental assessment capabilities; (2) development of new risk analysis methodology; and (3) development of new modeling approaches to address important economic, energy, environmental, and health issues.

Laboratory-scale work provides the initial information needed to develop and evaluate the feasibility of alternative control technologies for application to coal conversion processes. Investigations are (1) evaluating the applicability of known control technologies (biological degradation, ozonation, adsorption, and wet oxidation) to coal conversion wastewaters; (2) identifying the toxic components of solid wastes from coal conversion processes and wastewaters; (3) evaluating the importance of various environmental parameters in mobilizing these toxic compounds; (4) assessing the ability of present technology to convert various sludges to stable form; and (5) evaluating alernatives to aqueous scrubbing for particulate removal. Onsite investigations are obtaining information on the performance of control technologies as the technologies are applied to large-scale fossil fuel facilities.

Technical support for planning for energy curtailments will expand and build upon past analysis and assessment capabilities. Work will include energy supply and demand analysis, contingency scenario analysis, support to the Strategic Petroleum Reserve, analysis of electric utility pooling and productivity improvement, and related work. ORNL will continue studies of coordinated planning for electric utility pooling and productivity improvement, which will also provide input for emergency planning. Technical support for dealing with radiological emergencies will continue and will be integrated with other emergency planning.

Energy Information Administration (EIA) (TA, TB, TC, TD)

To help meet the needs of energy policymakers for reliable and credible information, ORNL provides both

research and management support for EIA. The ORNL program consists of evaluation, assembly, and analysis of data and information relevant to energy (e.g., resource reserves, production, supply, demand, and technology). Related statistical and economic research is also provided. This research focuses on the adequacy of and requirements for information to meet national and regional/state analysis and planning needs in the future, both near and long term. Support activities, provided to each office within the EIA, include work in areas where DOE and the Laboratory have both interest and experience (e.g., research and analysis of energy import/export and consumption data, energy modeling, data and model validation, energy resource estimation, utilization and conservation, and fundamental aspects of scientific measurement, information processing, and analysis).

The ORNL role and future direction focus upon satisfying EIA needs for reliable and accurate data on energy use and related information and rigorous and credible methods for policy oriented data analysis and forecasting. By priority, elements of this role emphasize data and include analysis of present and future data needs, data validation, research and data validation techniques, development of rigorous and well-documented energy forecasting and policy analysis models and methods, model assessment, and evaluation research in model evaluation techniques.

ORNL conducts a lead laboratory mission in data quality assessment. This mission includes the development and demonstration of techniques for improving data quality as well as techniques for improving the quality of data use. Laboratory-developed techniques have led to improved characterization of data requirements and to improved precision and usefulness from data collection systems. ORNL research has contributed to innovative, flexible, and efficient methods of data handling and data storage, and analysis projects have produced definitive paradigms for data compilation as well as authoritative assessments of assorted technical issues. Interest is continuing in the application of these assessment tools to a broader context. Though this interest embraces both the extension and codification of methodology and the generalization of results to data settings outside the energy arena, the development of viable assessment tools for use with energy models remains a major thrust. Topical concern continues to cover all commodity, sector, and regional aspects of energy supply data and energy demand data, but concern is expanding to cover situational determinants (e.g., economic factors, transportation capability capacities, and international supply and demand) and data needs for crisis management and contingency planning.

This work is pursued through a balanced application of resources from within and from outside the Laboratory. Using both the Laboratory's research skills and its project management skills, teams of involved individuals working on specific issues are led to produce timely, relevant results.

Work for Others

Nuclear Regulatory Commission

The NRC sponsors about 8% of the total work at ORNL. This level of effort has held steady for the past few years, although the specific breakdown of the work has changed. The major thrust of the NRC work consists of reactor safety research and analysis in areas where ORNL has proven technical capabilities. These areas include fission product technology, instrumentation, solid mechanics, thermal hydraulics, heat transfer, fuel and cladding behavior, and materials technology. In addition, substantial support has been given to NRC in the area of radiation dose and health effects as related to human health and the environment.

The present NRC programs are changing significantly. Experimental efforts for several older programs that are concerned with the design basis loss-of-coolant accident are being completed, and new work in other areas has begun. The Blowdown Heat Transfer Program and the International 3D (Three-dimensional) Refill and Reflood Test Program were funded in FY 1980 at $10 million. In FY 1982 the level of funding will be less than $2 million. Although the number of research programs has grown, the trend has been toward smaller, analytical programs; thus, the collective growth of the NRC work has been surpassed by the decline of these major programs. The overall level of NRC programs is expected to remain constant throughout the planning period. It is also anticipated that the breakdown of the various key activities for NRC will remain essentially as shown for FY 1982 in the following table.

NRC Programs Summary[a]

	'81	'82	'83	'84	'85	'86	'87
Office of Nuclear Regulatory Research	26,602	18,600	21,280	22,200	22,200	22,200	22,200
Office of Nuclear Reactor Regulation	3,523	2,400	2,600	2,600	2,600	2,600	2,600
Office of Administration	475	460	500	600	600	600	600
Office of Nuclear Material Safety and Safeguards	2,375	1,969	1,925	2,000	2,000	2,000	2,000
Office of Analysis and Evaluation of Operational Data	744	1,460	1,480	1,600	1,600	1,600	1,600
Other Offices	52	100	55	60	60	60	60
Total	33,904	24,989	27,835	29,060	29,060	29,060	29,060

[a]Total operating costs under budget authority (BA) given in thousands of dollars.

Many new and challenging programs have resulted from NRC's analysis of the events surrounding the TMI accident. This work includes analysis of severe accident sequences, operational experience, man/machine interactions, human factors, containment performance, fission product release and transport, core melt, and advanced instrumentation and diagnostics. A significant increase has occurred in the activities related to the analysis of operating data, including licensee event reports, to determine those effects that may lead to significant accidents. A significant increase in the emphasis on risk assessment in ORNL programs has also occurred. These new programs are being accomplished through reallocation of staff and judicious selection of supporting subcontractors.

The future direction of NRC programs for the planning period is difficult to detail because of the lack of a well-established national plan for nuclear technology and because of the delays that currently exist in the nuclear reactor industry. However, ORNL is actively pursuing the development of programs based on both the experience gained from the TMI accident and the projected needs for the future. This pursuit involves work related to the corrective and mitigative measures that can be taken to prevent severe accidents in either existing or future reactors. The extent to which NRC will fund analytical efforts related to design improvement remains uncertain. Undoubtedly, there will be some involvement in establishing improved systems standards for new plants. It is expected that ORNL will use its expertise in support of LMFBR safety research and in support of environmental and technical assessments needed for licensing fuel cycle facilities. It is also expected that ORNL expertise in waste management can be utilized for confirmatory research related to long-term disposal of high-level and low-level waste.

There seems to be an NRC trend toward a more extensive use of DOE national laboratories as staff extensions to solve those challenging, difficult, short-range problems related to certain policy areas. The Laboratory must judiciously select from among these the tasks in which it will become involved. Traditionally, NRC programs have produced useful, timely results, both for research and for assessment problems. We feel that the work at ORNL and at the other DOE laboratories fills an urgent need for the combination of technical capability and objectivity required by NRC.

U.S. Department of Defense

As part of its assistance to the U.S. Department of Defense (DOD), ORNL performs research for the U.S. Army, U.S. Navy, U.S. Air Force, and the Defense Nuclear Agency. The largest part of that research is done for the U.S. Army and involves physical and chemical characterization of military occupational exposure. Currently, we are studying the physical and chemical properties of diesel fuel and of

white phosphorus-based military obscurants. We have developed laboratory-scale generators to produce materials for biological study so that the properties of the aerosols thus produced can be compared with those properties generated under actual field conditions. In addition, sampling, monitoring, and analytical methods are being developed and applied to studies of the influence of operating parameters and environmental effects on the properties of the aerosols. In related work, we are purifying munitions compounds and marker dyes for biological testing after first identifying their respective impurities using spectroscopic and chromatographic methods.

The Laboratory collaborates with the U.S. Army Corps of Engineers on several studies along the Mississippi and Ohio River basins. These studies include aid with research design, field work involving research and monitoring, research-data management, and synthesis and reporting.

ORNL has long had a support program for the Defense Nuclear Agency, which has provided tools for calculating the transport of weapons radiations through the atmosphere and through structures of interest. Now that these tools are largely available, the major activity is to keep operational the analysis methods and input data and make them available to military users throughout the country. Specific analyses of particularly difficult radiation-shielding problems are sometimes carried out for the Defense Nuclear Agency.

Other Federal Agencies

Life Sciences Work

About one-third of the support for our life sciences programs comes from agencies other than DOE. Major benefits accrue directly to work supported by the Assistant Secretary for Energy Research (ASER) as a result of our involvement with work for other agencies, some of which has resulted from interagency planning efforts. In addition to providing support for portions of the basic life sciences programs, a large fraction of the work funded in this manner is directly complementary with programs conducted for the ASER. Because all the work is performed in the same general locations within laboratories, there is a close interaction among staff as well as a continuing exchange of scientific information. These non-DOE-supported programs assist us in maintaining a healthy mix of basic and applied work, but increasingly more of the non-DOE-supported work is applied research rather than basic research.

Environmental Protection Agency. With the support of the Environmental Protection Agency (EPA), we are exploring the areas of toxic effects of pollutants associated with energy production processes and waste disposal. Other efforts include radiation dosimetry, epidemiology, and information systems support to EPA. The evaluation of regional economic-forecasting models points toward the development of a model specifically designed to meet EPA needs.

Administrative management, coordination, and information support are provided to the EPA GeneTox Program to aid evaluation of mutagenicity bioassay systems. Funded under the same interagency agreement are projects involving information assessment in the area of toxicity-testing methods and quantitative mutagenicity testing of specific chemicals. Other efforts include the development of a solid waste extraction protocol for classification of toxic wastes, a chemical-scoring method to be used in screening the EPA chemical inventory, and development of the first comprehensive data system on chemicals identified in human tissues.

Several key accomplishments in EPA-funded work have been initiated, including application of existing multimedia transport models for Toxic Substances Control Act (TSCA) assessments and development and implementation of methods for use in assessing compliance with the Clean Air Act. In 1982 and 1983, we expect to develop new ecological test procedures for TSCA and new multimedia transport models for assessments and to initiate experimental field studies in order to confirm and validate test methods and transport models. New work is the examination of the alternative methodologies suitable for environmental risk analyses and the critical ecological criteria to use in quantitative analyses.

Department of Health and Human Services. The major efforts supported by the National Institutes of Health (NIH) are in the research areas of carcinogenesis, genetics, and toxicology. The subjects of studies supported by the National Institute of Environ-

mental Health Sciences (NIEHS) include toxicity of particulates and inorganic materials and the multistep nature of neoplastic transformation. We have initiated expanded research activities with NIEHS in the area of mammalian genetics. Several activities funded by the National Library of Medicine and the National Toxicology Program encompass the development of computerized data files in the areas of toxicology, mutagenesis, and teratogenesis.

Researchers in ORNL's Biology Division are studying mechanisms of chemical carcinogenesis and the dynamics of neoplastic development for the National Cancer Institute. Mechanisms being studied include transcription, transformation, gene expression, tumor promotion, and DNA repair. Potential carcinogens being studied are chemicals and uv light.

Researchers in the Health and Safety Research Division are studying the development of radiolabeled fatty acids for subsequent investigations into myocardial metabolism.

Of further concern to the Laboratory is the pressure to convert from contract work to grants. For large program elements it is far easier to manage R&D by contract. We welcome the peer review process and propose the retention of the contract arrangement with the addition of peer reviews.

National Science Foundation. The major goals of our work for the National Science Foundation are the following: (1) to perform ecosystem analysis studies including the further development of systems theory in ecology, the study of nutrient and carbon dynamics in streams and reservoirs, and the development of advanced ecosystem simulation models; (2) to study the ecological, climatic, and paleoclimatic factors associated with atmospheric CO_2; and (3) to operate and imporve a small-angle neutron-scattering facility. Key goals include completion of studies on material spiraling in stream ecosystems and addressing similar hypotheses in reservoir ecosystems—1984, completion of a disaggregated model of the global carbon cycle—1982, and development of climate-vegetation relationships for the CO_2 model—1985.

Others. Other agencies from which we receive support in the life sciences area are the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the Food and Drug Administration, the U.S. Department of Agriculture, the U.S. Department of the Interior's (DOI's) Fish and Wildlife Service, and the Consumer Products Safety Commission.

The Electric Power Research Institute (EPRI) supports programs in the life sciences in coal combustion, acid rain, ash characterization, and nonnuclear waste management. The institute is supporting a project to determine the environmental variables that promote high densities of Legionnaires' Disease bacterium.

We shall continue to emphasize joint cooperative programs with TVA in various environmental areas, including studies of fish populations; the fouling clam, *Corbicula*; water quality; instream flow needs below dams; effects of strip-mining on streams; coal gasification; and instrument development.

Department of the Interior

Our work with the Office of Surface Mining (OSM) to design and implement a national inventory of abandoned coal mine problems will continue. As the OSM level of effort declines, however, work for other branches of DOI is anticipated to rise as some former DOE functions are transferred to DOI. These include work for the U.S. Geological Survey to develop a computerized geographic and geologic information system and work with the Bureau of Land Management to develop models to support coal-leasing activities. Other anticipated DOI work includes analysis and evaluation of water/energy resource conflicts, evaluation of energy and minerals resource potential, and evaluation of wilderness area/resource development conflicts.

Other Agencies

When work demands the special capabilities of the Laboratory, we also undertake research for other non-DOE sponsors in the areas of impact, technology, and policy assessments. For example, we currently have small programs for the Federal Emergency Management Agency and the Rural Electrification Administration of the U.S. Department of Agriculture. ORNL will put its expertise in transportation energy research to work for the Department of Transportation for the first time in FY 1982 when the Laboratory begins data-analysis forecasting and vehicle testing.

Nonfederal Organizations

The Laboratory also receives a small amount of funding from nonfederal organizations that rely on ORNL's unique facilities and expertise (e.g., EPRI). All programs sponsored by nonfederal organizations require DOE approval before being undertaken by the Laboratory.

New Initiatives

The process of proposing new initiatives to DOE has allowed ORNL to identify and pursue important new areas of R&D in which we can make significant contributions. As a result, several of our past new initiatives have now grown into strong research endeavors at the Laboratory, including

- biotechnology development,
- coal chemistry,
- energy risk assessment,
- environmental studies on coal conversion,
- high-level waste isolation,
- high-temperature materials,
- instrumentation for fission energy systems,
- Materials and Structures Technology Center,
- materials for fossil energy systems,
- National Environmental Research Park, and
- toxicology.

Although some past new initiatives have failed to materialize in any meaningful way because of a variety of circumstances, we find that the new initiative process is a useful means to highlight important areas of research that otherwise might not receive proper attention.

Engineering Science Center

Research in engineering science is needed to advance energy technology development because basic engineering information in many technologies is inadequate to meet important national energy goals. Futhermore, substantial savings would result from improved engineering that would come from improved understanding, more and better data, and models made possible through research in engineering science. Technological achievements would be more feasible, safer, and more efficient because of the knowledge resulting from such research.

To address this need for research in engineering science, we developed a specific proposal* in December 1980 (which is now at DOE) to create an engineering science center at ORNL for conducting research in the areas of transport phenomena and mechanics of solids (under the general title of Continuum Mechanics). The scope of the center would include fluid dynamics, heat transfer, mass transfer, and solid mechanics, and proposed research topics would include theoretical investigations, computational investigations, experimental activities, and the development of improved instrumentation. Research activities at the proposed center will be directed toward the following objectives:

- developing a base of fundamental knowledge in such areas as mass transfer in multiphase mixtures and across interfaces;
- reducing dependence on empiricism through research investigations in areas such as cryogenic, high-temperature, and interfacial heat transfer;
- eliminating the overdesign of components (e.g., in the design of fusion reactors); and
- providing timely transfer of basic research results to energy technology development efforts.

Anticipated results will have applications to fossil energy, conservation, nuclear, solar energy, and fusion energy technologies and to natural resource and environmental assessment.

Creating such a national center for engineering sciences at ORNL, which has both strong interdisciplinary science programs and large technology development programs, is an efficient and cost-effective way to provide the needed engineering research. This center would perform long-term research which industry does not undertake and for which universities lack resources and structure.

*This document, *Proposal for an Engineering Science Center on Continuum Mechanics—Transport and Mechanics of Solids—at Oak Ridge National Laboratory* (February 28, 1981), is available on request.

ORNL is perhaps uniquely qualified to organize an engineering science center that would concentrate on research in transport phenomena and solid mechanics because the Laboratory has a long history of technology development that has required engineering science input, particularly in these areas. Development activities have included (1) R&D in the nuclear fuel cycle, culminating in a major national program to develop processes for and the design of a major hot demonstration of a fuel reprocessing facility for LMFBR spent fuel; (2) the design, construction, and testing of six nuclear reactors; (3) process development in coal conversion; (4) construction of major development facilities for use in fossil and nuclear energy programs (e.g., a fluidized-bed used in studying coal combustion and flue-gas treatment, and a blow-down heat transfer facility for use in nuclear reactor safety R&D); and (5) increasing roles in nuclear reactor safety, environmental control technology, and conservation.

Research activities at the center will be directed toward basic studies in continuum mechanics which require specialized facilities and a broad range of technical expertise. The proposed center would be physically dispersed but centrally funded and managed—much as existing programs are now—in a matrix structure. This center would serve as a focal point for collaborative efforts among researchers from government, industry, and the academic community and would provide opportunities for research that is beyond the scope of individual institutions. To promote a maximum interaction with the industrial sector, management activities at the Center would

- organize workshops involving industry and universities to present results and discuss research priorities,
- establish a visiting scientist program to allow researchers from industry and universities to work at the center, and
- provide for the publication of the major results of the center's research activities in the open literature.

Resource projections for the proposed engineering science center[a]

	'83	'84	'85	'86	'87
Operating cost	1.0	1.4	2.5	3.5	5.0
Direct FTE	10	14	25	35	48

[a]Funding for FY 1983 is in millions of current dollars and reflects a 10% escalation factor from FY 1981 to FY 1982 and from FY 1982 to FY 1983. Funding for FY 1984 through FY 1987 is in millions of constant 1983 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Strategic Materials for Energy

Potential shortages of strategic materials, especially metals critical to energy production or energy conservation, threaten serious problems for both the domestic and world economy. Of particular concern is our increasing dependence on foreign suppliers for these materials. New domestic supplies of these minerals are potentially available from unconventional sources. In the future, the United States may experience domestic supply problems for such critical energy-production metals as uranium, thorium, tungsten, and platinum. Other metals such as aluminum and chromium, both of which are critical to our economy, are already predominantly imported.

We propose that ORNL play a major role in developing and implementing a multidisciplinary research program directed toward the identification and solution of long-range resource problems. Activities would range from basic geologic characterization of resources to economic analysis, to development of processing technology, and to substitution analysis. Such a program would focus on efficiently recovering fuel materials and metals critical to energy production or conservation from unconventional sources, such as low-grade ores, waste substances, or eastern shales. Several current research efforts (e.g., exploratory assessment of Chattanooga shale as a potential source of oil, uranium, and strategic metals; recovery of

uranium from low-grade ore; and resource recovery from fly ash and coal combustion residues) would be unified.

For example, if the small, exploratory assessment of Chattanooga shale confirms that the coproduction of metals with oil is economically feasible, this project would be expanded. In addition to the present field testing of the Chattanooga shale for its hydrocarbon potential, geologists would study the mechanisms by which the trace metals are incorporated in the shale, the relationships between metal concentration and depositional environment, and the behavior of the trace metals during changes in temperature and pressure. The metal resource potential of the black shales can be fully assessed only if knowledge of metal distributions is available and if relationships between abundance and depositional environment can be established. Based on such information, predictive tools for resource evaluation can be fashioned. In addition, the environmental and health impacts would be assessed to ensure the timely and environmentally acceptable use of the eastern shales.

Another emphasis would be on recovering useful metals trom the solid waste residues of energy processes (e.g., coal combustion fly ash, coal conversion solid residues, mill tailings, and oil shale residues). Extraction concepts and product purification processes would be developed to recover metals such as aluminum, iron, and titanium as well as chromium and various trace metals and to remove potential leachable pollutants so that the resulting solid waste could be disposed of economically.

Considerable expertise exists within ORNL that could be directed toward a study of long-range resource problems. Much of the Laboratory's reputation is built on excellence in

- chemical processing techniques,
- materials processing techniques,
- geologic research,
- environmental research on effects of technology and industry, and
- expertise in economic analysis relevant to resource problems.

Past experience in dealing with massive technical problems through the use of a large staff of diverse skills makes ORNL well suited to play a major role in offering solutions to future resource problems.

The research projects at ORNL in this area are now supported on an individual basis by various sources (e.g., DOE, EPA, and DOI) when the scope of the project complements existing goals of the respective agency. However, a coordinated, central funding source for long-range research applied to this truly national need is necessary to counter the potential shortages of strategic materials, especially metals (such as chromium, cobalt, platinum, and other 100%-imported materials) that are critical to energy production or energy conservation. A shortage of these materials would threaten both the domestic and world economy. These projects are important not only for energy production considerations but also for energy consumption. The mere extension of present technology to our more dilute sources (when possible at all) generally entails large increases in losses and a much greater energy consumption per unit of material produced. It is essential that new techniques be developed to process these resources in an energy-efficient manner. Addressing the research needs in strategic materials may be one of the most important contributions DOE can make to energy research.

Resource projections for strategic materials[a]

	'83	'84	'85	'86	'87
Operating cost	0.8	1.0	1.2	1.2	1.5
Direct FTE	8	10	12	12	15

[a]Funding for FY 1983 is in millions of current dollars and reflects a 10% escalation factor from FY 1981 to FY 1982 and from FY 1982 to FY 1983. Funding for FY 1984 through FY 1987 is in millions of constant 1983 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Environmental Control Technology

An integrated environmental control technology program is necessary to ensure that emerging coal conversion technologies and potentially important oil shale technologies are environmentally acceptable and impose no adverse health effects. Real deficiencies now exist in the application of control technologies to these new coal conversion processes. Because the coal conversion industry is at a developmental stage, data on the characteristics of the output streams are not

available. Consequently, the information needed to design efficient control systems is also unavailable. In addition, the industry historically has not concentrated on a coordinated, long-term approach to environmental control; instead, it has merely added on the minimum amount of control technology needed to meet permit requirements, with little consideration of the integration of the process and the controls or of obtaining data for future control development.

ORNL is currently proposing to accelerate the initiative it is taking in the area of environmental control technology to answer this need. New R&D is being proposed at all levels, including (1) performing basic research in analytically characterizing effluents from plants and in bioassaying the toxicity and mutagenicity of these effluents; (2) developing advanced control processes; (3) developing and demonstrating pilot treatment systems; and (4) monitoring and assessing (including both economic and technical assessments) full-scale treatment systems at demonstration and commercial sites. Finally, ORNL will explore its possible role in integrating and coordinating large national programs for DOE.

As a natural extension of its strong historical involvement in the management and treatment of radioactive wastes, ORNL has developed a significant generic capability in environmental control technology, both through several specific R&D projects that addressed the needs of a wide variety of industries and through the establishment of related basic environmental sciences programs. These R&D projects have included the design, development, and operation of pilot-scale biodenitrification processes for wastewater treatment at the DOE facilities in Portsmouth, Ohio (a gaseous diffusion plant operated by Goodyear Atomic Corporation, 25 m^3/d) and in Cincinnati, Ohio (a feed material processing center operated by National Lead of Ohio, 160 m^3/d). Other large-scale experimental projects have included the development and demonstration of advanced, energy-conserving treatment systems for municipal wastewater (with Oak Ridge, Tennessee, and the Norton Chemical Company, 19 m^3/d, and with Knoxville, Tennessee, and Glitsch, Inc., 190 m^3/d). ORNL is now developing an advanced wastewater treatment pilot plant (5.5 m^3/d) for the treatment of wastewaters generated during coal conversion processes. This plant will initially be used for R&D purposes at the H-Coal demonstration plant in Catlettsburg, Kentucky. Other ongoing experimental projects include development of solid waste (biological sludges and gasification ash/slag) treatment processes and disposal options, especially with respect to the Resource Conservation and Recovery Act (RCRA); development of control technologies for gaseous effluents (e.g., fluegas desulfurization with the TVA, NO_x scrubbing, $^{14}CO_2$ sorption, cryogenic stripping of tritium, and catalytic incineration of carbon monoxide and hydrocarbons); and the assessment of bioassays of the toxicity and mutagenicity of raw and treated waters and sludges.

Such projects have provided support for a strong initiative on ORNL's part to be a national leader in ensuring the health and environmental acceptability of coal conversion technologies as well as those associated with oil shale and advanced combustion. It is also anticipated that such an initiative would encompass existing and developing environmental control processes for nuclear fission and fusion technologies. This initiative represents an integration of considerable expertise in experimental R&D with nationally recognized programs in technology assessment and monitoring. These programs have historically included EISs for the NRC on nuclear power plant siting and have recently expanded to encompass the requirements of DOE Fossil Energy for 6 EISs for synthetic fuels demonstration plants (Memphis Industrial Gas, Grace Industrial Fuel Gas, SRC-I, SRC-II, ICGG, and Conoco). The execution of the DOE EIS work involved the commitment of a 25 man-year effort by ORNL. ORNL has also been a key participant in the health and environmental monitoring and assessment programs conducted by DOE as part of its Gasifiers in Industry Program (at the University of Minnesota, Duluth) and as part of its H-Coal project.

ORNL has developed strong capabilities in process analysis and economic assessment, which have led to a generic understanding of liquefaction and gasification technology, including an understanding of environmental control technology needs and requirements. ORNL's work is currently being directed toward a variety of problems, including assessing the

environmental controls for low-Btu gasification and determining the environmental control costs for indirect coal liquefaction processes.

Resource Projections for environmental control technology[a]

	'81	'82	'83	'84	'85	'86	'87
Operating cost	0.3	1.8	5.0	7.0	10.0	12.0	15.0
Direct FTE	3	15	40	50	60	68	75

[a]Funding for FY 1981 through FY 1983 is in millions of current dollars and reflects a 10% escalation factor from FY 1981 to FY 1982 and from FY 1982 to FY 1983. Funding for FY 1984 through FY 1987 is in millions of constant 1983 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Hazardous Waste Technology

Hazardous materials, as defined and regulated by the EPA in RCRA, and low-level radioactive (LLR) waste, as defined and regulated by NRC, have similar waste management traits. Both are exposure hazards to the public and are persistant in the environment for long periods of time. In addition, both are political issues with a high public awareness and concern. It is, therefore, essential that ORNL have an effective program for managing these wastes.

Until recently, the ultimate disposal method of hazardous and LLR wastes was shallow land burial in unlined trenches. With the advent of RCRA and NRC-proposed regulations, it became evident that more stringent waste management requirements would be imposed. Stringent requirements were recommended for permeabilities and other geologic parameters for hazardous waste disposal. Engineered barriers and leachate collection systems were proposed where site conditions did not conform. The method of pathways analysis to identify and evaluate potential exposure routes for LLR waste disposal facilities was proposed by NRC. Hydrologic studies at ORNL have shown that water movement, and thereby waste movement, is frequently through fracture-flow systems. Previously, porous-flow systems were assumed to be the predominant method of water movement. Because present-day mathematical models are based on porous flow, new models are being formulated at ORNL to include fracture-flow systems. For both hazardous and LLR wastes, the primary goal is to protect the public and the environment from exposure to the materials of concern by providing long-term isolation. Facility designs to provide positive containment will, therefore, be similar.

The toxicity extraction procedure used by EPA to classify nonnuclear solid wastes as hazardous or nonhazardous under RCRA is being evaluated and modified at ORNL to include capabilities to extract organic compounds. An alternate extraction procedure is also being developed for EPA which simulates the leaching of an industrial waste deposited in a municipal waste landfill and which can be used in aquatic and phytotoxicity testing protocols. Another area of study is the action of microorganisms on waste, particularly fossil-fuel-derived waste. Acidic leachates result from microorganisms attacking such wastes containing sulfur and iron. The acid condition favors leachability of formerly fixed ions and hinders the absorption properties of the soil. Several mitigating actions are being tested.

An expanded geoscience research group has contributed to waste management practices by providing (1) predictive capabilities related to the hydrologic circuit, mineral reactions, rock fracture patterns, and trace element transport; (2) information for preventing or minimizing potential adverse effects resulting from man's actions; and (3) methodologies for mitigating or correcting existing undesirable conditions. Geological studies include the mineralogy and geochemistry of waste interactions with elements such as Cd, As, Ba, Cr, Pb, Hg, Se, and Ag. One example of these geological studies in the area of fossil-fuel-derived waste is the study of arsenic absorption that is dependent upon valence state. Depending upon coal combustion conditions, two valence states—arsenates (AsO_3) and arsenic oxides (As_2O_3)—are formed. Arsenates are not absorbed by soil, whereas arsenic oxides become part of the soil matrix material.

As a result of the regulatory framework imposed, ORNL has initiated several actions to address the waste management problems associated with hazardous and LLR wastes. Where possible (i.e., when wastes are not contaminated with radionuclides), hazardous waste will be disposed of at commercial

facilities. A building for collecting, handling, storing, and shipping wastes for commercial disposal is proposed as a general plant project. ORNL is also participating in a solid waste management planning effort for the Oak Ridge reservation. Early studies are indicating that new facilities will be required for storage/disposal of hazardous and sanitary wastes. Efforts continue at ORNL for improving operations of existing burial grounds and participating with the Oak Ridge Gaseous Diffusion Plant and Y-12 Plant in locating and designing new facilities for disposal of LLR waste.

We propose to build a strong research base (e.g., in geoscience) to support a unified program in nuclear and nonnuclear waste studies.

Resource projections for hazardous waste technology[a]

	'81	'82	'83	'84	'85	'86	'87
Operating cost	0.3	1.2	1.3	1.5	1.6	1.8	1.9
Capital equipment	0	0.3	0.3	0.4	0.4	0.4	0.5
Construction[b]	0	1.0	1.1	1.2	1.3	1.5	1.6
Total	0.3	2.5	2.7	3.1	3.3	3.7	4.0
Direct FTE	2	8	9	10	11	12	13

[a]Funding for FY 1981 through FY 1983 is in millions of current dollars and reflects a 10% escalation factor from FY 1981 to FY 1982 and from FY 1982 to FY 1983. Funding for FY 1984 through FY 1987 is in millions of constant 1983 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b]Construction items to be funded from general plant project funds restricted to waste programs.

Global Environmental Concerns

Several emerging environmental concerns related to energy development and use have worldwide implications. The burning of fossil fuels and, perhaps, the cutting of forests without compensatory replanting are causing a steady, measurable buildup of carbon dioxide in the atmosphere which threatens a widespread climate change in the future. Fossil fuel combustion, especially coal combustion, may also lead to the formation of acids in the atmosphere which may be deposited hundreds of miles from their source.

As with most technology-related pollution problems, an interdisciplinary approach is required to plan and conduct research related to source-term characterization, environmental transport and distribution, environmental effects (ecological and human health effects), and social and economic consequences. Effective environmental information systems are needed to support environmental assessments that integrate these diverse sources of data and provide the basis for federal policy decisions and environmental regulations.

ORNL staff members have demonstrated capabilities and ongoing activities in all of the aforementioned areas and are investigating the biogeochemical cycles of forest ecosystems so that the state of chemical releases to the environment can be quantitatively related to biotic and abiotic processes influencing (1) atmospheric deposition, (2) storage with ecosystem components, (3) biological responses to perturbations, and (4) eventual release from the landscape system to groundwater in aquatic ecosystems. The research includes (1) monitoring of inputs, outputs, and concentrations of levels of biota and soils; (2) research to elucidate mechanisms controlling biogeochemical cycles; and (3) development of mathematical models of element transport as a means to summarize complex data in order to design relevant future research and eventually to apply research results to other landscape systems. The Laboratory's long-standing major research program in biogeochemical cycling has been expanded to include the development of sophisticated mathematical models that simulate global cycles. We are studying improved measurement technology pertinent to cycling studies and are pursuing research in basic soil processes involving anion mobility.

ORNL's experimental approach to the study of acid deposition utilizes a combination of Laboratory greenhouse and field studies designed to establish thresholds for physiological damage from single and

combined doses of SO_2, O_3, NO_2, and acid rain and to evaluate the relationship between the level and duration of ambient exposure episodes, short-term physiological responses, and the yield of a selected forest and agricultural species.

We propose that the Laboratory become a center of expertise in the investigation of ecological transport and effects and in the assessment of consequences of acid deposition. We propose to continue a strong and diverse program in experimental research on important biogeochemical cycles (e.g., those of nitrogen, sulfur, phosphorus, and carbon dioxide) and to expand this work to include a larger space and longer time scale—global biogeochemistry.

Resource projections for global environmental concerns[a]

	'81	'82	'83	'84	'85	'86	'87
Operating cost	2.2	2.6	2.9	3.0	3.1	3.2	3.3
Capital equipment	0.0	0.2	0.3	0.2	0.2	0.2	0.2
Construction	0.0	0.0	0.2	0.4	0.3	0.0	0.0
Total	2.2	2.8	3.4	3.6	3.6	3.4	3.5
Direct FTE	25	27	30	30	30	30	30

[a]Funding for FY 1981 through FY 1983 is in millions of current dollars and reflects a 10% escalation factor from FY 1981 to FY 1982 and from FY 1982 to FY 1983. Funding for FY 1984 through FY 1987 is in millions of constant 1983 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

PERSONNEL RESOURCES

PERSONNEL RESOURCES

ORNL, one of the largest scientific and technological multiprogram laboratories in the world, numbers among its strengths the diversity of its technical staff. Forty percent of the Laboratory's personnel are college graduates, of which number more than 870 hold the Ph.D. degree. There are about 660 engineers, primarily chemical, electrical, and mechanical; about 20 mathematicians; about 590 physical scientists; and about 300 biomedical and environmental scientists. Furthermore, the Laboratory now has a staff of 40 economists and other social scientists.

About 500 full-time equivalent (FTE) guest scientists on assignment for periods ranging from a few months to a year or more are also among the Laboratory population. About 75 of these scientists represent foreign laboratories or research centers; among the others are scientists from U.S. industries and government. About 1300 college and university visitors, working in a variety of research participation and advanced study programs, spend from a few days to several months at the Laboratory annually. This number includes participants in ORNL's University Relations Program (about 1000 in 1980), as well as Oak Ridge Associated Universities (ORAU) contractors and ORNL consultants from the university community.

In addition to ORNL technical staff and guests, the Union Carbide Corporation–Nuclear Division (UCC–ND) central organizations serving three Oak Ridge installations have a general engineering staff of 1290 and a computer sciences staff of 840, all of whom are available to contribute to ORNL research efforts. Currently, ORNL uses about 375 of the available engineering staff and 315 of the computer sciences staff. ORNL programs located at the Y-12 Plant use over 400 of the service and support staff located there (see Fig. 8). An additional 110 from central management services groups also provide support to ORNL (Fig. 8).

Personnel Trends and Requirements

As was discussed in the chapter entitled "Laboratory Trends and Future Development," the Laboratory's population declined rapidly from 1968 to 1974. Following that period and the subsequent creation of, first, the Energy Research and Development Administration (ERDA) and, later, DOE, the Laboratory staff increased substantially. Current planning projections are that the number of employees will decrease over the next several years. The largest drops will occur in the conservation and fossil energy programs. Fission energy programs and the sciences are projected to remain stable or to decline slightly. Some small growth is expected in the fusion program.

Recruiting continues to be an important area for the Laboratory. ORNL currently has an overall recruiting acceptance rate of 55%, an acceptance rate for Ph.D.'s of 67%, and an acceptance rate of 49% for B.S. and M.S. candidates. Since January 1979, when mandatory retirement at age 65 was eliminated, 118 employees have reached age 65. Of

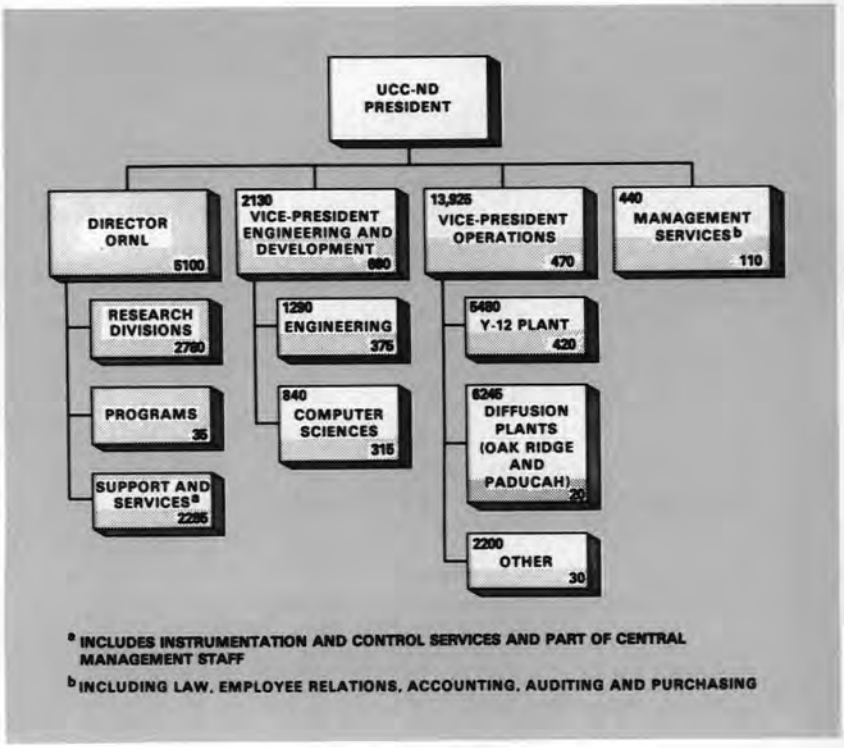


Fig. 8. ORNL receives extensive support from other parts of UCC-ND, as is indicated by these employment figures. Figures in the upper-left corner of each box represent the total number of full-time equivalents (FTEs) in each organization; figures in the lower-right corner represent the number of FTEs that support ORNL work.

this number, 55 are still employed, and another 17 worked beyond their 65th year but have since retired. Over the last few years, the average age of employees at the Laboratory has been fairly constant at 42.

Having experienced some difficulty in recruiting females in engineering disciplines, the Laboratory will emphasize this area as a part of its commitment to the Affirmative Action Program. Requirements for engineering personnel for FY 1982 are evenly distributed throughout the electrical, mechanical, chemical, and nuclear engineering disciplines.

ORNL will continue to draw upon the very strong capabilities of UCC-ND in procurement, computing, contracting, and engineering support. However, any large new technological undertakings will certainly require the addition of special capabilities and some adjustment of personnel planning levels.

Personnel Development Programs

Increased emphasis will be placed on in-house development of the existing Laboratory populations through the utilization of the following programs:

- In-Hours Continuing Education Program for scientific and technical personnel
- Management Resource Development
- In-House Development Program for administrative and technical support personnel

In addition, a new Career Planning Program will be available to help salaried employees plan their career strategies, pilots for Supervisory Assessment Centers will be developed in the *R&D* community, and interaction modeling training methods will be stressed in the development of first-line supervisors.

SITE AND FACILITIES DEVELOPMENT

SITE AND FACILITIES DEVELOPMENT

A major consideration in the overall institutional planning process is the future of the Laboratory site and its facilities. The continuing utility of existing facilities, as well as the appropriateness and utility of those planned, cannot be ensured unless plans to modify, update, or construct them are implemented before old facilities become inadequate to handle new or revised program activities. This planning is crucial if the Laboratory is to maintain its physical capability to perform DOE missions.

To ensure proper planning and management of its facilities, ORNL's Facilities Planning Manager acts as a liaison between DOE and Laboratory management and conducts internal planning and management activities. The Laboratory is striving to respond to new or changing program requirements and to maintain the continuity of ongoing programs by redirecting or reassigning existing facilities whenever possible and by making optimal use of its facilities (e.g., through consolidating similar operations, eliminating obsolete or unneeded equipment and supplies, and providing more efficient work area arrangements). Also, energy and resource conservation continues to be given particular consideration in identifying site and facility modifications and new construction projects. Costly and poorly utilized facilities are being identified so that a well-defined program for disposing of or replacing them can be established and maintained.

Where possible, the severely limited general plant project (GPP) and operating funds are being used for emergency maintenance and for facility renovation so that essential short-term program needs can be met. For the longer term, however, we rely on the approval of line-item projects to provide both multiprogram general purpose facilities projects (MGPF) and specific programmatic facilities (See Appendix A, Tables A.5–A.7).

Laboratory Site and Facilities Development

The changing nature of the Laboratory's work, which often requires new and different capabilities, has continued to make significant demands of building utilities and plant services. The pressure of these demands has significantly affected office housing, laboratories, materials stores, food services, and other plant and operational support activities.

The ORNL Site Development Plan, completed and published during FY 1981, is responsive to DOE's increasing emphasis on sound facility management and planning. In particular, DOE Order 4320.1, "Site Development and Facility Utilization Planning," and the *Site Development Planning Handbook* (DOE/AP/06212-1), now serve as key references in our management and planning of facilities and land use. The *Plan* allows us to accurately evaluate planned and proposed site and facility modifications in terms of overall plant capability. Its objective is to

provide a flexible long-range scheme for the orderly development of the Laboratory's physical facilities. Thus, based on management objectives for the next five years or more and on the requirements of the programs described here, the *Plan* is designed to serve Laboratory management and DOE as an instrument for improving the effectiveness and efficiency of planning and operating future facilities. The zoning classifications established by the *Plan* have already forced the reconsideration of site selections for several projects already in the early planning stages and have even resulted in decisions to relocate some facilities. These decisions were facilitated by such aspects of the *Plan* as its discussion of the opportunities and constraints presented by the natural site features, its documentary mapping and description of man-made improvements, and its treatment of the important operating and support activities.

The *Plan* has also helped identify those site and facility changes that require priority attention. As a result of the General Purpose Facility Survey Report, completed in FY 1980 and updated in FY 1981 at the request of DOE's Office of Energy Research (OER), many improvements and new projects have been identified as being needed to make the level of Laboratory facilities more acceptable. The guidance given by the *ORNL Site Development Plan* will be essential in the extensive review process now required for project identification budgeting, planning, and execution.

Facilities Projects

In considering our facility needs, our focus is on such timely issues as environmental protection, waste management, energy conservation, and general purpose facilities (GPF) improvements. The many projects (Tables A.5–A.7) designed to meet new program and plant needs are being examined closely to determine their impact on general plant resources, as well as their compliance with the increasingly rigid standards that govern the release and control of hazardous solids, liquids, and gases. Because of the Laboratory's involvement in new programs, several new classes of toxic and noxious chemicals have been identified that must be dealt with and whose handling will require new and better facilities. Additional information gathered on these materials and on others not yet identified will probably require more improvements and additions to the GPF.

Good GPF management is crucial to maintaining the Laboratory's physical capability to perform DOE missions. As is noted previously, both GPP and expense funding are being used to meet our essential short-term needs. However, many of our deficiencies can only be corrected via line-item projects (i.e., those totaling more than $1 million). Several of these larger project needs relate to existing or impending environmental safety regulations or legal requirements for state and federal agencies. Other proposed projects involve the tasks of providing adequate laboratories with state-of-the-art capabilities, renovating inadequate and substandard office space, improving inferior plant monitoring and emergency control facilities, expanding insufficient storage and warehousing, and upgrading extensive amounts of old, deteriorated utilities and service systems.

We propose to correct many of the GPF deficiencies cited in the General Purpose Facility Survey and Report through thirty-five line-item projects, totaling about $201 million. Eleven of the projects provide for building space; seventeen cover the upgrading of utility service systems; three provide for the correction of environmental problems; and two cover the relocation and realignment of roadways. Only two of the projects were funded in FY 1981; the remainder either have been or will be included in budget submissions.

ORNL has proposed as an FY 1983 line-item project a Laboratory Emergency Response Center (LERC) that would cost $4.2 million. The LERC would be a multipurpose facility designed to provide a modern, advanced center for continuously monitoring Laboratory functions and recording data pertaining to safeguards and security, process waste, facility radiation and contamination, environmental conditions, and utility alarms. It would also be used as a command center during emergency situations.*

*If a system such as the one being proposed had been available at Three Mile Island, much of the confusion that occurred during that incident could have been avoided [see the Crawford Committee Report, DOE/US-0005, *A Report on a Safety Assessment of Department of Energy Nuclear Reactors* (March 1981), by the Nuclear Facility Personnel Qualification and Training Committee].

Considerable progress has been made toward organizing a High-Temperature Materials Program, but two crucial preliminary steps that must be taken are the construction of the High-Temperature Materials Laboratory (HTML) and the consolidation of our research in that building. The HTML is necessary for several reasons.

First, it would allow six research groups (Environmental Interactions, Mechanical Behavior, High-Temperature Chemistry, Physical Properties, Structural Characterization, and Materials Synthesis) to interact more effectively and thus make optimum progress. Also, researchers working in applied and basic areas would benefit significantly from their interaction within the Laboratory. Finally, the more than $3-million new equipment allocation together with existing equipment would make this facility a prime resource for researchers from all sectors, including industries and universities.

The Laboratory's programmatic radioactive waste management activities are also receiving increased attention. Three ORNL projects are in various stages of study, design, construction, or commissioning: the Intermediate-Level Waste Facilities Modification Project was completed in FY 1980; the new Hydrofracture Facility will be commissioned during FY 1982; and the Improvements to Radioactive Waste Facilities Project is to be completed in FY 1984. The information obtained during the planning, design, and operation stages of these facilities will benefit the overall Radioactive Waste Management Program in its implementing of low-level radioactive waste management programs at DOE and other federal installations.

Current Status of the Physical Plant

Aside from the general deterioration of the plant caused by aging and/or increased loading, the overcrowding of personnel and the lack of new facilities with new capabilities continue to be major problems. Even with the reductions in force effected during FY 1981 and the addition of the HTML in FY 1987, some 1100 personnel will still be situated in substandard facilities. While the construction of this project continues to be delayed, existing buildings—Quonset huts, trailers, and old wooden structures—continue to deterioriate and to require extensive and expensive repairs and are poor environments for advanced technology enterprises. The last general laboratory facility constructed at ORNL was authorized in 1957. As Fig. 9 shows, most of our buildings date from wartime or the immediate postwar years.

Our programs today are much different from what they were earlier, and many impose special requirements that our present facilities were not designed to meet (i.e., the containment of toxic and carcinogenic substances, provisons for handling explosion hazards, precise climate control, and adequate height for special columns). Though some modifications have been made, they often proved unsatisfactory.

ORNL's actual and projected construction expenditures are provided in Fig. 10. As has been noted, large construction projects are required to meet both current and projected program needs and to correct existing general plant deficiencies. Needs are reflected in the actual and projected costs for line-item projects. Many of the GPF and program deficiencies with estimated costs ranging from a few thousand to less than one million dollars will require correction via the GPP programs. Currently, funding is received under fusion energy, waste management, and energy conservation activities.

For over a decade, ORNL has had to rely on severely inadequate GPP funding to provide for the necessary short-term maintenance and renovation of the Laboratory's facilities. To illustrate the severity of this problem, Fig. 11 shows that GPP funding, as a fraction of Laboratory operating funds, has fallen very rapidly since 1964. To return to a comparative level with that of only a decade ago, GPP funding would have to be raised to almost $11 million in 1983.

The Laboratory currently uses 29 DOE-owned trailers at both the X-10 and Y-12 sites. The book value of these trailers is about $250 thousand. Most are used as temporary housing for personnel and are scheduled for retirement as new, permanent facilities become available.

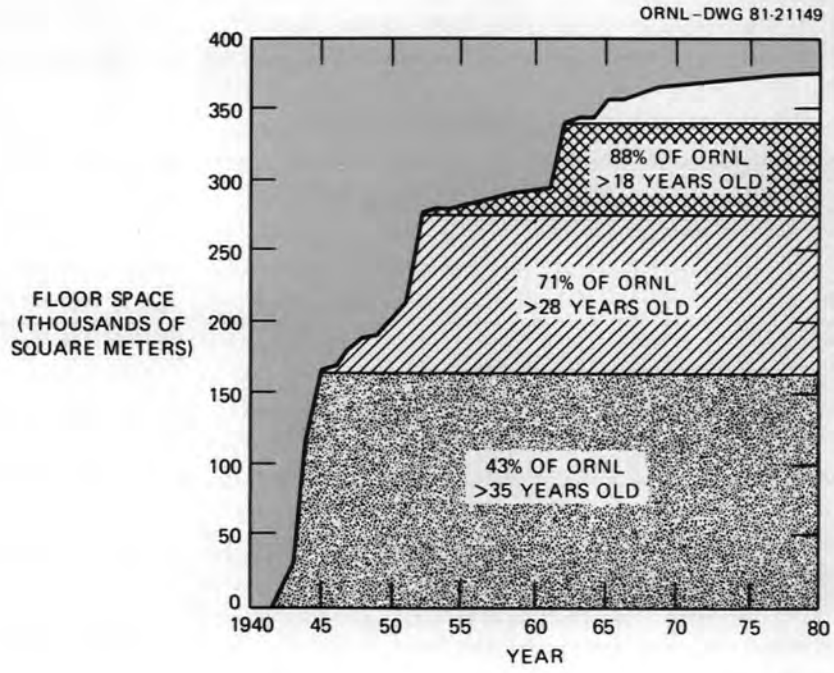


Fig. 9. History of facility construction at ORNL.

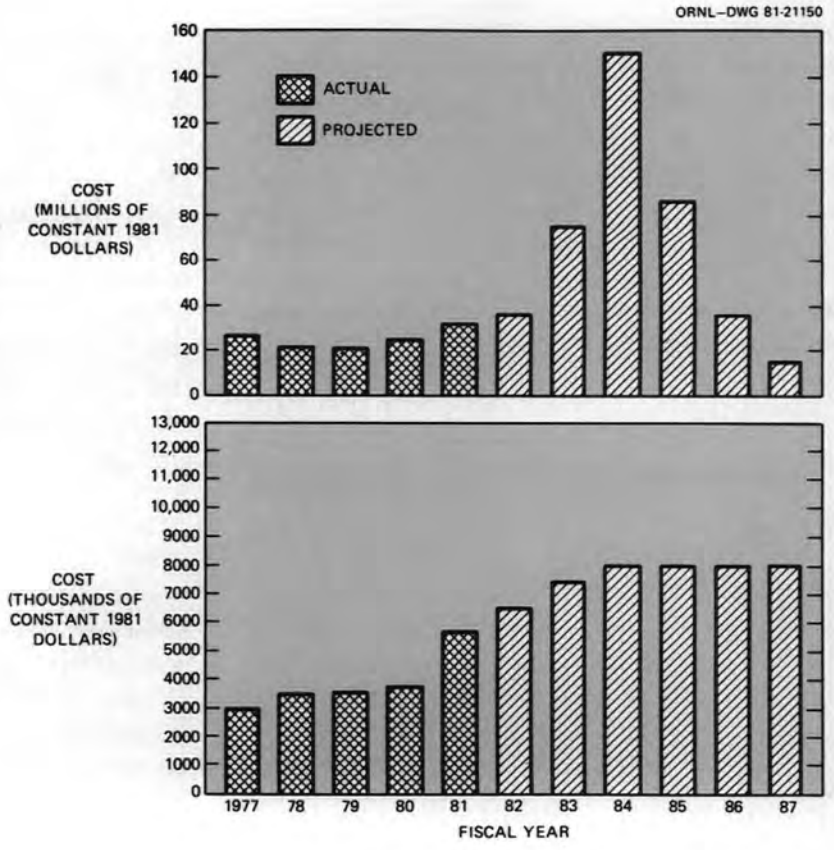


Fig. 10. Construction expenditures. Expenditures for line-item projects are shown in the top chart of this figure; those for general plant projects are shown in the bottom chart.

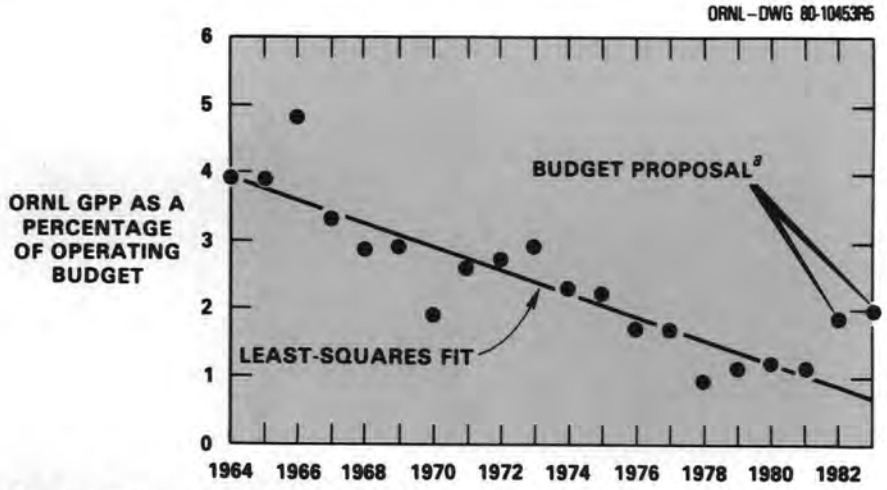


Fig. 11. General plant project funding as a fraction of the operating budget has decreased over the past.

Facility Maintenance

For many years the Laboratory has spent less than 3% of its annual operating budget to maintain its facilities. This achievement has resulted from our adherence to a combination of highly efficient preventative and normal maintenance procedures and schedules. However, because many of the plant's facilities are reaching design lifetime and/or have experienced excessive wear from increased loadings, expenditures for replacements and repairs are expected to increase over the next several years, unless GPF funding relief for upgradings and replacements is received. Maintenance costs for FY 1981 were $10.3 million. A breakdown of the costs is given in Table 2. Increased pressures to reduce overhead expenditures, combined with increased maintenance requirements, will make it extremely difficult to accomplish this goal. Through continued improvement in productivity, it is believed costs and manpower levels can be maintained at or near current levels. However, with the expected budget cuts, maintenance will be stretched out and facilities will suffer.

The GPF maintenance work force and the total plant replacement value are shown in Fig. 12. Figure 13 compares the cost of preventative maintenance for the X-10 site alone to the costs for the total maintenance effort. The source of maintenance is shown in Fig. 14. Most maintenance activities are carried out by onsite operations personnel. However, activities such as maintenance paving, stack inspections, roofing, and certain incidental services are contracted to outside service organizations.

Table 2. Plant maintenance activities budget for FY 1981

Activity	Expenditures (thousands of dollars)
Utilities	1,156.0
Grounds	1,151.0
Buildings	4,463.0
Plant services	493.0
Field services	974.0
Grounds—ORNL at Y-12	99.0
Buildings—ORNL at Y-12	1,938.0
Total	10,274.0

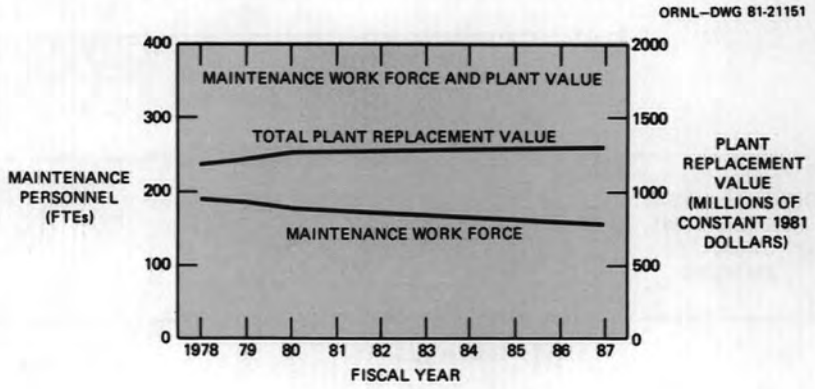


Fig. 12. General plant facility maintenance work force at ORNL (X-10).

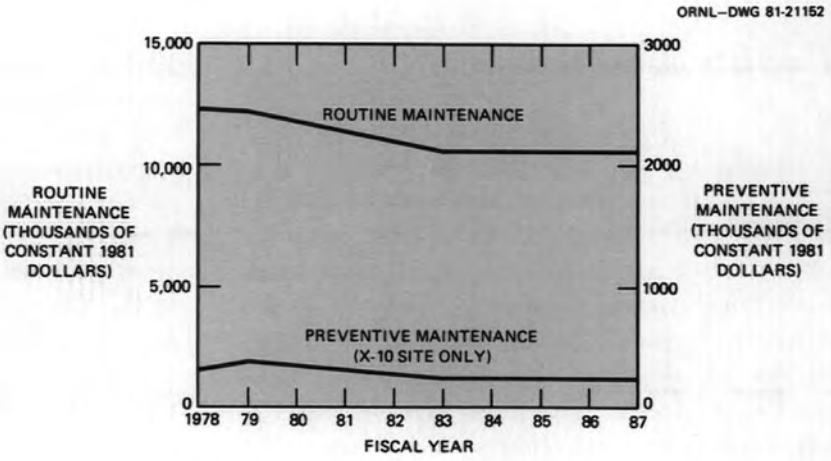


Fig. 13. Makeup of maintenance at ORNL (X-10 and Y-12).

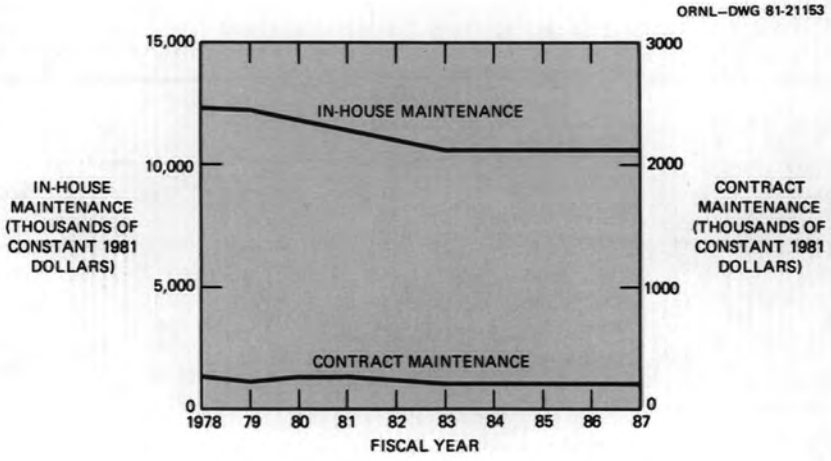


Fig. 14. Sources of maintenance efforts at ORNL (X-10 and Y-12).

Utility and Fuel Costs

Because of increased personnel and programmatic expansion, energy use at ORNL has increased steadily since FY 1977. Energy conservation efforts, however, have effectively minimized these increases. Projections for future energy use would include a rather sharp increase were it not for oncoming energy conservation projects. Estimates are that these new projects will reduce the FY 1975 reference base usage by about 30%. These two opposing forces, then, balance each other and result in an essentially flat projection after FY 1981 (Fig. 15).

As is shown in Fig. 16, fuel costs at ORNL were reduced from 0.9% of the total operating budget in the late 1970s to 0.67% of the current budget. How-

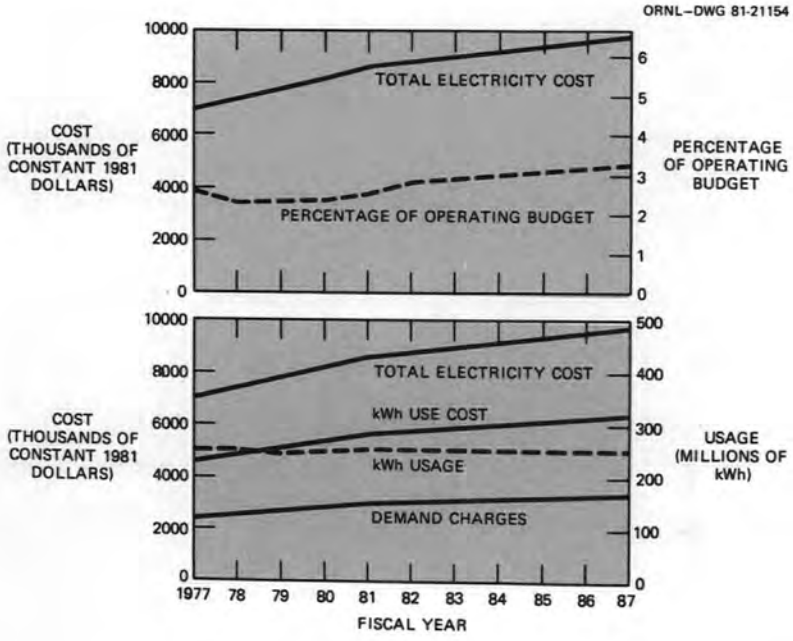


Fig. 15. Electrical utilities costs. The top graph of the figure shows electricity costs as a percentage of the total Laboratory operating budget; the bottom graph shows electricity cost components.

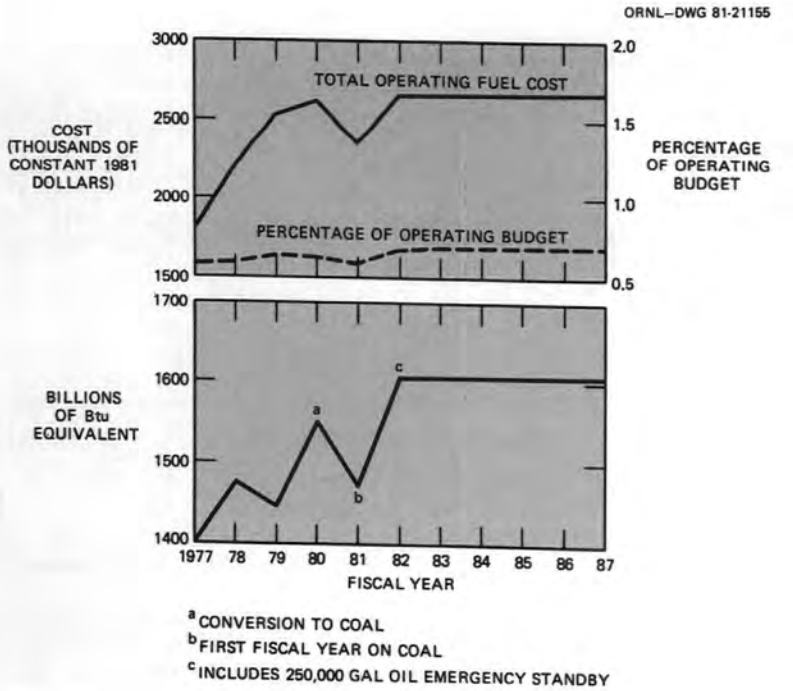


Fig. 16. Utilities costs for operating fuels. The top graph of the figure shows fuel costs as a percentage of the Laboratory's overall operating budget; the bottom graph shows Laboratory operating usage.

ever, actual fuel costs increased from $1.8 million in FY 1977 to $2.6 million in FY 1978, then dropped to $2.35 million in FY 1979 when the steam plant was converted to burn coal.

Automated Data Processing Requirements

Planning Process

The Computer Sciences Division (CSD) manages the operation of the central computer systems at ORNL, the Oak Ridge Gaseous Diffusion Plant (ORGDP), and the Y-12 Plant, all of which are operated by Union Carbide Corporation–Nuclear Division (UCC-ND). Although the computer systems are located at three sites, ten miles from each other, they are considered a single UCC-ND resource and, consistent with restraints imposed by reporting schedules and security requirements, are operated on an integrated, total-load-management basis. Organizationally, CSD reports to a Vice-President of UCC-ND and is not a part of ORNL.

The CSD is also responsible for the long-range planning of computer acquisitions for general-purpose use within UCC-ND. Because of the variety of users of the computer centers, the planning process is tailored to the characteristics of each of the three sites. Also, CSD planning activities and findings are reported at appropriate intervals to upper management of UCC-ND for review and approval.

Because of the number and diversity of DOE programs located at ORNL, projections of the Laboratory's computer needs are made differently from those for the other two sites. The Laboratory has established a Computer Steering Committee that reports to the Laboratory's executive director and serves as a liaison between the director and CSD management. The Committee, whose members are chosen to represent the diversity of Laboratory computer uses, assists CSD in planning future equipment acquisitions and in projecting work loads. Composite work-load projections are then presented to Laboratory management for approval and are incorporated into the *ORNL Institutional Plan*.

Current Equipment

Table 3 shows the major computer systems currently installed to serve the Oak Ridge complex.

Table 3. Major computer systems serving the Oak Ridge complex

System description	Date of installation of basic computer system
ORNL	
IBM 3033, with 8MB memory and 12 channels	October 1979
IBM 3033, with 8MB memory and 12 channels	November 1979
Combined equipment of these systems: 107 disks, 1 mass-storage device, and 14 magnetic tape drives	
DEC KL10, with 1664K-word memory, a triple processor, 6 channels, 22 disk drives, and 2 magnetic tape drives	January 1977
DEC KA10 plus SEL and PDP minicomputers to collect and analyze data at the Oak Ridge Electron Linear Accelerator	April 1977
DEC KL10 with 1024K-word memory, dual processor, 5 channels, 8 disk drives, and 2 magnetic tape drives to collect and analyze data for the Fusion Energy Division	July 1976
ORGDP	
IBM 360/195, with 4MB memory, 7 channels, 40 disks, 3 drums, 17 magnetic tape drives, and 1 mass storage device	November 1972
IBM 370/155, with 4MB memory, 6 channels	February 1973
IBM 4341 with 4MB memory, 6 channels	January 1981
Combined equipment for the IBM 155 and the IBM 4341 includes 26 disk drives and 4 magnetic tape drives	
Y-12	
CDC 3300, with 80K-word memory, 16 disk drives, and 6 magnetic tape drives	May 1968
IBM 4341 with 4MB memory, 6 channels, 11 disk drives, and 6 magnetic tape drives	May 1981

Major ORNL Computers

The IBM Dual 3033 systems primarily serve ORNL's scientific research and development work. One 3033 is used during the day to provide a text-editing service and a time-sharing service to users under the time-sharing option and Interact System. An extensive on-line bibliographic retrieval system, RECON, is the heaviest daytime user. The same 3033 is devoted to batch processing during the night and on weekends. The other 3033 handles batch computations.

The DEC KL10 is a general-purpose time-sharing system that serves ORNL and other UCC-ND groups. Over 1500 users access the system, which is vital both to program development for the IBM systems at the X-10 and K-25 sites and to on-line data analysis and graphical displays. The system is in continual operation except for maintenance and currently can handle 150 simultaneous users with reasonable response characteristics. It is considered to be adequately reliable. Systems software supplied by the vendor is being used, although modifications have been made. Maintenance of the system is competitively bid periodically.

The IBM 3033 complex and the DEC PDP-10 complex each have extensive communications systems. Currently, the IBM 3033 computer system has two IBM 3705 communications processors. Interactive services are divided between a time-sharing system and the RECON information system. More than 30 remote job entry (RJE) stations are also connected to the IBM 3033s.

The data communications facilities for the PDP-10 system are oriented toward providing interactive time-sharing service. All terminals serviced by the Digital Communications Associates statistical multiplexers are interactive devices. Three high-speed circuits connect the PDP-10 complex to the 3033 complex, one low-speed circuit connects the PDP-10 to the IBM 370/155-4341 at K-25, and one low-speed circuit provides a one-way link from the PDP-10 to the 360/195 complex. There is also a low-speed connection to a PDP-10 operated by the Fusion Energy Division (FED).

Many of the larger minicomputer systems at ORNL are located at the large experimental facilities such as the Oak Ridge Electron Linear Accelerator, FED's tokamak facilities, and the Holifield Heavy Ion Research Facility (HHIRF). These systems provide data acquisition from sensors, archiving of results for further processing, conversion and processing of sensor data for feedback for direct computer control, and feedback for the operations staff of these facilities.

Smaller minicomputers, which are scattered throughout the ORNL complex, perform a variety of data acquisition and control tasks. These minicomputers are not general-purpose machines in the conventional ADP sense but are computer-based systems configured for on-line, real-time acquisition, analysis, and control for which high availability and, hence, reliability are critical issues. These systems will generally provide all the necessary analyses of the data acquired for feedback to the scientist or engineer or for direct feedback to the device or the process that is being controlled.

Process-control computers are also being used—at the Oak Ridge Research Reactor, for in-pile irradiation experiments; at the Aquatic Laboratory, for thermal pollution studies; and at the Consolidated Fuel Reprocessing Facility, for control of wet chemical processes. These systems provide a variety of direct digital control functions for controling parameters (e.g., temperatures, pressures, flows, and pH) as well as functions for monitoring, converting, analyzing, limit checking, and alarm signaling.

Accountability and safeguards systems for sensitive materials—such as the Facility Inventory Control System—employ minicomputers to acquire data from physical processes and to monitor for improper movement of materials. Furthermore, minicomputer systems are being implemented to upgrade the safeguards and security at all UCC-ND sites. These systems will provide improved control of access to restricted and classified areas, fire alarm monitoring, and intrusion alarms for peripheral areas.

At all three plants some minicomputers provide data to be processed on the central computer system, particularly where large, complex iterative codes are required for processing the data. Often, the data must be analyzed before further tests or schedules can be completed. If the availability of processing time on the large machines is restricted or delayed, the users of the minicomputers feel the impact almost immediately. Thus, planning for these minicomputers and for

their potential impact on the central system must be carefully controlled. Frequently, in cases for which the requirement is real-time control, the minicomputer will provide all the computational capabilities required to enhance its reliability and will also provide the highest possible availability. Such systems will have little or no impact on the central facility ADP needs.

Physical Location of Major Computers—ORNL

The large computing facilities at ORNL are located in the Central Research Laboratory building, but because of growth and expansion, have physically outgrown the available space. When the IBM 3033 system was installed in 1979, it was necessary to relocate the DEC PDP-10 system to an area remote from the original site. Further expansion of either area will be, at best, very difficult and very expensive.

A plan is being considered to provide an easily expandable building for installation of all new or replacement computer systems, with a goal of eventually having all computers and associated operations staff located in one central facility.

Projected Demand and Capacity

The projected ADP requirements at the Oak Ridge complex during this planning period are given in Schedule E3 of the *UCC-ND FY 1983 ADP Long-Range Site Plan.*

One major ORNL computer item is projected during this planning period: a scientific "number cruncher" will be acquired in FY 1984. The capacity of this computer will be sufficient to meet the growth in computer work load projected by ORNL programs in the planning period. The nature of the projected work load seems to include a few types of calculations that will only be possible with the largest-capacity "number cruncher" available. Most problems will continue to be of a less demanding nature.

Because the calculational capacity of this additional computer will be very great, the incremental addition to the local computing facilities may not be fully used when it is first installed. Therefore, it is necessary to consider the option of sharing a large computer with other DOE laboratories, either on a program or a laboratory basis. The success of the fusion energy computing network has demonstrated the feasibility of this type of approach, at least within a limited community of users. Success in such a computer network depends upon the availability of high-speed communications. As a step toward extending communications to other installations, an internal high-speed data network is being planned for ORNL users at both the X-10 and Y-12 sites.

The proposed schedule for adding a scientific "number cruncher" would prevent a repetition of difficulties and delays caused by capacity falling below demands. Future demand is particularly difficult to forecast now, because the impact of full-cost recovery, which has been imposed over the last two to three years, has appeared to depress the demand. Assuming that full-cost recovery is now in place, computing demands will again increase within the overall ORNL levels of effort identified in the *ADP Long-Range Site Plan.* Therefore, slippages in the planned replacement schedule would result in the capacity falling below demand in 1985.

APPENDIX RESOURCE PROJECTIONS

APPENDIX
RESOURCE
PROJECTIONS

Note: The following tables represent laboratory goals for the planning period. The totals of the subprogram goals do not agree with the summary graphs presented in chapter II of this plan. Chapter II summaries contain managerial judgment on total resources. That judgment could not be detailed to the subprogram level.

Table A.1. Laboratory summary

Funding summary
(Expressed in millions of dollars)

	FY 1981		FY 1982[a]		FY 1983[b]		FY 1984[c]		FY 1985		FY 1986		FY 1987	
	BA[d]	BO[e]	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
DOE effort	281.7	281.5	285.3	287.1	327.9	312.4	334.3	318.7	334.9	319.3	331.9	313.3	333.0	314.1
Work for others	79.6	55.2	53.0	54.5	56.8	57.9	60.5	59.7	61.4	60.6	61.3	60.5	61.3	61.0
Total operating	361.3	336.7	338.3	341.6	384.7	370.3	394.8	378.4	396.3	379.9	393.2	373.8	394.3	375.1
Capital equipment	22.9		28.5		31.3		32.1		30.7		32.0		30.4	
Program construction	28.2		33.8		45.9		41.3		20.0		10.0		8.5	
General purpose facilities	1.9		2.5		0		0		0		0		0	
General plant projects	5.7		6.5		7.4		8.0		8.0		8.0		8.0	
General purpose equipment	3.0		4.5		5.5		5.5		5.5		5.5		5.5	
Total Laboratory funding	423.0		414.1		474.8		481.7		460.5		448.7		446.7	
Proposed construction	0.0		1.4		49.4		61.6		80.5		31.4		12.5	

Personnel summary
(Expressed in FTEs)

	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987
Direct DOE[f]	1862.7	1925.5	1956.2	1958.8	1958.0	1930.7	1931.4
Direct work for others	432.6	452.5	454.5	461.9	468.8	468.4	470.1
Total direct	2295.3	2378.0	2410.7	2420.7	2426.8	2399.1	2401.5
Indirect	2728.0	2658.0	2600.0	2600.0	2600.0	2600.0	2600.0
Total personnel	5073.3	5036.0	5010.7	5020.7	5026.8	4999.1	5001.5

[a] FY 1982 funding projections contain a 10% inflation factor over FY 1981.
[b] FY 1983 funding projections contain a 10% inflation factor over FY 1982.
[c] FY 1984 through FY-1987 funding projections are in constant FY 1983 dollars.
[d] Budget authority.
[e] Budget outlay.
[f] Includes isotopes staff (86 FTEs), who are not charged directly to research programs.

Table A.2. Resources by subprogram

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AT05 Applied Plasma Physics														
Internal operating		3.9		4.2		4.5		4.5		4.5		4.5		4.5
Procurement		0.3		0.3		0.3		0.3		0.3		0.3		0.3
Total operating	4.1	4.2	4.5	4.5	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Capital equipment	0.1		0.2		0.2		0.2		0.2		0.2		0.2	
Total activity	4.2		4.7		5.0		5.0		5.0		5.0		5.0	
Direct personnel	29.5		37.4		37.4		37.4		37.4		37.4		37.4	
AT10 Confinement Systems														
Internal operating		14.5		14.7		16.2		16.2		16.2		16.2		16.2
Procurement		4.6		7.3		9.9		9.9		9.9		9.9		9.9
Total operating	18.8	19.1	23.0	22.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
Capital equipment	3.4		4.1		6.2		6.2		6.2		6.2		6.2	
Construction	7.9		14.0		33.0		41.0		20.0		10.0		8.5	
Total activity	30.1		41.1		65.2		73.2		52.2		42.2		40.7	
Direct personnel	72.6		83.8		83.8		83.8		83.8		83.8		83.8	
AT15 Development and Technology														
Internal operating		13.5		16.1		20.2		20.2		20.2		20.2		20.2
Procurement		14.2		13.2		12.4		12.4		12.4		12.4		12.4
Total operating	25.0	27.7	31.3	29.3	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.5
Capital equipment	2.8		6.0		2.3		2.3		2.3		2.3		2.3	
Construction	5.3		6.0		5.4		0.0		0.0		0.0		0.0	
Total activity	33.1		43.3		40.2		34.8		34.8		34.8		34.8	
Proposed construction	0.0		0.0		7.6		0.0		0.0		0.0		0.0	
Direct personnel	76.6		96.7		100.0		100.0		100.0		100.0		100.0	
AT Fusion Energy Research & Dev														
Internal operating		31.9		35.1		40.8		40.8		40.8		40.8		40.8
Procurement		19.2		20.7		22.5		22.5		22.5		22.5		22.5
Total operating	47.9	51.1	58.8	55.8	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3
Capital equipment	6.3		10.3		8.7		8.7		8.7		8.7		8.7	
Construction	13.2		20.0		38.4		41.0		20.0		10.0		8.5	
Total program	67.4		89.1		110.4		113.0		92.0		82.0		80.5	
Proposed construction	0.0		0.0		7.6		0.0		0.0		0.0		0.0	
Direct personnel	178.7		217.9		221.2		221.2		221.2		221.2		221.2	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
HA02 Biological & Environmental Research														
Internal operating		17.4		18.2		19.7		20.5		20.5		20.5		20.5
Procurement		1.6		1.3		1.3		1.5		1.5		1.5		1.5
Total operating	23.9	19.0	26.2	19.5	28.8	21.0	30.0	22.0	30.0	22.0	30.0	22.0	30.0	22.0
Capital equipment	1.7		1.9		2.0		2.0		2.0		2.0		2.0	
Construction	2.0		0.0		0.0		0.0		0.0		0.0		0.0	
Total activity	27.6		28.0		30.8		32.0		32.0		32.0		32.0	
Proposed construction	0.0		1.0		6.8		29.4		14.3		1.7		0.0	
Direct personnel	177.7		175.0		175.0		175.0		175.0		175.0		175.0	
HA Environmental Res & Develop														
Internal operating		17.4		18.2		19.7		20.5		20.5		20.5		20.5
Procurement		1.6		1.3		1.3		1.5		1.5		1.5		1.5
Total operating	23.9	19.0	26.2	19.5	28.8	21.0	30.0	22.0	30.0	22.0	30.0	22.0	30.0	22.0
Capital equipment	1.7		1.9		2.0		2.0		2.0		2.0		2.0	
Construction	2.0		0.0		0.0		0.0		0.0		0.0		0.0	
Total program	27.6		28.0		30.8		32.0		32.0		32.0		32.0	
Proposed construction	0.0		1.0		6.8		29.4		14.3		1.7		0.0	
Direct personnel	177.7		175.0		175.0		175.0		175.0		175.0		175.0	
HB01 General Life Sciences														
Internal operating		5.6		6.3		7.0		8.0		8.0		8.0		8.0
Procurement		0.4		0.4		0.5		0.5		0.5		0.5		0.5
Total operating	8.1	6.0	8.9	6.6	9.8	7.5	10.0	8.5	10.0	8.5	10.0	8.5	10.0	8.5
Capital equipment	0.3		0.4		0.4		0.5		0.5		0.5		0.5	
Total activity	8.4		9.3		10.2		10.5		10.5		10.5		10.5	
Direct personnel	59.0		65.0		65.0		66.0		66.0		66.0		66.0	
HB02 Nuclear Medicine Applications														
Internal operating		1.5		1.1		1.1		1.1		1.1		1.1		1.1
Procurement		0.1		0.0		0.1		0.1		0.1		0.1		0.1
Total operating	1.9	1.5	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Capital equipment	0.0		0.1		0.2		0.2		0.2		0.2		0.2	
Total activity	1.9		1.2		1.4		1.4		1.4		1.4		1.4	
Direct personnel	9.0		10.0		10.0		10.0		10.0		10.0		10.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
HB Life Sciences Res & Nuclear Med														
Internal operating		7.1		7.3		8.2		9.1		9.1		9.1		9.1
Procurement		0.5		0.4		0.5		0.6		0.6		0.6		0.6
Total operating	10.0	7.6	10.0	7.7	11.0	8.7	11.2	9.7	11.2	9.7	11.2	9.7	11.2	9.7
Capital equipment	0.3		0.5		0.6		0.7		0.7		0.7		0.7	
Total program	10.2		10.5		11.6		11.9		11.9		11.9		11.9	
Direct personnel	68.0		75.0		75.0		76.0		76.0		76.0		76.0	
KA01 Physics Research														
Internal operating		0.5		0.6		0.6		0.6		0.6		0.6		0.6
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Capital equipment	0.0		0.0		0.1		0.0		0.0		0.0		0.0	
Total activity	0.5		0.6		0.8		0.7		0.7		0.7		0.7	
Direct personnel	4.5		5.3		5.3		5.3		5.3		5.3		5.3	
KA High Energy Physics														
Internal operating		0.5		0.6		0.6		0.6		0.6		0.6		0.6
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Capital equipment	0.0		0.0		0.1		0.0		0.0		0.0		0.0	
Total program	0.5		0.6		0.8		0.7		0.7		0.7		0.7	
Direct personnel	4.5		5.3		5.3		5.3		5.3		5.3		5.3	
KB01 Medium Energy Physics														
Internal operating		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct personnel	0.6		0.8		0.8		0.8		0.8		0.8		0.8	
KB02 Heavy Ion Physics														
Internal operating		6.1		6.8		8.0		8.0		8.0		8.0		8.0
Procurement		0.4		0.4		0.5		0.5		0.5		0.5		0.5
Total operating	6.1	6.5	7.2	7.2	8.7	8.5	8.7	8.5	8.7	8.5	8.7	8.5	8.7	8.5
Capital equipment	1.0		1.2		1.4		1.4		1.4		1.4		1.4	
Construction	0.2		0.0		0.0		0.0		0.0		0.0		0.0	
Total activity	7.3		8.4		10.2		10.2		10.2		10.2		10.2	
Proposed construction	0.0		0.4		2.4		5.9		3.2		0.0		0.0	
Direct personnel	62.1		69.5		73.4		73.4		73.4		73.4		73.4	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
KB03 Nuclear Theory														
Internal operating		0.6		0.6		0.8		0.8		0.8		0.8		0.8
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.5	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Capital equipment	0.0		0.0		0.1		0.1		0.1		0.1		0.1	
Total activity	0.5		0.7		0.9		0.9		0.9		0.9		0.9	
Direct personnel	5.0		6.0		7.0		7.0		7.0		7.0		7.0	
KB Nuclear Physics														
Internal operating		6.8		7.5		8.8		8.8		8.8		8.8		8.8
Procurement		0.5		0.5		0.6		0.6		0.6		0.6		0.6
Total operating	6.7	7.2	7.9	8.0	9.7	9.4	9.7	9.4	9.7	9.4	9.7	9.4	9.7	9.4
Capital equipment	1.0		1.2		1.5		1.5		1.5		1.5		1.5	
Construction	0.2		0.0		0.0		0.0		0.0		0.0		0.0	
Total program	7.9		9.1		11.2		11.2		11.2		11.2		11.2	
Proposed construction	0.0		0.4		2.4		5.9		3.2		0.0		0.0	
Direct personnel	67.7		76.3		81.2		81.2		81.2		81.2		81.2	
KC01 Nuclear Sciences														
Internal operating		12.2		13.6		17.4		17.4		17.4		17.4		17.4
Procurement		0.6		0.5		0.6		0.5		0.5		0.5		0.5
Total operating	12.0	12.8	14.2	14.2	18.4	17.9	18.4	17.9	18.4	17.9	18.4	17.9	18.4	17.9
Capital equipment	0.5		0.6		0.9		0.9		0.9		0.9		0.9	
Total activity	12.6		14.7		19.3		19.3		19.3		19.3		19.3	
Direct personnel	160.6		158.6		171.2		171.2		171.2		171.2		171.2	
KC02 Materials Sciences														
Internal operating		16.7		18.3		23.1		23.3		23.6		23.8		24.1
Procurement		0.8		0.9		1.1		1.1		1.1		1.1		1.1
Total operating	16.4	17.5	20.5	19.3	25.9	24.2	26.1	24.4	26.4	24.7	26.7	24.9	26.9	25.2
Capital equipment	1.7		1.7		3.0		3.0		3.0		3.1		3.1	
Total activity	18.1		22.1		28.9		29.1		29.4		29.7		30.0	
Proposed construction	0.0		0.0		3.0		15.7		0.0		0.0		0.0	
Direct personnel	169.2		171.3		182.4		184.2		186.1		187.9		189.8	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
KC03 Chemical Sciences														
Internal operating		7.0		7.5		9.7		9.8		9.8		9.9		9.9
Procurement		0.4		0.3		0.4		0.4		0.4		0.4		0.4
Total operating	7.0	7.4	7.8	7.8	10.4	10.1	10.4	10.1	10.5	10.2	10.5	10.2	10.6	10.3
Capital equipment	0.5		0.6		1.0		1.0		1.0		1.0		1.0	
Construction	0.2		0.0		0.0		0.0		0.0		0.0		0.0	
Total activity	7.7		8.4		11.4		11.5		11.5		11.6		11.6	
Proposed construction	0.0		0.0		0.4		0.0		0.0		0.0		0.0	
Direct personnel	78.4		82.8		92.5		93.0		93.4		93.9		94.4	
KC04 Engineering, Math, and Geosciences														
Internal operating		1.1		1.1		1.5		1.5		1.6		1.6		1.7
Procurement		0.0		0.0		0.1		0.1		0.1		0.1		0.1
Total operating	1.1	1.1	1.1	1.1	1.7	1.5	1.7	1.6	1.8	1.6	1.8	1.7	1.9	1.7
Capital equipment	0.2		0.1		0.2		0.2		0.2		0.2		0.2	
Total activity	1.3		1.3		1.8		1.9		1.9		2.0		2.1	
Direct personnel	4.2		5.5		6.8		7.0		7.2		7.4		7.6	
KC Basic Energy Sciences														
Internal operating		37.0		40.5		51.6		52.0		52.4		52.7		53.1
Procurement		1.9		1.8		2.1		2.0		2.0		2.0		2.0
Total operating	36.5	38.9	43.5	42.3	56.3	53.7	56.7	54.1	57.0	54.4	57.4	54.7	57.8	55.1
Capital equipment	3.0		2.9		5.1		5.1		5.1		5.2		5.3	
Construction	0.2		0.0		0.0		0.0		0.0		0.0		0.0	
Total program	39.7		46.5		61.4		61.8		62.2		62.6		63.0	
Proposed construction	0.0		0.0		3.4		15.7		0.0		0.0		0.0	
Direct personnel	412.4		418.2		452.9		455.4		457.9		460.4		463.0	
KD01 Assessment Projects														
Internal operating		0.2		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Total operating	0.6	0.3	0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Direct personnel	2.3		2.3		2.1		2.1		2.1		2.1		2.1	
KD04 Advanced Technology Projects														
Internal operating		0.0		0.2		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.3		2.0		0.4		0.0		0.0		0.0		0.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
KD Technology Assessment Projects														
Internal operating		0.2		0.4		0.3		0.2		0.2		0.2		0.2
Procurement		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Total operating	0.8	0.3	0.1	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Direct personnel	2.6		4.3		2.5		2.1		2.1		2.1		2.1	
KE01 University Research Support														
Internal operating		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Procurement		0.1		0.2		0.3		0.5		0.6		0.6		0.6
Total operating	0.2	0.2	0.4	0.4	0.5	0.5	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8
Direct personnel	1.0		1.0		1.0		1.5		1.5		2.0		2.0	
KE University Research Support														
Internal operating		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Procurement		0.1		0.2		0.3		0.5		0.6		0.6		0.6
Total operating	0.2	0.2	0.4	0.4	0.5	0.5	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8
Direct personnel	1.0		1.0		1.0		1.5		1.5		2.0		2.0	
Assistant Secretarial Office Office of Energy Research														
Internal operating		101.0		109.7		130.1		132.3		132.6		133.0		133.3
Procurement		23.8		25.1		27.6		27.8		28.0		28.0		28.0
Total operating	126.6	124.8	147.6	134.8	170.7	157.6	172.5	160.1	173.1	160.6	173.4	160.9	173.8	161.3
Capital equipment	12.3		16.9		18.0		18.0		18.1		18.1		18.2	
Construction	15.6		20.0		38.4		41.0		20.0		10.0		8.5	
Total A/S level	154.4		184.5		227.1		231.6		211.1		201.5		200.5	
Proposed construction	0.0		1.4		20.2		51.0		17.5		1.7		0.0	
Direct personnel	912.6		973.0		1014.1		1017.7		1020.2		1023.2		1025.8	
AE20 Space and Terrestrial Applications														
Internal operating		3.3		3.8		3.5		2.6		2.6		2.6		2.6
Procurement		1.4		0.7		0.8		0.8		0.8		0.8		0.8
Total operating	3.5	4.6	3.2	4.5	4.4	4.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Capital equipment	0.1		0.0		0.1		0.1		0.1		0.1		0.1	
Total activity	3.6		3.3		4.5		3.5		3.5		3.5		3.5	
Direct personnel	23.6		30.5		27.9		22.5		22.5		22.5		22.5	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AE Advanced Nuclear Systems														
Internal operating		3.3		3.8		3.5		2.6		2.6		2.6		2.6
Procurement		1.4		0.7		0.8		0.8		0.8		0.8		0.8
Total operating	3.5	4.6	3.2	4.5	4.4	4.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Capital equipment	0.1		0.0		0.1		0.1		0.1		0.1		0.1	
Total program	3.6		3.3		4.5		3.5		3.5		3.5		3.5	
Direct personnel	23.6		30.5		27.9		22.5		22.5		22.5		22.5	
AF05 Fuel Cycle Research & Development														
Internal operating		13.6		14.0		14.9		18.1		18.1		18.1		18.1
Procurement		5.0		4.0		4.9		6.9		6.9		6.9		6.9
Total operating	17.3	18.6	23.0	18.0	25.8	19.8	32.0	25.0	32.0	25.0	32.0	25.0	32.0	25.0
Capital equipment	5.0		5.0		5.5		5.5		5.5		5.5		5.5	
Construction	5.0		3.8		2.5		0.3		0.0		0.0		0.0	
Total activity	27.3		31.8		33.8		37.8		37.5		37.5		37.5	
Proposed construction	0.0		0.0		20.0		60.0		20.0		0.0		0.0	
Direct personnel	120.9		125.2		122.8		135.0		137.0		138.0		138.0	
AF10 Gas Cooled Breeder Reactor (GCBR)														
Internal operating		0.6		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.1	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital equipment	0.4		0.0		0.0		0.0		0.0		0.0		0.0	
Construction	1.8		0.0		0.0		0.0		0.0		0.0		0.0	
Total activity	2.3		0.0		0.0		0.0		0.0		0.0		0.0	
Direct personnel	4.5		0.0		0.0		0.0		0.0		0.0		0.0	
AF15 Lq.Mtl Fast Breeder Reactor (LMFBR)														
Internal operating		10.6		11.3		12.8		13.0		12.9		13.0		13.3
Procurement		0.9		0.7		0.7		1.0		1.1		1.0		0.7
Total operating	11.4	11.4	12.0	12.0	14.0	13.5	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Capital equipment	0.6		0.6		0.8		1.0		0.9		0.8		0.5	
Total activity	11.9		12.6		14.8		15.0		14.9		14.8		14.5	
Direct personnel	94.2		85.0		88.0		89.0		89.0		89.0		89.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AF Breeder Reactor Systems														
Internal operating		24.8		25.3		27.7		31.1		31.0		31.1		31.4
Procurement		6.1		4.7		5.6		7.9		8.0		7.9		7.6
Total operating	28.8	30.8	35.0	30.0	39.8	33.3	46.0	39.0	46.0	39.0	46.0	39.0	46.0	39.0
Capital equipment	6.0		5.6		6.3		6.5		6.4		6.3		6.0	
Construction	6.8		3.8		2.5		0.3		0.0		0.0		0.0	
Total program	41.5		44.3		48.6		52.8		52.4		52.3		52.0	
Proposed construction	0.0		0.0		20.0		60.0		20.0		0.0		0.0	
Direct personnel	219.6		210.2		210.8		224.0		226.0		227.0		227.0	
AG25 High Temperature Reactors														
Internal operating		5.6		4.8		5.1		5.2		5.2		4.6		5.4
Procurement		0.6		0.4		0.6		1.1		1.7		3.0		3.0
Total operating	4.9	6.2	6.3	5.2	7.5	5.7	8.5	6.3	9.0	6.9	10.0	7.6	11.0	8.4
Capital equipment	0.7		1.5		1.5		2.0		1.5		3.0		1.5	
Total activity	5.6		7.8		9.0		10.5		10.5		13.0		12.5	
Proposed construction	0.0		0.0		0.0		2.0		4.0		3.0		1.0	
Direct personnel	43.8		41.0		41.0		41.0		41.0		41.0		41.0	
AG30 Three Mile Island Activities (TMI)														
Internal operating		0.0		0.4		0.6		0.4		0.3		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.0	0.6	0.4	0.7	0.6	0.4	0.4	0.2	0.3	0.0	0.0	0.0	0.0
Direct personnel	0.0		4.5		5.5		3.0		3.0		0.0		0.0	
AG36 Light Water Reactor Systems														
Internal operating		0.3		0.0		0.3		0.3		0.3		0.3		0.3
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	0.3	0.0	0.0	1.6	0.3	1.3	0.3	1.0	0.3	0.9	0.3	0.8	0.3
Direct personnel	2.8		0.0		2.0		2.0		2.0		2.0		2.0	
AG40 Thermal Reactor Fuel Cycle														
Internal operating		3.2		5.0		6.0		7.0		7.0		7.0		7.0
Procurement		5.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	8.3	8.3	0.0	5.0	0.0	6.0	0.0	7.0	0.0	7.0	0.0	7.0	0.0	7.0
Direct personnel	31.2		34.8		37.2		38.5		38.5		38.5		38.5	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AG Conventional Reactor Systems														
Internal operating		9.0		10.3		12.0		12.9		12.8		11.9		12.7
Procurement		5.8		0.4		0.6		1.1		1.7		3.0		3.0
Total operating	13.5	14.8	6.9	10.7	9.8	12.6	10.2	14.0	10.2	14.5	10.9	14.9	11.8	15.7
Capital equipment	0.7		1.5		1.5		2.0		1.5		3.0		1.5	
Total program	14.2		8.4		11.3		12.2		11.7		13.9		13.3	
Proposed construction	0.0		0.0		0.0		2.0		4.0		3.0		1.0	
Direct personnel	77.8		80.3		85.7		84.5		84.5		81.5		81.5	
AH10 Remedial Actions														
Internal operating		1.3		1.9		2.5		2.1		2.0		1.9		1.9
Procurement		1.2		0.2		0.5		0.5		0.9		1.1		1.1
Total operating	2.4	2.4	2.6	2.2	3.3	3.0	2.7	2.6	2.9	2.9	2.9	2.9	2.9	2.9
Capital equipment	0.0		0.0		0.0		0.0		0.1		0.0		0.0	
Total activity	2.4		2.6		3.3		2.8		3.0		3.0		3.0	
Direct personnel	13.2		13.8		14.0		14.0		14.0		14.0		14.0	
AH Remedial Action Programs														
Internal operating		1.3		1.9		2.5		2.1		2.0		1.9		1.9
Procurement		1.2		0.2		0.5		0.5		0.9		1.1		1.1
Total operating	2.4	2.4	2.6	2.2	3.3	3.0	2.7	2.6	2.9	2.9	2.9	2.9	2.9	2.9
Capital equipment	0.0		0.0		0.0		0.0		0.1		0.0		0.0	
Total program	2.4		2.6		3.3		2.8		3.0		3.0		3.0	
Direct personnel	13.2		13.8		14.0		14.0		14.0		14.0		14.0	
AP05 Commercial Waste Management														
Internal operating		1.5		2.6		2.7		3.9		3.9		3.9		3.9
Procurement		0.1		0.2		0.1		0.1		0.1		0.1		0.1
Total operating	1.0	1.6	2.8	2.8	3.1	2.8	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Capital equipment	0.3		0.2		0.3		0.3		0.2		0.2		0.2	
Total activity	1.3		2.9		3.5		4.2		4.1		4.1		4.1	
Direct personnel	14.0		28.7		32.0		33.4		32.5		32.5		32.5	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AP Commercial Nuclear Waste														
Internal operating		1.5		2.6		2.7		3.9		3.9		3.9		3.9
Procurement		0.1		0.2		0.1		0.1		0.1		0.1		0.1
Total operating	1.0	1.6	2.8	2.8	3.1	2.8	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Capital equipment	0.3		0.2		0.3		0.3		0.2		0.2		0.2	
Total program	1.3		2.9		3.5		4.2		4.1		4.1		4.1	
Direct personnel	14.0		28.7		32.0		33.4		32.5		32.5		32.5	
AS05 Spent Fuel Storage														
Internal operating		0.2		0.1		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.0		0.1		0.1		0.1		0.1		0.1
Total operating	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Capital equipment	0.1		0.1		0.0		0.0		0.0		0.0		0.0	
Total activity	0.3		0.3		0.3		0.3		0.3		0.3		0.3	
Direct personnel	1.8		1.4		2.0		2.0		2.0		2.0		2.0	
AS Spent Nuclear Fuel														
Internal operating		0.2		0.1		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.0		0.1		0.1		0.1		0.1		0.1
Total operating	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Capital equipment	0.1		0.1		0.0		0.0		0.0		0.0		0.0	
Total program	0.3		0.3		0.3		0.3		0.3		0.3		0.3	
Direct personnel	1.8		1.4		2.0		2.0		2.0		2.0		2.0	
CD20 Uranium Resource Assessment														
Internal operating		0.3		0.1		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.2		0.0		0.0		0.0		0.0		0.0		0.0	
CD Uranium Resources & Enrichment														
Internal operating		0.3		0.1		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.2		0.0		0.0		0.0		0.0		0.0		0.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Assistant Secretarial Office Nuclear Energy														
Internal operating		40.4		44.1		48.6		52.8		52.6		51.7		52.8
Procurement		14.5		6.3		7.6		10.4		11.5		12.9		12.6
Total operating	49.7	54.8	50.8	50.4	60.7	56.2	66.6	63.2	66.8	64.1	67.6	64.6	68.5	65.4
Capital equipment	7.1		7.4		8.3		8.9		8.3		9.6		7.8	
Construction	6.8		3.8		2.5		0.3		0.0		0.0		0.0	
Total A/S level	63.6		61.9		71.5		75.8		75.1		77.2		76.3	
Proposed construction	0.0		0.0		20.0		62.0		.24.0		3.0		1.0	
Direct personnel	350.2		364.9		372.4		380.4		381.5		379.5		379.5	
AA05 Advanced Environmental Control Tech														
Internal operating		0.4		0.2		0.5		0.5		0.5		0.5		0.5
Procurement		0.2		0.2		0.1		0.1		0.1		0.1		0.1
Total operating	0.8	0.6	0.4	0.4	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6
Direct personnel	3.4		2.4		4.0		4.0		4.0		4.0		4.0	
AA15 Advanced Research & Technology Dev														
Internal operating		2.8		4.0		4.8		4.8		4.8		4.8		4.8
Procurement		4.9		5.8		5.2		5.3		5.3		5.3		5.3
Total operating	9.2	7.7	8.7	9.8	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Capital equipment	0.1		0.3		0.4		0.4		0.4		0.4		0.4	
Total activity	9.3		9.0		10.4		10.4		10.4		10.4		10.4	
Direct personnel	26.5		43.7		41.0		41.0		41.0		41.0		41.0	
AA25 Coal Liquefaction														
Internal operating		0.5		1.7		0.8		0.8		0.8		0.8		0.8
Procurement		0.0		0.1		0.2		0.2		0.2		0.2		0.2
Total operating	1.5	0.5	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Capital equipment	0.0		0.0		0.1		0.1		0.1		0.1		0.1	
Total activity	1.6		1.0		1.1		1.1		1.1		1.1		1.1	
Direct personnel	6.3		17.7		6.5		6.5		6.5		6.5		6.5	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AA35 Combustion Systems														
Internal operating		1.1		0.9		0.4		0.5		0.5		0.5		0.5
Procurement		0.8		1.3		0.3		0.2		0.2		0.2		0.2
Total operating	0.4	1.9	0.2	2.2	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Capital equipment	0.0		0.4		0.0		0.0		0.0		0.0		0.0	
Total activity	0.4		0.6		0.7		0.8		0.8		0.8		0.8	
Direct personnel	7.5		9.0		4.0		4.0		4.0		4.0		4.0	
AA45 Fuel Cells														
Internal operating		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.9		0.0		0.0		0.0		0.0		0.0		0.0	
AA55 Heat Engines and Heat Recovery														
Internal operating		0.6		0.6		0.0		0.0		0.0		0.0		0.0
Procurement		1.1		1.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.6	1.7	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	4.6		3.7		0.0		0.0		0.0		0.0		0.0	
AA65 In Situ Coal Gasification														
Internal operating		0.0		0.0		0.1		0.1		0.1		0.1		0.1
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct personnel	0.2		0.0		1.0		1.0		1.0		1.0		1.0	
AA75 Mines Research & Development														
Internal operating		0.8		0.0		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.4	0.8	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	8.3		0.0		2.0		2.0		2.0		2.0		2.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AA85 Surface Coal Gasification														
Internal operating		0.5		0.8		1.3		1.3		1.3		1.3		1.3
Procurement		0.5		0.6		2.5		2.5		2.5		2.5		2.5
Total operating	1.0	1.1	1.9	1.4	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Capital equipment	0.0		0.0		0.1		0.1		0.1		0.1		0.1	
Total activity	1.0		1.9		3.9		3.9		3.9		3.9		3.9	
Direct personnel	3.5		8.2		11.0		11.0		11.0		11.0		11.0	
AA Coal														
Internal operating		6.9		8.2		8.2		8.2		8.2		8.2		8.2
Procurement		7.7		8.9		8.3		8.3		8.3		8.3		8.3
Total operating	13.9	14.6	12.1	17.2	16.7	16.5	16.7	16.5	16.7	16.5	16.7	16.5	16.7	16.5
Capital equipment	0.2		0.8		0.6		0.6		0.6		0.6		0.6	
Total program	14.1		12.9		17.2		17.3		17.3		17.3		17.3	
Direct personnel	61.2		84.7		69.5		69.5		69.5		69.5		69.5	
AC05 Advanced Process Technology														
Internal operating		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	1.0		0.0		0.0		0.0		0.0		0.0		0.0	
AC15 Enhanced Oil Recovery														
Internal operating		0.6		0.1		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.7	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	4.1		1.0		1.8		1.8		1.8		1.8		1.8	
AC20 Oil Shale														
Internal operating		0.0		0.1		0.3		0.3		0.3		0.3		0.3
Procurement		0.0		0.0		0.1		0.1		0.1		0.1		0.1
Total operating	0.0	0.0	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Direct personnel	0.0		1.5		2.0		2.0		2.0		2.0		2.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AC Petroleum														
Internal operating		0.6		0.2		0.5		0.5		0.5		0.5		0.5
Procurement		0.1		0.0		0.1		0.1		0.1		0.1		0.1
Total operating	0.0	0.7	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Capital equipment	0.0		0.0		0.1		0.1		0.1		0.1		0.1	
Total program	0.0		0.3		0.6		0.6		0.6		0.6		0.6	
Direct personnel	5.1		2.5		3.8		3.8		3.8		3.8		3.8	
CA01 Low/Medium BTU Gas Commercial.														
Internal operating		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.5		0.0		0.0		0.0		0.0		0.0		0.0	
CA Coal														
Internal operating		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.5		0.0		0.0		0.0		0.0		0.0		0.0	
CG01 Federal Leasing														
Internal operating		0.2		0.2		0.0		0.0		0.0		0.0		0.0
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.6	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	1.7		2.0		0.0		0.0		0.0		0.0		0.0	
CG Multi-Resource														
Internal operating		0.2		0.2		0.0		0.0		0.0		0.0		0.0
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.6	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	1.7		2.0		0.0		0.0		0.0		0.0		0.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
CH05 Program Management														
Internal operating		0.0		0.1		0.1		0.1		0.1		0.1		0.1
Procurement		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Total operating	0.0	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct personnel	1.0		1.3		1.3		1.3		1.3		1.3		1.3	
CH Alternate Fuels Production														
Internal operating		0.0		0.1		0.1		0.1		0.1		0.1		0.1
Procurement		0.1		0.1		0.1		0.1		0.1		0.1		0.1
Total operating	0.0	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct personnel	1.0		1.3		1.3		1.3		1.3		1.3		1.3	
Assistant Secretarial Office Fossil Energy														
Internal operating		7.9		8.8		8.8		8.8		8.8		8.8		8.8
Procurement		8.1		9.2		8.5		8.4		8.4		8.4		8.4
Total operating	14.5	16.0	12.6	17.9	17.5	17.3	17.5	17.3	17.5	17.3	17.5	17.3	17.5	17.3
Capital equipment	0.2		0.8		0.6		0.7		0.7		0.7		0.7	
Total A/S level	14.7		13.4		18.1		18.2		18.2		18.2		18.2	
Direct personnel	69.5		90.5		74.6		74.6		74.6		74.6		74.6	
AK05 Power Delivery														
Internal operating		1.6		1.0		1.5		1.2		1.4		1.4		1.4
Procurement		0.8		1.6		1.5		1.8		2.6		2.6		2.6
Total operating	3.7	2.4	1.0	2.6	3.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
Capital equipment	0.1		0.2		0.3		0.3		0.3		0.3		0.3	
Total activity	3.8		1.2		3.3		4.3		4.3		4.3		4.3	
Direct personnel	15.3		9.7		12.0		12.0		14.0		14.0		14.0	
AK10 Systems Architecture & Integration														
Internal operating		1.1		1.2		0.5		0.5		0.5		0.5		0.5
Procurement		2.8		6.0		3.5		3.5		3.5		1.5		1.5
Total operating	6.4	3.8	1.0	7.2	2.0	4.0	1.0	4.0	2.5	4.0	2.0	2.0	2.0	2.0
Capital equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Total activity	6.4		1.1		2.1		1.1		2.6		2.1		2.1	
Direct personnel	9.2		10.0		4.0		4.0		4.0		4.0		4.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AK Electric Energy Systems														
Internal operating		2.7		2.2		2.0		1.7		1.9		1.9		1.9
Procurement		3.6		7.7		5.0		5.3		6.1		4.1		4.1
Total operating	10.1	6.3	2.0	9.8	5.0	7.0	5.0	7.0	6.5	8.0	6.0	6.0	6.0	6.0
Capital equipment	0.1		0.3		0.4		0.4		0.4		0.4		0.4	
Total program	10.3		2.3		5.4		5.4		6.9		6.4		6.4	
Direct personnel	24.5		19.7		16.0		16.0		18.0		18.0		18.0	
AL10 Thermal and Mechanical Storage														
Internal operating		1.4		1.0		1.2		1.2		1.2		1.2		1.2
Procurement		3.2		3.0		2.8		2.8		2.8		2.8		2.8
Total operating	2.4	4.6	1.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Capital equipment	0.1		0.2		0.2		0.2		0.2		0.2		0.2	
Total activity	2.5		1.2		4.2		4.2		4.2		4.2		4.2	
Direct personnel	13.2		8.0		8.0		8.0		8.0		8.0		8.0	
AL Energy Storage Systems														
Internal operating		1.4		1.0		1.2		1.2		1.2		1.2		1.2
Procurement		3.2		3.0		2.8		2.8		2.8		2.8		2.8
Total operating	2.4	4.6	1.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Capital equipment	0.1		0.2		0.2		0.2		0.2		0.2		0.2	
Total program	2.5		1.2		4.2		4.2		4.2		4.2		4.2	
Direct personnel	13.2		8.0		8.0		8.0		8.0		8.0		8.0	
AM05 Geopressured Resources Development														
Internal operating		0.1		0.2		0.2		0.2		0.2		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0
Direct personnel	1.3		2.0		2.0		2.0		2.0		0.0		0.0	
AM10 Geothermal Technology Development														
Internal operating		0.5		0.4		0.2		0.2		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.5	0.5	0.4	0.4	0.2	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	4.7		3.7		1.5		1.5		0.0		0.0		0.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AM15 Hydrothermal Industrialization														
Internal operating		0.1		0.4		0.3		0.3		0.3		0.3		0.3
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	0.1	0.2	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct personnel	1.3		3.5		2.0		2.0		2.0		2.0		2.0	
AM Geothermal														
Internal operating		0.7		0.9		0.7		0.7		0.5		0.3		0.3
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	1.0	0.8	0.8	0.9	0.7	0.7	0.6	0.7	0.4	0.5	0.3	0.3	0.3	0.3
Direct personnel	7.3		9.2		5.5		5.5		4.0		2.0		2.0	
CE10 Small Scale Hydropower														
Internal operating		0.0		0.1		0.0		0.0		0.0		0.0		0.0
Procurement		0.4		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.6	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.0		1.0		0.0		0.0		0.0		0.0		0.0	
CE20 Feasibility Studies Loan Program														
Internal operating		0.3		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	2.8		0.0		0.0		0.0		0.0		0.0		0.0	
CE Hydropower														
Internal operating		0.3		0.1		0.0		0.0		0.0		0.0		0.0
Procurement		0.4		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.9	0.7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	2.8		1.0		0.0		0.0		0.0		0.0		0.0	
EB01 Solar Applications for Buildings														
Internal operating		0.5		0.3		0.3		0.3		0.3		0.3		0.3
Procurement		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.5	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct personnel	5.0		2.5		2.3		2.5		2.5		2.5		2.5	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EB02 Solar Applications for Industry														
Internal operating		1.7		1.1		1.5		1.5		1.9		1.9		1.9
Procurement		2.6		3.2		3.2		3.2		3.2		3.2		3.2
Total operating	6.2	4.3	4.3	4.3	4.9	4.7	4.9	4.7	5.4	5.1	5.4	5.1	5.4	5.1
Direct personnel	16.7		9.0		9.0		9.0		9.0		9.0		9.0	
EB03 Solar Applications for Power														
Internal operating		0.3		0.2		0.2		0.0		0.0		0.0		0.0
Procurement		0.1		0.4		0.2		0.0		0.0		0.0		0.0
Total operating	0.5	0.3	0.6	0.6	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	2.6		2.0		2.0		0.0		0.0		0.0		0.0	
EB11 Alcohol Financial Assistance														
Internal operating		0.2		0.6		0.3		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.9	0.2	0.6	0.6	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	2.2		5.5		2.7		0.0		0.0		0.0		0.0	
EB Solar Energy														
Internal operating		2.7		2.2		2.3		1.8		2.2		2.2		2.2
Procurement		2.8		3.6		3.3		3.2		3.2		3.2		3.2
Total operating	8.2	5.5	5.9	5.8	5.9	5.7	5.2	5.0	5.7	5.4	5.7	5.4	5.7	5.4
Direct personnel	26.5		19.0		16.0		11.5		11.5		11.5		11.5	
EC01 Building Systems														
Internal operating		1.8		0.8		1.4		1.4		1.4		1.5		1.5
Procurement		1.2		2.1		1.6		1.6		1.6		1.5		1.5
Total operating	2.6	3.0	3.6	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.5	3.0	3.5	3.0
Capital equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Total activity	2.6		3.7		3.1		3.1		3.1		3.6		3.6	
Direct personnel	12.9		8.0		13.0		13.0		13.0		14.0		14.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EC02 Appliance Standards														
Internal operating		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.4		0.0		0.0		0.0		0.0		0.0		0.0	
EC03 Community Systems														
Internal operating		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	2.7		0.0		0.0		0.0		0.0		0.0		0.0	
EC04 Urban Waste														
Internal operating		0.4		0.3		0.3		0.0		0.0		0.0		0.0
Procurement		0.4		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.4	0.8	0.3	0.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	4.3		1.5		3.0		0.0		0.0		0.0		0.0	
EC05 Technology and Consumer Products														
Internal operating		2.1		2.0		1.7		1.1		1.1		1.3		1.4
Procurement		6.7		6.8		1.8		0.2		0.2		0.3		0.4
Total operating	6.6	8.8	7.5	8.9	1.2	3.5	1.3	1.3	1.3	1.3	1.6	1.6	1.8	1.8
Capital equipment	0.1		0.1		0.1		0.1		0.1		0.1		0.1	
Total activity	6.8		7.6		1.3		1.4		1.4		1.7		1.9	
Direct personnel	18.1		18.0		14.0		10.0		10.0		12.0		13.0	
EC06 Analysis and Technology Transfer														
Internal operating		0.3		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.7	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	2.1		1.0		1.0		1.0		1.0		1.0		1.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EC07 Residential Conservation Service														
Internal operating		0.8		0.3		0.1		0.0		0.0		0.0		0.0
Procurement		0.8		0.5		0.1		0.0		0.0		0.0		0.0
Total operating	2.1	1.5	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	8.3		4.0		0.0		0.0		0.0		0.0		0.0	
EC Buildings and Community Systems														
Internal operating		5.7		3.6		3.4		2.6		2.6		2.9		3.0
Procurement		9.4		9.4		3.5		1.9		1.8		1.8		1.9
Total operating	13.0	15.1	11.6	13.0	4.6	6.9	4.4	4.4	4.4	4.4	5.3	4.8	5.4	4.9
Capital equipment	0.1		0.2		0.2		0.2		0.2		0.2		0.2	
Total program	13.1		11.8		4.8		4.6		4.6		5.4		5.6	
Direct personnel	48.8		32.5		31.0		24.0		24.0		27.0		28.0	
ED01 Waste Energy Reduction														
Internal operating		0.7		0.9		1.0		1.0		1.0		1.0		1.0
Procurement		0.0		0.1		0.0		0.0		0.0		0.0		0.0
Total operating	0.5	0.7	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Direct personnel	6.1		9.0		9.0		9.0		9.0		9.0		9.0	
ED03 Industrial Cogeneration														
Internal operating		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	1.0		0.0		0.0		0.0		0.0		0.0		0.0	
ED Industrial														
Internal operating		0.7		0.9		1.0		1.0		1.0		1.0		1.0
Procurement		0.2		0.1		0.0		0.0		0.0		0.0		0.0
Total operating	0.8	0.9	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Direct personnel	7.1		9.0		9.0		9.0		9.0		9.0		9.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EE05 Transportation Utilization Programs														
Internal operating		0.6		0.5		0.5		0.5		0.5		0.5		0.5
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.7	0.9	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Direct personnel	5.0		4.5		4.5		4.5		4.5		4.5		4.5	
EE Transportation														
Internal operating		0.6		0.5		0.5		0.5		0.5		0.5		0.5
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.7	0.9	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Direct personnel	5.0		4.5		4.5		4.5		4.5		4.5		4.5	
EF01 Schools and Hospitals														
Internal operating		0.1		0.1		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	1.1		1.0		0.0		0.0		0.0		0.0		0.0	
EF06 Energy Management Partnership Act														
Internal operating		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	1.3		0.3		0.0		0.0		0.0		0.0		0.0	
EF07 Emergency Energy Conservation Prog.														
Internal operating		0.5		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	4.0		0.0		0.0		0.0		0.0		0.0		0.0	
EF State/Local Programs														
Internal operating		0.7		0.1		0.0		0.0		0.0		0.0		0.0
Procurement		0.3		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.4	1.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	6.4		1.3		0.0		0.0		0.0		0.0		0.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EG05 Energy Conversion Technology														
Internal operating		0.2		0.6		0.6		1.1		1.1		1.1		1.1
Procurement		0.0		0.7		0.6		0.9		0.9		0.9		0.9
Total operating	0.4	0.3	1.5	1.3	1.5	1.3	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Capital equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Total activity	0.4		1.6		1.6		2.1		2.1		2.1		2.1	
Direct personnel	2.3		6.0		6.0		10.0		10.0		10.0		10.0	
EG Multi-Sector														
Internal operating		0.2		0.6		0.6		1.1		1.1		1.1		1.1
Procurement		0.0		0.7		0.6		0.9		0.9		0.9		0.9
Total operating	0.4	0.3	1.5	1.3	1.5	1.3	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Capital equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Total program	0.4		1.6		1.6		2.1		2.1		2.1		2.1	
Direct personnel	2.3		6.0		6.0		10.0		10.0		10.0		10.0	
Assistant Secretarial Office Conservation and Renewable Energy														
Internal operating		15.7		12.1		11.7		10.6		10.9		11.0		11.1
Procurement		20.3		24.4		15.3		14.1		14.8		12.8		12.9
Total operating	37.8	36.0	24.4	36.5	23.1	27.0	22.7	24.6	24.6	25.8	24.7	23.9	24.9	24.1
Capital equipment	0.5		0.9		0.9		0.9		0.9		0.9		0.9	
Total A/S level	38.3		25.3		24.0		23.7		25.5		25.6		25.8	
Direct personnel	143.9		110.2		96.0		88.5		89.0		90.0		91.0	
AR05 Defense Waste Management Programs														
Internal operating		10.4		14.6		20.3		18.5		18.6		18.4		18.4
Procurement		2.9		2.1		3.2		6.1		5.4		4.4		4.4
Total operating	12.6	13.4	18.7	16.7	23.8	23.5	24.4	24.6	23.6	23.9	22.8	22.8	22.8	22.8
Capital equipment	1.1		0.9		1.7		2.1		1.5		1.4		1.4	
Construction	5.8		10.0		5.0		0.0		0.0		0.0		0.0	
Total activity	19.5		29.6		30.5		26.5		25.1		24.2		24.2	
Proposed construction	0.0		0.0		0.0		19.0		31.0		24.0		11.5	
Direct personnel	96.6		130.5		155.5		154.5		150.9		147.5		147.5	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AR Defense Waste Management														
Internal operating		10.4		14.6		20.3		18.5		18.6		18.4		18.4
Procurement		2.9		2.1		3.2		6.1		5.4		4.4		4.4
Total operating	12.6	13.4	18.7	16.7	23.8	23.5	24.4	24.6	23.6	23.9	22.8	22.8	22.8	22.8
Capital equipment	1.1		0.9		1.7		2.1		1.5		1.4		1.4	
Construction	5.8		10.0		5.0		0.0		0.0		0.0		0.0	
Total program	19.5		29.6		30.5		26.5		25.1		24.2		24.2	
Proposed construction	0.0		0.0		0.0		19.0		31.0		24.0		11.5	
Direct personnel	96.6		130.5		155.5		154.5		150.9		147.5		147.5	
GD01 Nuclear Matls Security & Safeguards														
Internal operating		0.1		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
Capital equipment	0.0		0.0		0.0		0.0		0.0		0.0		0.1	
Total activity	0.2		0.2		0.2		0.3		0.3		0.3		0.3	
Direct personnel	1.2		1.6		1.8		2.0		2.2		2.4		2.5	
GD Nuclear Matls Security & Safeguards														
Internal operating		0.1		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
Capital equipment	0.0		0.0		0.0		0.0		0.0		0.0		0.1	
Total program	0.2		0.2		0.2		0.3		0.3		0.3		0.3	
Direct personnel	1.2		1.6		1.8		2.0		2.2		2.4		2.5	
GE03 Supporting Services														
Internal operating		5.2		3.2		4.7		5.2		5.2		2.0		1.5
Procurement		1.0		2.4		0.8		0.3		0.3		0.1		0.1
Total operating	5.9	6.2	5.9	5.6	5.5	5.5	5.3	5.5	5.5	5.5	2.1	2.1	1.6	1.6
Capital equipment	0.0		0.0		0.1		0.0		0.0		0.0		0.0	
Total activity	6.0		5.9		5.5		5.3		5.6		2.1		1.7	
Direct personnel	41.2		44.0		40.0		44.0		44.0		18.0		15.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
GE Materials Production														
Internal operating		5.2		3.2		4.7		5.2		5.2		2.0		1.5
Procurement		1.0		2.4		0.8		0.3		0.3		0.1		0.1
Total operating	5.9	6.2	5.9	5.6	5.5	5.5	5.3	5.5	5.5	5.5	2.1	2.1	1.6	1.6
Capital equipment	0.0		0.0		0.1		0.0		0.0		0.0		0.0	
Total program	6.0		5.9		5.5		5.3		5.6		2.1		1.7	
Direct personnel	41.2		44.0		40.0		44.0		44.0		18.0		15.0	
Assistant Secretarial Office Defense Programs														
Internal operating		15.7		18.0		25.2		23.9		24.0		20.7		20.2
Procurement		4.0		4.5		3.9		6.4		5.7		4.5		4.5
Total operating	18.7	19.7	24.8	22.5	29.5	29.2	29.9	30.3	29.3	29.7	25.2	25.2	24.7	24.7
Capital equipment	1.2		0.9		1.9		2.2		1.6		1.4		1.5	
Construction	5.8		10.0		5.0		0.0		0.0		0.0		0.0	
Total A/S level	25.6		35.7		36.3		32.1		30.9		26.6		26.2	
Proposed construction	0.0		0.0		0.0		19.0		31.0		24.0		11.5	
Direct personnel	139.2		176.1		197.3		200.5		197.1		167.9		165.0	
HA01 Overview and Assessment														
Internal operating		4.0		4.0		4.7		4.7		4.7		4.7		4.7
Procurement		1.7		2.7		2.7		2.7		2.7		2.7		2.7
Total operating	7.9	5.8	8.2	6.7	9.1	7.4	9.5	7.4	9.5	7.4	9.5	7.4	9.5	7.4
Capital equipment	0.3		0.2		0.1		0.2		0.2		0.2		0.2	
Total activity	8.1		8.4		9.3		9.8		9.8		9.8		9.8	
Direct personnel	39.1		32.5		32.5		32.5		32.5		32.5		32.5	
HA Environmental Res & Develop														
Internal operating		4.0		4.0		4.7		4.7		4.7		4.7		4.7
Procurement		1.7		2.7		2.7		2.7		2.7		2.7		2.7
Total operating	7.9	5.8	8.2	6.7	9.1	7.4	9.5	7.4	9.5	7.4	9.5	7.4	9.5	7.4
Capital equipment	0.3		0.2		0.1		0.2		0.2		0.2		0.2	
Total program	8.1		8.4		9.3		9.8		9.8		9.8		9.8	
Direct personnel	39.1		32.5		32.5		32.5		32.5		32.5		32.5	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Assistant Secretarial Office Env. Protect, Safety & Emerg. Prep.														
Internal operating		4.0		4.0		4.7		4.7		4.7		4.7		4.7
Procurement		1.8		2.7		2.7		2.7		2.7		2.7		2.7
Total operating	7.9	5.8	8.2	6.7	9.1	7.4	9.5	7.4	9.5	7.4	9.5	7.4	9.5	7.4
Capital equipment	0.3		0.2		0.1		0.2		0.2		0.2		0.2	
Total A/S level	8.1		8.4		9.3		9.8		9.8		9.8		9.8	
Direct personnel	39.1		32.5		32.5		32.5		32.5		32.5		32.5	
TA01 Program Prime Procurement														
Internal operating		0.2		0.4		0.4		0.3		0.2		0.2		0.2
Procurement		0.1		0.3		0.4		0.1		0.0		0.0		0.0
Total operating	0.4	0.2	0.9	0.6	0.7	0.8	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	1.3		3.0		3.0		2.5		1.5		1.5		1.5	
TA Energy Applied Analysis														
Internal operating		0.2		0.4		0.4		0.3		0.2		0.2		0.2
Procurement		0.1		0.3		0.4		0.1		0.0		0.0		0.0
Total operating	0.4	0.2	0.9	0.6	0.7	0.8	0.4	0.4	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	1.3		3.0		3.0		2.5		1.5		1.5		1.5	
TB01 Program Prime Procurement														
Internal operating		0.1		0.4		0.6		0.4		0.4		0.4		0.4
Procurement		0.0		0.0		0.1		0.1		0.0		0.0		0.0
Total operating	0.5	0.2	0.6	0.4	0.7	0.8	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Direct personnel	0.6		3.5		5.0		3.5		3.0		3.0		3.0	
TB Collection, Production & Dissemin														
Internal operating		0.1		0.4		0.6		0.4		0.4		0.4		0.4
Procurement		0.0		0.0		0.1		0.1		0.0		0.0		0.0
Total operating	0.5	0.2	0.6	0.4	0.7	0.8	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Direct personnel	0.6		3.5		5.0		3.5		3.0		3.0		3.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
TC01 Program Prime Procurement														
Internal operating		1.4		2.0		2.0		1.3		1.3		1.2		1.2
Procurement		3.0		4.0		4.0		3.2		2.2		2.0		2.0
Total operating	5.2	4.4	5.0	6.0	5.7	6.0	4.5	4.5	3.3	3.5	3.2	3.2	3.2	3.2
Direct personnel	12.2		16.0		16.0		12.5		12.5		12.5		12.5	
TC03 ADP Prime Procurement														
Internal operating		0.0		0.1		0.1		0.1		0.1		0.1		0.1
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct personnel	0.0		0.6		0.8		0.7		0.7		0.6		0.6	
TC Data Validation														
Internal operating		1.4		2.1		2.1		1.4		1.4		1.3		1.3
Procurement		3.0		4.0		4.0		3.2		2.2		2.0		2.0
Total operating	5.2	4.4	5.1	6.1	5.8	6.1	4.6	4.6	3.4	3.6	3.3	3.3	3.3	3.3
Direct personnel	12.2		16.6		16.8		13.2		13.2		13.1		13.1	
TD03 ADP Prime Procurement														
Internal operating		0.0		0.3		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.2		0.1		0.0		0.0		0.0		0.0
Total operating	0.3	0.0	0.9	0.4	0.4	0.3	0.0	0.2	0.0	0.2	0.1	0.2	0.2	0.2
Direct personnel	0.0		2.0		1.5		1.0		1.0		1.0		1.0	
TD Data Information Services														
Internal operating		0.0		0.3		0.2		0.2		0.2		0.2		0.2
Procurement		0.0		0.2		0.1		0.0		0.0		0.0		0.0
Total operating	0.3	0.0	0.9	0.4	0.4	0.3	0.0	0.2	0.0	0.2	0.1	0.2	0.2	0.2
Direct personnel	0.0		2.0		1.5		1.0		1.0		1.0		1.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Assistant Secretarial Office Energy Information Administration														
Internal operating		1.7		3.0		3.3		2.3		2.1		2.0		2.0
Procurement		3.1		4.6		4.6		3.4		2.3		2.1		2.1
Total operating	6.4	4.9	7.4	7.6	7.7	7.9	5.4	5.7	4.0	4.4	4.0	4.1	4.1	4.1
Total A/S level	6.4		7.5		7.7		5.4		4.0		4.0		4.1	
Direct personnel	14.1		25.1		26.3		20.2		18.7		18.6		18.6	
UA01 Contractural Activity														
Internal operating		1.2		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.9		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	10.2		0.0		0.0		0.0		0.0		0.0		0.0	
UA Fuels Conversion														
Internal operating		1.2		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.9		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	10.2		0.0		0.0		0.0		0.0		0.0		0.0	
UB01 Utility Regulatory Assistance														
Internal operating		0.2		0.3		0.5		0.5		0.5		0.5		0.5
Procurement		0.1		1.0		1.0		1.0		1.0		1.0		1.0
Total operating	0.0	0.4	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Direct personnel	1.7		4.0		5.0		5.0		5.0		5.0		5.0	
UB Utility Prog & Regulatory Interven														
Internal operating		0.2		0.3		0.5		0.5		0.5		0.5		0.5
Procurement		0.1		1.0		1.0		1.0		1.0		1.0		1.0
Total operating	0.0	0.4	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Direct personnel	1.7		4.0		5.0		5.0		5.0		5.0		5.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
UC01 Office of Special Counsel														
Internal operating		0.1		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.7		0.4		0.4		0.4		0.4		0.4		0.4
Total operating	1.2	0.9	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Direct personnel	1.2		2.0		2.0		2.0		2.0		2.0		2.0	
UC Compliance														
Internal operating		0.1		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.7		0.4		0.4		0.4		0.4		0.4		0.4
Total operating	1.2	0.9	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Direct personnel	1.2		2.0		2.0		2.0		2.0		2.0		2.0	
UD01 Contractual Activity														
Internal operating		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
UD Regulation Development														
Internal operating		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct personnel	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Assistant Secretarial Office Economic Regulatory Administration														
Internal operating		1.5		0.5		0.7		0.7		0.7		0.7		0.7
Procurement		1.8		1.4		1.4		1.4		1.4		1.4		1.4
Total operating	2.1	3.4	1.9	1.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Total A/S level	2.1		1.9		2.1		2.1		2.1		2.1		2.1	
Direct personnel	13.1		6.0		7.0		7.0		7.0		7.0		7.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
LA01 Technical Information Center														
Internal operating		0.4		0.5		0.6		0.6		0.6		0.6		0.6
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.6	0.4	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Capital equipment	0.0		0.1		0.1		0.2		0.1		0.1		0.2	
Total activity	0.6		0.7		0.7		0.8		0.7		0.7		0.8	
Direct personnel	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
LA Technical Information Services														
Internal operating		0.4		0.5		0.6		0.6		0.6		0.6		0.6
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.6	0.4	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Capital equipment	0.0		0.1		0.1		0.2		0.1		0.1		0.2	
Total program	0.6		0.7		0.7		0.8		0.7		0.7		0.8	
Direct personnel	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Assistant Secretarial Office Management and Administration														
Internal operating		0.4		0.5		0.6		0.6		0.6		0.6		0.6
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.6	0.4	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Capital equipment	0.0		0.1		0.1		0.2		0.1		0.1		0.2	
Total A/S level	0.6		0.7		0.7		0.8		0.7		0.7		0.8	
Direct personnel	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
PE01 Policy, Planning, and Analysis														
Internal operating		0.2		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.2	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	1.1		0.6		2.0		2.0		2.0		2.0		2.0	
PE Policy Analysis & Systems Studies														
Internal operating		0.2		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.2	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	1.1		0.6		2.0		2.0		2.0		2.0		2.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Assistant Secretarial Office Office of Policy, Planning and Anal														
Internal operating		0.2		0.2		0.2		0.2		0.2		0.2		0.2
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.2	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total A/S level	0.2		0.3		0.2		0.2		0.2		0.2		0.2	
Direct personnel	1.1		0.6		2.0		2.0		2.0		2.0		2.0	
VI01 Contractual Activity														
Internal operating		0.0		0.0		0.1		0.2		0.2		0.2		0.2
Procurement		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	0.5		0.5		1.0		2.0		2.0		2.0		2.0	
VI Other Services														
Internal operating		0.0		0.0		0.1		0.2		0.2		0.2		0.2
Procurement		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct personnel	0.5		0.5		1.0		2.0		2.0		2.0		2.0	
Assistant Secretarial Office Fed. Energy Regulatory Commission														
Internal operating		0.0		0.0		0.1		0.2		0.2		0.2		0.2
Procurement		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total A/S level	0.0		0.1		0.1		0.2		0.2		0.2		0.2	
Direct personnel	0.5		0.5		1.0		2.0		2.0		2.0		2.0	
NRC/Nuclear Reactor Regulation														
Internal operating		2.0		2.2		2.4		2.4		2.4		2.4		2.4
Procurement		0.5		0.1		0.1		0.1		0.1		0.1		0.1
Total operating	3.5	2.4	2.4	2.3	2.6	2.5	2.6	2.5	2.6	2.5	2.6	2.5	2.6	2.5
Direct personnel	20.9		20.0		20.0		20.0		20.0		20.0		20.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
NRC/Administration														
Internal operating		0.2		0.5		0.5		0.6		0.6		0.6		0.6
Procurement		0.2		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.5	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Direct personnel	6.5		2.5		2.5		3.0		3.0		3.0		3.0	
NRC/Nuc. Mat. Safety & Safeguards														
Internal operating		0.9		1.7		1.9		2.0		2.0		2.0		2.0
Procurement		0.6		0.1		0.0		0.0		0.0		0.0		0.0
Total operating	2.4	1.6	2.0	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Direct personnel	8.0		14.0		14.0		14.0		14.0		14.0		14.0	
NRC/Nuclear Regulatory Research														
Internal operating		14.2		16.6		18.6		18.7		18.7		18.7		18.7
Procurement		6.2		3.3		3.3		3.1		3.1		3.1		3.1
Total operating	26.6	20.4	18.6	19.9	21.3	21.8	22.2	21.8	22.2	21.8	22.2	21.8	21.8	21.8
Capital equipment	1.0		0.9		1.1		0.6		0.6		0.6		0.6	
Total activity	27.6		19.5		22.4		22.8		22.8		22.8		22.4	
Direct personnel	141.9		126.0		127.5		127.5		127.5		127.5		127.5	
NRC/Analysis & Eval. of Oper. Data														
Internal operating		0.4		1.3		1.4		1.5		1.5		1.5		1.5
Procurement		0.1		0.1		0.0		0.0		0.0		0.0		0.0
Total operating	0.7	0.6	1.5	1.4	1.5	1.5	1.6	1.5	1.6	1.5	1.6	1.5	1.6	1.5
Direct personnel	9.0		16.7		16.0		16.0		16.0		16.0		16.0	
NRC/Other Offices														
Internal operating		0.0		0.1		0.1		0.1		0.1		0.1		0.1
Procurement		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct personnel	0.0		0.0		0.0		0.0		0.0		0.0		0.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Nuclear Regulatory Commission														
Internal operating		17.8		22.3		24.8		25.2		25.2		25.2		25.2
Procurement		7.6		3.6		3.4		3.3		3.3		3.3		3.3
Total operating	33.9	25.4	25.0	25.9	27.8	28.3	29.0	28.5	29.1	28.5	29.1	28.5	28.7	28.5
Capital equipment	1.0		0.9		1.1		0.6		0.6		0.6		0.6	
Total program	34.9		25.9		29.0		29.7		29.7		29.7		29.3	
Direct personnel	186.3		179.2		180.0		180.5		180.5		180.5		180.5	
Dept. of Defense														
Internal operating		2.6		2.9		3.1		3.6		4.0		4.0		4.0
Procurement		0.4		0.4		0.3		0.3		0.3		0.3		0.3
Total operating	6.0	3.0	3.3	3.3	3.4	3.4	3.8	3.8	4.3	4.3	4.3	4.3	4.3	4.3
Capital equipment	0.1		0.1		0.0		0.0		0.0		0.0		0.0	
Total program	6.1		3.3		3.4		3.9		4.3		4.3		4.3	
Direct personnel	30.3		29.3		28.9		29.3		33.3		32.8		32.8	
Dept. of Interior														
Internal operating		0.7		1.0		0.8		0.9		0.9		1.0		1.0
Procurement		1.7		0.6		0.0		0.0		0.0		0.0		0.0
Total operating	2.9	2.4	1.6	1.6	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0
Direct personnel	6.6		11.1		7.1		7.1		7.0		7.1		7.1	
Dept. of Health and Human Services														
Internal operating		5.9		7.1		7.4		7.9		7.9		7.9		7.9
Procurement		0.6		0.4		0.4		0.4		0.4		0.4		0.4
Total operating	12.5	6.5	7.2	7.5	6.9	7.7	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Capital equipment	0.1		0.0		0.0		0.0		0.0		0.0		0.0	
Total program	12.6		7.2		6.9		8.3		8.3		8.3		8.3	
Direct personnel	76.5		85.9		86.5		88.0		88.0		88.0		88.0	
Environmental Protection Agency														
Internal operating		7.5		7.5		7.5		7.6		7.6		7.6		7.6
Procurement		1.2		0.5		0.5		0.4		0.4		0.4		0.4
Total operating	12.6	8.7	7.2	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Capital equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Total program	12.6		7.3		8.1		8.1		8.1		8.1		8.1	
Direct personnel	81.3		80.0		80.0		80.0		80.0		80.0		80.0	

Table A.2 (continued)

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
National Science Foundation														
Internal operating		1.1		1.9		1.9		1.9		1.9		1.9		1.9
Procurement		0.4		0.2		0.2		0.2		0.2		0.2		0.2
Total operating	2.6	1.4	2.1	2.1	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Direct personnel	10.7		14.4		14.4		14.4		14.4		14.4		14.4	
Tenn. Valley Authority														
Internal operating		0.8		0.6		0.8		0.8		0.8		0.8		0.8
Procurement		0.1		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	1.9	0.9	0.8	0.6	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Direct personnel	6.9		5.5		6.0		7.0		7.0		7.0		7.0	
DOE Contractors and Operations Off.														
Internal operating		10.5		6.9		5.6		5.8		5.9		6.0		6.0
Procurement		4.7		0.9		1.0		1.1		1.0		0.9		0.9
Total operating	17.4	15.3	6.8	7.9	6.6	6.6	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Capital equipment	0.2		0.1		0.1		0.1		0.1		0.1		0.1	
Total program	17.5		6.8		6.7		7.0		7.0		7.0		7.0	
Direct personnel	93.4		60.1		47.0		47.4		47.4		47.4		47.4	
Other Federal Agencies														
Internal operating		1.7		1.8		2.5		2.6		2.6		2.3		2.3
Procurement		0.6		0.6		0.8		0.9		0.9		0.9		0.9
Total operating	3.1	2.2	2.4	2.4	3.3	3.3	3.4	3.4	3.5	3.5	3.1	3.1	3.1	3.1
Direct personnel	9.9		16.1		20.6		20.6		20.6		17.6		17.6	
Elec. Power Research Institute														
Internal operating		1.5		2.4		2.7		3.2		3.6		3.9		4.3
Procurement		0.3		0.2		0.2		0.2		0.2		0.2		0.2
Total operating	3.9	1.7	2.6	2.6	2.9	2.9	3.4	3.4	3.8	3.8	4.1	4.1	4.5	4.5
Capital equipment	0.1		0.0		0.0		0.0		0.0		0.0		0.0	
Total program	4.0		2.6		2.9		3.4		3.8		4.1		4.5	
Direct personnel	20.5		26.0		26.0		30.0		33.0		36.0		39.0	
Other Nonfederal Agencies														
Internal operating		2.1		0.6		0.6		0.5		0.5		0.4		0.4
Procurement		0.6		0.0		0.0		0.0		0.0		0.0		0.0
Total operating	0.3	2.7	0.8	0.6	0.8	0.6	0.7	0.5	0.7	0.5	0.6	0.4	0.6	0.4
Direct personnel	3.6		5.0		5.0		5.0		5.0		5.0		3.7	

TABLE A3. WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
AA0505050	00201	Chem Of Adv Mag Scrub for SO2-NO2 C
AA0505050	00207	Assess of Bioler Air Pollution Opti
AA0510150	00107	Energy Demand Modeling and Analysis
AA0515000	00006	Fossil Ener Envir Supp
AA0515000	00207	Asses of Boiler Air Emission Option
AA0515000	00211	FE Solid Waste Extractions
AA1505000	00157	Ceramic Hx for FF Comb
AA1505000	00500	AFBC Matls (METC)
AA1510100	00028	AR&TD Fossil Energy Mtls Program
AA1515050	00214	MPC Ph II Monitor
AA1515100	00084	Process Research Digest
AA1515100	00208	Selective Ben & SCT Lique
AA1515100	00209	Indirect Liquefaction Chem Res
AA1515100	00302	New Liquefaction Techniques
AA1515100	00305	Physical Properties of Coal Liquids
AA1520150	00213	Liquefaction Ect Assessments
AA1520151	00311	IEA - EA Service
AA1520151	00316	Systems Analysis Support
AA1520151	00324	Performance Assurance & Stand
AA1520152	00016	Industrial Boiler Lens Anal.
AA1520152	00200	Aspen
AA1520152	00204	Envir Cont Assess
AA1520152	00213	Liquefaction ECT Assessments
AA1520152	00223	Environmental Newsletter
AA1520152	00224	FE In-Depth Envir. Analysis
AA1520152	00228	FE Environ. Safety & Health Supp.
AA1520152	00800	Pollution Control Doc. Rev.
AA1520153	00016	Industrial Coal Analytical Support
AA1520153	00205	GEMS/Liquid-Gaseous Fuel Supplies
AA2520000	00209	Ind Lique Chem Res
AA2525200	00155	SRC Market Penetration
AA2530100	00206	H-Coal Env Field Eval
AA2530100	00216	Eff Of Hydrotreat & Other Mitig Pro
AA2530100	00225	Health Effects Indirect Liquefact
AA3505100	00202	Oxygen Meas Sys.
AA3505150	00212	FBC Activities in India
AA3505300	00017	Coal Combustion for Coal Generat
AA3505300	00229	Carbon Utilization Improvement
AA3505400	00017	Coal Combustor for Cogenerat
AA3510100	00326	Systems Assessment of PFBC
AA3510150	00326	Systems Assessment of PFBC
AA3520100	00326	Systems Assessment of PFBC
AA3525050	00202	OMS Probe
AA3525050	00326	Systems Assessment of PFBC
AA4515000	00005	Phy Chem High Temp Fu Cell El
AA4515000	00006	Environmental Assistance
AA5505050	00159	Dist Heating - Fossil Ener Po
AA5505100	00107	Coal Tech Market Penetration
AA5515150	00011	Low-Temperature Heat Utilization
AA6525000	00115	UCG

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
AA7505100	00100	Coal Preparation Plant Automation
AA7505100	00116	Magnetic Benification
AA7505150	00100	Coal Preparation Plant Automation
AA7505150	00116	Magnetic Beneficiation
AA7505200	00326	Systems Assessment of PFBC
AA8515100	00810	Metc Gasif Matls
AA8515150	00214	Materials Testing In Gasif Pilot Pl
AA8525050	00001	Synthetic Fuels Data Mgt-UMD
AA8525050	00067	Tech Supt & Wkshp on Crit Coal Conv
AA8525050	00203	METC Modeling Support
AA8530050	00076	Gasif Demo EIS & Follow-On
AA8530050	00078	Synthetic Fuels Leachate
AC0505000	00115	UCG
AC1505101	00316	LTAS
AC1510104	00075	Chemicals for Enhanced Oil Recovery
AC1510104	00087	Ionex and Enhanced Oil Recovery
AE0505000	01307	Support for Energy Center Studies
AE0505000	01308	NEC Atmospheric Effects (METER)
AE0505000	01311	Assessment of Process Applications
AE0505000	01478	District Heating Studies
AE0510000	01447C	Program Planning and Analysis
AE0510000	01478A	District Heating (SPDHDC)
AE0510000	1447D	Nuclear/Coal Generation Cost
AE1515000	02313	Solar-Polar Mission Mtls & Support
AE1520000	01322	Space Flight Systems Hardware
AE1535000	01367	Terrestrial Radioisotope Appl Dev
AE1535000	01495	Systems Technology Support
AF0515000	CFR1	Breeder Reprocessing
AF0515000	CFR1000	CFRP (BFR) Prog Mgmt
AF0515000	CFR1100	CFRP (BFR) Studies and Anal
AF0515000	CFR1200	CFRP (BFR) Breeder Reproc
AF0515000	CFR1310	CFRP (TRP) Mech Head-end
AF0515000	CFR1310	CFRP (TRP) Mech Head-End
AF0515000	CFR1320	CFRP (BFR) Noloxidation
AF0515000	CFR1330	CFRP (BFR) Dissolution
AF0515000	CFR1335	CFRP (BFR) Feed Preparation
AF0515000	CFR1340	CFRP (BFR) Off Gas
AF0515000	CFR1350	CFRP (BFR) Solvent Extract
AF0515000	CFR1360	CFRP (BFR) Adv Process
AF0515000	CFR1370	CFRP (BFR) Lab Studies
AF0515000	CFR1380	CFRP (BFR) Hot Cell Studies
AF0515000	CFR1390	CFRP (BFR) Dummy Fuel Proc
AF0515000	CFR1630	CFRP (BFR) Waste Handling
AF0515000	CFR1680	CFRP (BFR) Waste Handling
AF0515000	CFR1810	CFRP (BFR) Environ and safety
AF0515000	CFR1820	CFRP (BFR) Analytical Dev
AF0515000	CFR1830	CFRP (BFR) Safeguards Assess
AF0515000	CFR1840	CFRP (BFR) Nuc Eng
AF0515000	CFR1860	CFRP (BFR) Inst and Controls
AF0515000	CFR1871	CFRP (BFR) Special Remote Sys

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
AF0515000	CFR1875	CFRP (BFR) Remote Control Eng
AF0515000	CFR1880	CFRP (BFR) Facility Operations]
AF0515000	CFR1890	CFRP (BFR) Mat'ls Comp
AF0515000	CFR1920	CFRP (BFR) Inst Equip Test
AF0515000	CFR1930	Hot Experimental Facility
AF1015000	01352	Core Flow Test Loop (CFTL)
AF1025000	01350	GCFR PCRV and Closures
AF1025000	01351	GCFR Shielding Studies
AF1540101	OH016	Measurements & Controls Technology
AF1540102	OH037	Clad/Duct Development
AF1540103	OR1.1	High-Temp Structural Design Tech
AF1540103	OR1.10	MSTMC Development
AF1540103	OR1.3	Mech Props Design Data
AF1540103	OR1.4	Fabrication
AF1540103	OR1.5	NDT Technology
AF1540103	OR1.7	Advanced Alloy Development
AF1540103	OR1.8	Documentation
AF1540104	OH004	Fast Shielding Experimenal Prog
AF1540104	OH013	Cross Sections for Reactor Mtls
AF1540104	OH015	Radiation Shielding Info Center
AF1540104	OH054	Meth Dev, Sensit Anal-INT Exp Test
AF1540104	OH057	Shielding Analysis
AF1540104	OH153	US/UK Actinide Irradiations
AF1540105	OH020	R&D Integration
AF1540105	OH044	LOA-2 THORS
AF1540105	OH136	LOA-4 Environment
AF1540352	OH022	Nuclear Standards Management Center
AG2505000	01329	HTGR Chemistry Studies
AG2505000	01330	Fueled Graphite Development
AG2505000	01331	PCRV Development
AG2505000	01332	HTR Materials Studies
AG2505000	01333	HTGR Graphite Studies
AG2505000	01334	HTR Shielding
AG2505000	01335	HTR Physics
AG2505000	01336	HTR Assessments
AG2505000	01337	GA Irradiation Services
AG2505000	01338	HTR CFTL Studies
AG2505000	01339	HTR Safety
AG3510000	1447E	Nuclear/Coal Gen Cost
AG3520000	OH020A	NSIC (DOE-LWR)
AG3520000	ORLWRS1	Special Assignment-Flanagan
AG3530100	ORTMI01	TMI-Examinations
AG4010100	CFR3000	LWR Fuel Cycle Reprocessing
AG4010100	CFR3330	CFRP (BFR)-Dissolution
AG4010100	CFR3340	CFRP (BFR)-Off-Gas
AG4010100	CFR3350	CFRP (BFR) Solvent Extract
AG4010100	CFR3380	CFRP (BFR) Hot Cell Studies
AG4010100	CFR3400	CFRP (LWR) Products Conver
AG4010100	CFR3810	CFRP (LWR) - Environ and Safety
AG4010100	CFR3875	CFRP (BFR) Remote Control Eng

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
AG4015100	CFR2000	Thorium Fuel Cycle Reprocessing
AG4015100	CFR2100	CFRP (TRP) - Hot Exp Fac
AG4015100	CFR2310	CFRP (TRP) - Mech Head-end
AG4015100	CFR2340	CFRP (TRP) - Off Gas
AG4015100	CFR2350	CFRP (TRP) -Solvent Extract
AG4015100	CFR2370	CFRP (TRP) - Lab Studies
AH1005000	ONLWF01	FUSRAP Management
AH1005000	ONLWF02	FUSRAP R&D
AH1005000	ONLWF03	FUSRAP Information Support
AH1015000	ONLWDX1	Uranium Mill Tailings Treatment
AH1015000	ONLWDX3	EIS Assistance
AH1015000	ONLWDX5	Liners for Mill Tailings
AH1020000	ONLWD05	FPDL Decommissioning
AH1020000	ONLWD06	ILW Transfer Line Decommissioning
AH1020000	ONLWD09	Commercial Surplus Fac Surveil
AH1020000	ONLWD15	MSRE Decommissioning
AK0505000	00002	2nd Intern'l Symp on Gaseous Dielec
AK0505000	00004	High Voltage Research
AK0505000	00006	Environ Eff of Dielectric Gases
AK0505000	00012	High Voltage Technology
AK0510000	00012	HVTP
AK0525000	00012	High Voltage Technology
AK1005000	00014	EES New Tech Integration
AK1010000	00007	Electric Energy Use Mgmt
AK1010000	00011	DOE/TVA/TVPPA Load Mgmt & Dist Auto
AL0505050	00004	CS Strategy Sub.
AL0505050	00035	CS Strategy
AL1005050	00001	Thermal Energy Storage Program
AL1015000	00001	TES Technical and Economic Analysis
AM0520000	00005	Env Anal of Geoth Engy - Geopressur
AM1005100	00003	Heat Rej In Geo Power Plants
AM1505000	00004	Env Anal of Geoth Energy - Hydrothe
AM1515000	00003	Waste Heat in Geo. Plants
AP0515250	ONLWR02	Commercial Waste Transport Studies
AP0525050	ONLWA02	Krypton Hydrofracture
AP0525100	ONLWH01	HLW Analysis
AP0525100	ONLWH02	Fixation of Wastes in Concrete
AP0525100	ONLWH10	High-Level Waste Container Dev-ORNL
AP0525100	ONLWH12	Matl's Research Society
AP0525100	ONLWH16	ORNL Sol-Gel Coated Particles
AP0525150	ONLWL03	Waste Mgmt Info Sup
AP0525150	ONLWL46	Zeolite Stability
AP0525200	ONLWI99	Integrated Data Base
AR0505000	ONLWD08	Defense Surplus Fac Surveil
AR0505000	ONLWD11	Curium Facility Decommissioning
AR0505000	ONLWD12	Metal Recovery bldg Decommissioning
AR0505000	ONLWD13	ILW Transfer Line Decommissioning
AR051005K	ONLWI01	Int. Waste Mgmt. Data Base
AR051005K	ONLWN01	Liquid & Gaseous Waste Syst Oper
AR051005K	ONLWN02	ORNL Site Specific Low Level

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
AR051005K	ONLWN03	Gunite Tank Sludge Removal
AR051005K	ONLWN04	Solid Waste Storage Management
AR051005K	ONLWN05	Hydrofracture Mix Development
AR051005K	ONLWN06	Operational Planning & Development
AR051005K	ONLWN07	Volume Reduction Operations
AR051005K	ONLWN08	Conversion of Cellulosics
AR051005K	ONLWN09	LLWDF Design & Dev. Support
AR051005K	ONLWN10	Mgmt Metal Waste-UCND Sites
AR051005K	ONLWN12	Int Waste Mgmt Data Base
AR051005K	ONLWN13	Central Waste Disposal Facility
AR051005K	ONLWR07	Transportation Studies
AR0515050	ONLWA05	Carbon-14 Immobilization
AR0515100	ONLWH04	ORNL Sol-Gel Technology
AR0515100	ONLWH07	ORNL Sol-Gel Coated Particles
AR0515150	ONLWL01	LL Waste Program Management
AR0515150	ONLWL09	ORNL Remedial Action
AR0515150	ONLWL14	ORNL Disposal Site
AR0515150	ONLWL25	FRG Cooperative PRogram
AR0515150	ONLWL32	Shallow Land Burial-Handbook
AR0515150	ONLWL33	Remedial Action-Handbook
AR0515150	ONLWL34	Handling Study
AR0515150	ONLWL35	SLB Barriers Migration
AR0515150	ONLWL37	Remedial Action Engineering
AR0515150	ONLWL38	Decontamination Effectiveness
AR0515150	ONLWL47	Site Evaluation Procedures
AR0515200	ONLWR08	Transportation Studies
AR0515200	ONLWT01	Vol Red Metal Scrap by Melting
AR0515200	ONLWT02	TRU Waste In Concrete
AR0515200	ONLWT04	TRU Waste Alternatives Assessment
AR0515200	ONLWT09	TRU Waste Disposal
AR0515200	ONLWT10	Instrumentation Support
AR0525000	ONLWR01	Defense Waste Transport Studies
AS0505100	ONLWS02	SF Trans Studies
AT0520210	00046	Tokamak Confinement Theory
AT0520230	00115	EBT Confinement Theory
AT0520240	00047	Theoretical Atomic Phy for Fusion
AT0530320	00048	Controlled Fusion Atomic Data Ctr
AT0530320	00049	Diagnostics of High Temp Plasmas
AT0530320	00050	Atom Molec Nuc Physics in CTR
AT0540420	00052	User Service Center Operations
AT101011G	00002	Tokamak Operations
AT101011G	00134	ISX-C Operations
AT101011G	00136	ISX-C Heating
AT101011G	00153	Ion Beam Probe
AT101011G	00155	ECH on ISX-B at 28GHz
AT101011Z	00152	Neutronics Exp. At TFIR
AT101011Z	00154	Pellet Fueling-Confinement
AT101012B	00102	ISX-B Bundle Divertor
AT102021C	00008	EBBT-S Base
AT102021C	00127	EBT-P Related Operations

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
AT102021C	00138	EBT-S Divertor Fabrication
AT102021C	00139	EBT-S ICRH Installation
AT102021C	00140	EBT-S ECH
AT102021C	00156	EBT-S Scattering
AT102021C	00157	EBT-S Time-of-Flight
AT1510131	00011	LCP Coil Subcontract
AT1510132	00013	LCTF Construction
AT1510133	00122	LCP R&D Activities
AT1510134	00012	LCP ORNL Management
AT1510135	00014	LCTF Operations
AT1510141	00056	Advanced Conductor Development
AT1510142	00010	12 Tesla Coil Program
AT1520212	00017	Adv Positive Ion Source Dev
AT1520213	00148	Negative Ion Source Development
AT1520214	00054	Neutral Beam Test Fac Operations
AT1520214	00147	Zephyr Beam Line Design
AT1520220	00021	Gyrotron Development
AT1520250	00023	Pellet Fueling
AT1530310	00025	Alloy Development for Irrad Perf
AT1530320	00027	Plasma-Materials Interactions
AT1530320	00162	Advanced Limiters and Liners
AT1530330	00032	Insulators for Supercon Magnets
AT1530340	00033	Damage Analysis & Dosimetry
AT1530352	00034	Radiation Facilities Operation
AT1540410	00035	FEDC
AT1540410	0035	ETF
AT1540420	00163	FEDC Model
AT1540430	00039	RSIC
AT1540430	00041	Blanket & Shield Int Exp
AT1540430	00160	Data Eval & Process Fusion Neutroni
AT1540450	00044	Plasma Systems Analysis (Tokamak)
AT1540450	00151	EBT Advanced Systems Analysis
AT1550510	00043	Magnetic Fusion Env Assess Prog
AT1550510	00133	Tritium Permeation and Steam Genera
AT3020000	00161	Magnetic Fusion Development
BA0301000	00005	Alcohol Fuels
CA0101000	00001	RA/LPDO-Int Region Sys. Coal
CA0401000	00001	RA Coal Production Goals
CD2001010	ORN102	Recovery of URanium from Phos Acid
CD2003010	ORN101	GJOIS
CE1003000	00002	Envir Research for Small Hydro
CE2000000	CE020	Low-Head Hydro Feasibility
CG0107000	00001	RA-Coal Production Goals
CG0107000	00002	RA/BLM Wilderness Studies
CH0513000	00001	Engy Res Lost Thru Land Withdraw
CH0513000	00002	Anal Of Energy Transportation
EB0102000	00401	Passive Solar
EB0102000	00411	Passive Solar-Res/Pro
EB0102000	A2014	ACSA Student Design
EB0103000	00015	Solar Gauge

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
EB0103000	00017	Eff of Wea & Atm Contam on PV
EB0103000	00018	Decentralized Solar (DSETAP)
EB0103000	00021	Tech Assist PV Demo Projects
EB0201000	00010	Agricultural Process Heat
EB0201000	00011	High Temp Appl of Solar Energy
EB0202000	00001	Fuel & Chem From Woody Biomass
EB0202000	00002	Effects of Whole Tree Harvesting
EB0202000	00003	Biomass Energy Environ Project
EB0202000	00005	Alcohol Fuels
EB0202000	00009	Pyrolysis Of Biomass In Hydrogen
EB0202000	00012	On-Farm Biomass
EB0202000	00026	Asses-Poten Use of Biomass for Prod
EB0202000	00048	FERT & Tilth Eff of Fuel Crop Res
EB0202000	NOEW1	Prod. of 2,3-Butanediol
EB0202000	NOEW10	On-Farm Biomass
EB0202000	NOEW3	Production of Ethylene
EB0202000	NOEW4	Enzymatic Cellulose Hydrolysis
EB0301000	00014	EES-Wind Dynamics
EB0302000	00013	OTEC Alternate Cycles Development
EC0100000	00002	Aces Implementation Program
EC0100000	00004	Engr-Econ Models of Energy Use
EC0100000	00020	Tech Mgt Of the Res Ener Conserv De
EC0100000	00027	Bldgs Division Information Syste,
EC0100000	00031	BEPSII
EC0100000	A1014	Administration/Technical Support
EC0100000	A2014	ACEC-Engr Fac 7910
EC0100000	B0014	E-Materials
EC0100000	C0014	Etesim C-Thermal Envelope Systems
EC0100000	D0014	D-Diagnostics
EC0100000	E0014	Innovative Concpets
EC0200000	00005	Energy Demand & Anal Res & Com Sect
EC0200000	00025	Iat Assess Bldgs Cons Program
EC0300000	00021	Bldgs End Use Data Book
EC0300000	00026	Dist Heat Film & Alt Heat Source
EC0300000	00030	District Heating Studies
EC0300000	00037	National District Htng Program
EC0300000	B0014	BTESIM: B -- Materials
EC0400000	00006	ANFLOW - Muncipal
EC0400000	00026	Alt Heat Srcs For St Paul Dist Heat
EC0400000	00032	Refuse/Energy Project
EC0400000	00035	Energy Savings from Recycling
EC0400000	00036	ANFLOW Packing Materials
EC0400000	C0014	BTESIM C - Thermal Envelope System
EC0500000	00001	Heat Pump R&D Program
EC0500000	00003	Management of Appliance Program
EC0500000	00007	Distributed Electric Systems
EC0500000	A2014	BTESIM: Az. Education/Information
EC0500000	D0014	BTESIM D - Diagnostics
EC0600000	00004	RCS-Tax Credit Analysis
EC0600000	00005	Engineering Economic Models

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
EC0600000	00020	RCS
EC0600000	00025	Integrated Assessment
EC0600000	00035	CS Strategy-Bldg Anal
EC0600000	E0014	Innovative Concepts
EC0700000	00020	Management of RCS Program
ED0101000	00001	Thermal Energy Stor-Dis Heat
ED0101000	00009	Materials - Waste Heat Utilization
ED0102000	00020	ANFLOW - Industrial Wastewater Trea
ED0103000	00004	Conservation and Solar Strategy Stu
ED0201000	00002	High Temp Process Support
ED0300000	00009	Mat'ls For Waste Heat Utilization
ED0403000	00002	Industry Data Valid.
ED0403000	00003	Industrial Data Validation
EE0315000	00004	CS Strategy Sub
EE0501010	00001	Motor Vehicle MPG & Mrkt Share Data
EE0501020	00001	Driver Efficiency and Vehicle Testi
EE0502010	00001	Intermodel Energy Conservation
EE0502030	00001	State Motor Fuel Conserv Targ
EE0503000	00001	Anal Of Transp Rel To Energy Use
EF0102000	00025	Integ Assess Of Bldgs In Cons Prog
EF0102000	00035	Planning Anal & Eval of Consers.
EF0400000	00045	Price Waterhouse Subcon.
EF0500000	00045	Price Waterhouse Subcon.
EF0600000	00035	Plan, Anal, & Eval at Conserv Progs
EF0700000	00001	Office of Emergency Programs
EG0500000	00001	ECUT Materials Project
GC0102080	OR00001	Proliferation Information Workshop
GD0101000	OR04011	OSS Mass Spectrometry
GE0348040	ON5419A	233U Dispensing Facility
GE0348040	ON5419B	Inventory--Heavy Element Production
GE0348040	ON5519A	Con-Ed Conversion
HA0101010	003474	Envir Tech Assist and Guidelines
HA0101020	003714	Information For Participation In Ne
HA0103010	002975	Regulatory Analysis Division
HA0103020	002976	Technology Assessments Division
HA0103030	002224	Regional Impacts Division
HA0107010	800048	Reduce Bioactivity of Dir. Liqu.
HA0107010	800060	Assessment of ECT for Coal Conv
HA0107010	800158	Effluent Control for HC/CO
HA0107010	800361	H-Coal Field Eval of ECT
HA0107010	800387	Hazard Evaluation of Solid Wastes
HA0107010	800403	Gasifiers in Industry-UMD-ECT
HA0107010	800411	Eval of Alt Raw Gas Scrubbing
HA0107010	800441	Disposal Sludges for Coal Conv
HA0107052	800477	Radiological Surveys
HA0108010	600097	Emergency Technology
HA0108020	NOEW50	Gasification Plant Guidelines
HA0201010	000801	Dosimetry for Human Exposures
HA0201010	003344	Anal & Effs from Cooling Tower

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
HA0202010	000143	Fission Neutrons & Gamma Ray
HA0202010	000146	Dose Response Relation In Chem
HA0202010	000190	Radiation Immunology
HA0202010	001562	Somatic Effects Of Environment
HA0202010	002374	Nucleic Acid Biochemistry
HA0202010	002589	Carcinogen Activity in Human
HA0202010	003148	Sol St Radioimmunoassay in Coc
HA0202010	003346	Chem Carcinogens & UV Radiation
HA0202010	003347	Metal Mutagens & Carcinogens
HA0202010	003350	Carcinogenic Interaction
HA0202010	003351	Radioimmunoassay of DNA Damage
HA0202010	003352	Chemical Effect on Nucleic Acids
HA0202010	003441	H-Coal Bioassay
HA0202010	003550	Benzopyrene-DNA Adduct Structures
HA0202010	003551	Interpretation of Cancer Tests
HA0202010	003552	Radn Carc-Time Dose Relation
HA0202010	004086	Rapid Assays for Carcinogenic
HA0202010	NOEW48	Radiation Risk Assessment
HA0202020	000173	Mammalian Biochem Genetics
HA0202020	000174	Mammalian Genetics
HA0202020	000181	Mammalian Cytogenetics
HA0202020	000237	Mammalian Cell Genetic Toxicology
HA0202020	000287	Medical & Molecular Genetics
HA0202020	001569	Comparative Mutagenesis
HA0202020	001570	Mammalian Chem Mutagenesis
HA0202020	002527	Genetic Effect of Plutonium
HA0202020	002591	Mechs of Mamm Mutagenesis
HA0202020	003152	Genetic Basis of Mutagenesis
HA0202020	003354	Genetic Dissection of DNA Repair
HA0202020	003445	H-Coal, Mammalian Cell
HA0202020	003446	H-Coal, In-vivo Mutagenesis
HA0202020	003447	H-Coal, Cell Screening
HA0202020	003555	Freezing Mouse Mutants
HA0202020	NOEW31	Flow Cytometric Assays for Carc.
HA0202020	NOEW49	Eastern Oil Shale, Cell Screening
HA0202030	000159	Biostatistics & Biomathematics
HA0202030	000183	Mammalian Gametogenesis
HA0202030	001702	Pollutants in Cardiovascular
HA0202030	002362	Chemical Toxicology
HA0202030	002373	Teratology Mechs and Prescreening
HA0202030	NOEW32	Pharmacokinetics and Dosimetry
HA0202030	NOEW33	Immunotoxicology
HA0202030	NOEW34	Mammalian Reproductive Toxicology
HA0203010	000604	Fusion Tech: Aquatic Environ Effec
HA0203010	000608	Transport, Fate, & Effs of Ener Eff
HA0203010	000681	Envir Effs of Enrichment Facs
HA0203010	000690	Actinides in the Environment
HA0203010	002382	Fld Site Env Res Rel Coal Conv
HA0203010	002528	Radionuc Srcs in Coastal Zone
HA0203010	003156	Technetium in the Environment

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
HA0203010	003157	Gasifiers in Industry
HA0203010	003356	Comp Env Tox Coal Liq Prod
HA0203010	003731	Eastern Shale Environmental
HA0203010	003912	Conf on Mitigation in Environ. from R
HA0203020	000609	Ecological Progs in Aquatic System
HA0203020	001693	Trans & Effs Coal Conv Effuents
HA0203020	003357	Ozonation of Cooling Waters
HA0203020	003546	H Coal Environmental Project
HA0203020	004081	Assess of Gas from Coal Conv
HA0203030	001565	Bioengineering Research
HA0203030	001711	Biochem Treatment of Wastes
HA0203030	002926	Utilization of Sulfur - Cycl Micro.
HA0203030	003659	Bioengineering Research
HA0203040	000929	National Environmental Research Par
HA0203040	001670	National Chlorination Conference
HA0203040	002936	Dev of Guidelines for Montr
HA0203040	002937	NERP Reference System
HA0204010	001710	Chem Char Org Matl Re Coal Conv
HA0204010	001722	Facility for Bioassay Chem Sup
HA0204010	002613	Auto Anal for Workplace
HA0204010	003175	Gasifiers in Industry-UMD
HA0204010	003176	Gasifiers in Industry-Pike
HA0204010	003469	H-Coal Field Evaluation
HA0204020	001624	Atmosphere-Canopy Interactions
HA0204030	001606	Dev-Auto Microfluor-Personnel Mon
HA0204030	001607	Analytical Spectroscropy of PAH's
HA0204030	001608	Resonance Ionization Spectroscopy
HA0204030	001608	Risk Data Base
HA0204030	001609	Environ. & Personnel Monitoring
HA0204040	000714	Health Physics Research Reactor
HA0204040	000717	Medical Physics & Internal Dos
HA0204040	001707	Dosimetry for New Energy Sys Poll
HA0204040	NOEW53	Validation of Organ Dosimetry
HA0204050	000722	Atomic & Molecular Physics
HA0204050	001478	Studies-Phys Param-Health Protectn
HA0204050	001602	Ion Chem in the Atmosphere
HA0204050	001604	Ion Formation & Clustering Phenom
HA0204050	001605	Surf Inter & Ion Part Accretion
HA0204050	001706	Microdosim & Biol Modeling
HA0205010	001669	Global Carbon Cycle & Climate
HA0205010	003160	Bioclimatology Of Energy Impacts
HA0205010	003457	Elevated CO2 Effects On Terrest
HA0205010	003547	Comparison Of Soil Org Carbon
HA0205010	003732	Dev. of Laser Detection System
HA0206000	003462	Health/Env. Impacts H-Coal
HA0206000	NOEW06	Water Clorination Conf.
HB0100000	000151	Regulation of Hematopoiesis
HB0100000	000158	Growth & Regeneration
HB0100000	000162	Mechanism of Radiation Lethal
HB0100000	000164	Bioprocessing for Energy Production

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
HB0100000	000165	Nucleic Acids in Pathogenesis
HB0100000	000167	Theoretical & Applied Cryobiol
HB0100000	000169	Enzyme Regulation
HB0100000	000177	Drosophila Cytology & Genetics
HB0100000	000178	Yeast Mutagenesis
HB0100000	000179	Microbial Mutagenesis & Cell
HB0100000	000184	Effects & Uses of Chromosomes
HB0100000	000233	Protein Synthesis-Aberrant Co
HB0100000	000282	Photophysics of Macromolecules
HB0100000	000283	Environmental Insults to DNA
HB0100000	000284	Chromosome Chemistry
HB0100000	000288	Molecular Genetics
HB0100000	000607	Dev of Ecological Systems
HB0100000	000611	Deciduous Forest Ecosystems Program
HB0100000	000718	Transport & Surface Physics
HB0100000	000719	Chemical Physics Studies
HB0100000	000720	Liquid & Submicron Physics
HB0100000	000721	Physics of Solids & Macromolecules
HB0100000	001471	X-Ray Diffraction
HB0100000	001472	Protein Chemistry
HB0100000	001476	Molecular Aspects of Radiation
HB0100000	001560	Chem Effects on the Immune
HB0100000	001603	Physicochem Prop of Chem Poll
HB0100000	001610	Energy pathways in Irrad Gases
HB0100000	001699	Gene Expression in Carcinogenesis
HB0100000	001701	Carcinogen-Cell Genome Interact
HB0100000	002360	Studies-Tumor Cell Immunology
HB0100000	002368	Reg of Membrane Transport System
HB0100000	002371	Metabolism of Aromatic Amino
HB0100000	003236	Mechanisms of Damage & Repair
HB0100000	003464	Tissue Culture Facility
HB0201000	000982	HFIR & 86-In Cyclotron Tech Support
HB0201000	001161	Nuc Medicine & Biomed Technology
HB0201000	NOEW20	Radisotope Prod Tech Dev
KA0101000	00001	High Energy Physics
KA0101000	00002	Hi Energy Accel Shield Studies
KB0101000	00011	Meson Physics
KB0201000	00012	Heavy Ion Nuclear Research
KB0202000	00016	Heavy Ion Laboratory Operations
KB0202000	00017	HHIRF User Support
KB0202000	00018	Heavy Ion Laboratory Development
KB0300000	00020	Theoretical Nuclear Physics
KC0101010	00001	Light Ion Nuclear Physics
KC0101010	00004	Basic Neutron Physics Research
KC0101020	00005	Operations - ORELA
KC0101020	00006	Nucl Data-Fusion & Fission React
KC0101020	00008	Neutron Capture
KC0101020	00010	One-Atom Det-Sol Neut Meas
KC0101030	00002	Nuclear Data Project
KC0101040	00012	Chem of Transuranium El & Comp

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
KC0102010	00013	Electromag Isotope Separation
KC0102010	00113	Isotope Enrichment for Sales
KC0102020	00014	High Flux Isotope Reactor
KC0102020	00015	Transuranium Element Processing
KC0102020	00016	Dist of Special Isotopes for Res
KC0201000	00128	Cap Equip for Hi Temp Matls Prog
KC0201010	00018	Structure of Matls for Energy Syst
KC0201010	00019	X-ray Research
KC0201010	00020	Anal & High Voltage Electron Micros
KC0201010	00179	Plan and Assess BES
KC0201020	00021	Def & Fract of Struct Matls
KC0201030	00022	Solid State Reacts & Transp Phen
KC0201040	00023	Radiation Effects
KC0201050	00024	Fundamentals of Welding & Joining
KC0201050	00025	Studies in Nondestructve Evaluation
KC0201050	00026	Structural Ceramics
KC0201050	00124	Research in Hi Temp Matl Processing
KC0201050	00125	Corrosion in Coal-Derived Liquids
KC0201050	NOEW3	Struct of Long-Range Ord Alloys
KC0202010	00027	Interatom Interact in Cond Systems
KC0202010	00028	Prop-Defects, Supercond, Hydrides
KC0202010	00029	Support for Neutron Users' Program
KC0202020	00031	Phys Prop of Superconductors
KC0202020	00032	Phytophys Proc-Solar Energy Conv
KC0202020	00033	Fund Aspects of Metal Fracture
KC0202020	00038	Scatter of Synchrotron Radiation
KC0202020	00134	High Temp Ceramic Materials
KC0202020	00136	Prep & Char of Res Matls
KC0202030	00039	Theory of Condensed Matter
KC0202040	00040	Radiation Effects in Metals
KC0202040	00044	Gases in Metals
KC0202040	00141	Normal of Ion & Neutron Damage
KC0202050	00017	R&D - Isotope Research Matls Prep
KC0202050	00042	Surface Physics & Catalysis
KC0202050	00143	Ion Beam Analysis & Ion Implant
KC0202050	00144	Radioactive Waste Storage
KC0202050	00145	Rapid Heating & Cooling Process
KC0202050	NOEW5	Homogeneous Hi Temp Cer & Alloys
KC0203010	00045	Chem Structure of Energy Rel Mat
KC0203020	00046	Thermodyn of Energy Related Syst
KC0203020	00047	Chem Eng Res (Matls Science)
KC0203020	00048	Hi Temp Chem & Thermo Str Mat
KC0203020	00179	Planning & Assessment - BES
KC0203020	NOEW6	Plasma Chemistry
KC0203020	NOEW7	Engr Prop-Fluids at Extreme Conds
KC0203030	00050	Phys Chem Molten Salts in Ener Util
KC0203030	00051	Local Corr & Str Cr Ph Rel En Te
KC0301020	00055	Atomic & Molecular Coll Dynamics
KC0301020	00056	Photo, Pyro & React Int by El Spin
KC0301020	00057	Theoretical Chemistry

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
KC0301020	00059	Molecular Res El Spectroscopy
KC0301030	00058	Merged Electron Heavy Ion Beam
KC0301030	00060	Collision of Low Energy Ions
KC0301030	00061	Accelerator Atomic Physics
KC0301030	00063	Theoretical Atomic Physics
KC0301030	00064	En-Tandem Operations
KC0302010	00069	Kinetics of Enzyme
KC0302010	00070	Inorg Chem of Hydrogen Cycles
KC0302010	00071	Aq Chem & Thermo El Temp & Pres
KC0302010	00073	Het Catal Related to Energy Systems
KC0302010	00074	Org Chem & Chem Fossil Fuels
KC0302010	00075	Molten Salt Cat Clean Fuel Synthesi
KC0302010	00186	Steam Generator Chemistry
KC0302020	00068	Fuel Cycle Chemistry
KC0302020	00076	Chem Eng Res (Chemical Science)
KC0302020	00077	Tritium Separation Technology
KC0302020	00078	Separations Systems Research
KC0302020	00080	Fund Concepts for Res Recovery
KC0302020	00082	Fund of Separations Chemistry
KC0302020	00084	Flow Through Porous Bodies
KC0302020	00085	Molten Salt Proc High Lev Rad Waste
KC0302020	NOEW8	Separations Systems Data Base
KC0302020	NOEW9	Recovery of U from Low-Grade Ore
KC0302030	00087	RD&D Adv Chem Meas Tech
KC0302030	00088	Mass Spec R&D for Inorg Act Anal
KC0302030	00089	IMMA R&D Surface Character
KC0302030	00090	Mass Spec R&D Org Analysis
KC0302030	00091	Adv Spec Meth for Chem Anal
KC0302030	00092	Non-Volatile Organic SIMS
KC0302040	00189	Sorption Pumping & Transfer Oper
KC0401000	00100	Sedimentation & Solid-Solid Sep
KC0401000	NOEW11	Effects of Vib on Agglomeration
KC0402010	00105	Computational Mathematics
KC0402010	00106	Applied Analysis
KC0402010	NOEW12	Adv Math Stud Sensit Uncert Analy
KC0402020	00107	Statistical Methods
KC0403020	00108	Phys Chem Geothermal Sol & Mat
KC0403020	00109	Inter Aq Media W/Const Nat Form
KD0100000	00001	Tech And Anal Support For OER
KD0400000	00112	Tech Development of Ordered Alloys
LA0101000	00012	Energy Data Base
LA0101000	00013	Special Support Project
LA0102000	00010	RECON Operations
LA0102000	00011	RECON Development
LA0102000	00014	Information Interchange Stds
LA0102000	00015	RECON Revenue
NA0200000	ORNA001	International Policy Analysis
NA0200000	ORNA002	SNM For IAEA
PE0100000	00001	Regional Economic and Energy Analys
PE0100000	00003	Eng. Econ. Models of Energy Use

(1) Base budget submittals during FY 1981.

WPAS Cross Reference

B&R Code	WPAS No.	WPAS Title
PE0100000	00008	Light Duty Vehicle Demand Model
PE0100000	00010	Synfuels Commer Stat Anal
PE0100000	00011	International Policy Analysis
PE0100000	00012	Bldgs Energy Use Data Book
PE0100000	00020	Local & Munic Renew Ener Plan
PE0100000	00025	Integ Assess Of Bldgs Ener Cons Pro
PE0100000	00034	Cartei Models In Decision Anal
PE0100000	ONPS003	Nuclear Policy Studies
TA0100000	00001	TA-EAI/Data Valida.
TA0100000	00003	Ener Demand Model & Anal - Ind
TA0100000	00004	Energy Demand Model & Anal
TA0100000	00006	Regional Analysis Program
TA0100000	00007	Eng-Econ Mod Of Energy Use
TA0100000	00021	Transportation Energy Modeling
TA0100000	00022	State Level Light Duty Demand
TA0100000	00025	Integ Assess of Bldg Ener Conserv
TB0100000	00002	End-Use Energy Conservation Data Bo
TB0100000	00003	OGIS Data Verification Support
TB0100000	00006	NEIS Impl Of the ORNL Data VALID
TB0100000	00007	EIA-Price Data Update
TC0100000	00001	Anal in Support of Infor Valid Prog
TC0300000	00001	TC-EIA/Data Validat.
TD0300000	00001	EIA-Valid Eval Coal Demo Reser
UA0100000	00008	Fuel Conversion Environmental Progr
UB0101000	00003	Electric Power System Reliability
UB0101000	00015	Power Plant Productivity Studies
UB0101000	00020	Study Of Pwr Plt & Ind Fuel Use
UB0201000	00015	Power Pooling Studies
UC0101000	00020	Regulatory Anal of Oil Refineries
UD0100000	00019	Marketability of High Cost Natural
UF0100000	00019	Marketability of Natural Gas
VI0104010	00001	Anal of Fuel Adjust Clause
VI0104010	00002	Wheeling

(1) Base budget submittals during FY 1981.

Table A.4. Phase of R&D analysis

Assistant Secretarial Office	Budget outlay (expressed in millions of dollars)		
	FY 1981	FY 1982	FY 1983
Energy Research			
Basic research	46.5	50.4	61.4
Applied research	61.4	66.0	75.4
Exploratory development	3.3	3.8	4.5
Advanced development	14.0	14.7	16.3
Engineering development			
Nuclear Energy			
Basic research	1.2	1.2	1.4
Applied research	12.6	12.3	13.9
Exploratory development	3.6	3.4	3.8
Advanced development	14.9	14.9	16.9
Engineering development	19.8	18.5	20.3
Fossil Energy			
Basic research			
Applied research	6.4	7.1	6.2
Exploratory development	0.7	0.2	0.3
Advanced development	7.6	7.2	5.6
Engineering development	4.1	3.5	5.2
Conservation and Renewable Energy			
Basic research	7.2	8.5	6.4
Applied research	10.8	8.9	7.5
Exploratory development	7.6	7.4	5.9
Advanced development	7.2	7.1	4.7
Engineering development	5.6	4.8	2.6
Defense Programs			
Basic research			
Applied research	1.5	1.8	2.5
Exploratory development	3.5	4.2	5.9
Advanced development	3.4	4.2	5.9
Engineering development	11.6	12.3	14.9
Environmental Protection, Safety and Emergency Preparedness			
Basic reseach			
Applied research	6.1	6.7	7.4
Exploratory development			
Advanced development			
Engineering development			
Energy Information Administration			
Basic research			
Applied research	6.3	7.6	7.9
Exploratory development			
Advanced development			
Engineering development			

Table A.4. (continued)

Assistant Secretarial Office	Budget outlay (expressed in millions of dollars)		
	FY 1981	FY 1982	FY 1983
Economic Regulatory Administration			
Basic research	0.4	0.6	0.8
Applied research	1.3	1.3	1.3
Exploratory development			
Advanced development			
Engineering development	2.1		
Management and Administration			
Basic research			
Applied research	0.5	0.5	0.6
Exploratory development		7.4	
Advanced development		7.1	
Engineering development		4.8	
Office of Policy, Planning, and Analysis			
Basic research			
Applied research	0.6	0.3	0.2
Exploratory development			
Advanced development			
Engineering development			
Federal Energy Regulatory Commission			
Basic research			
Applied research	0.2		0.1
Exploratory development			
Advanced development			
Engineering development			
Work for Others			
Basic research	6.6	8.0	8.2
Applied research	36.7	35.8	37.3
Exploratory development	4.8	4.5	5.1
Advanced development	7.1	7.1	8.1
Engineering development	10.4	7.1	5.9
Total for Laboratory			
Basic research	61.8	63.7	78.1
Applied research	144.2	148.1	160.4
Exploratory development	23.5	23.5	25.5
Advanced development	54.3	55.1	57.4
Engineering development	53.7	46.1	43.9

Table A.5. Major construction projects

Expressed in millions of dollars[a]

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		
	BA[b]	BO[c]	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	TEC[d]
Funded construction															
Program-related projects															
FY 1981 and prior years[e]															
New Hydrofracture Facility—Heavy Laboratory	0.8	0.8													5.4
Integrated Equipment Test Facility—Heavy Laboratory	5.0	5.0	3.8	3.8	2.5	2.5	0.2	0.2							15.4
Radioactive Waste Facility Improvements—Utilities/Other	5.0	5.0	10.0	10.0	5.0	5.0									21.3
Spent LWR Fuel Storage Facility	0.2	0.2													0.4
Advanced Toroidal Facility—Heavy Laboratory	2.5	2.5	8.5	2.0	15.0	5.0	9.7	10.0	1.3	12.0	10.0			8.5	50.0
Elmo Bumpy Torus Proof of Principal Experiment (EBT-POP)	7.9	7.4	72.0	12.0		28.0		31.0		8.0					86.0
Large Coil Test Facility—Heavy Laboratory	6.5	7.3	6.0	6.0	5.3	5.4									28.4
Modernization of Laboratories for Study of Environmental Pollutants—Light Laboratory	2.0	2.0													2.0
Accelerator Improvements Modification—EN tandem	0.2	0.2													0.2
Stage Alpha CFTL	1.8	1.8													9.6
PDX Ion Source	0.2	0.2													1.2
Multiprogram general purpose facilities projects															
FY 1981															
Upgrade Primary Electrical Substation—Utilities/Electrical	0.7	0.7	2.5	2.5											3.2
Energy Systems Research[f] Laboratory—Light Laboratory	1.2	1.2					6.0	6.0	7.0	7.0	2.3	2.3			16.5
Energy Monitoring and Control System—Utilities/Other	4.0	0.2		2.0		1.8									4.0

Table A.5 (continued)
Expressed in millions of dollars[a]

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		
	BA[b]	BO[c]	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	TEC[d]
Proposed construction															
Program-related projects															
FY 1982															
Teratogenic (Embryonic) Effect of Fossil Related Chemical Laboratory—Light Laboratory			1.0	1.0											1.0
Accelerator and Reactor Improvements and Modifications—HHIRF			0.4	0.4	0.2	0.2	0.2	0.2	0.1	0.1					0.9
FY 1983															
High Temperature Materials Laboratory—Light Laboratory				18.7	3.0	15.7									18.7
Toxic Substances Laboratory and Animal Facility—Light Laboratory					27.7	3.0		23.4		1.3					27.7
Accelerator Improvements and Modifications—EN tandem					0.4	0.4									0.4
CFRP Hot Experimentation Facilities—Heavy Laboratory					100.0	20.0		60.0		20.0					2000.0
Improvements to Fusion Energy Facilities—Heavy Laboratory					7.6	2.0		3.6	2.0						7.6
Mutagenic Screening and Testing Facility—Light Laboratory					2.4	2.4									2.4
Hazardous Waste Incinerator Facility—Light Laboratory					1.4	1.4									1.4
Superconducting ORIC Conversion HHIRF					11.0	2.2		5.7		3.1					11.0
FY 1984															
Waste Collection Tanks Project—Storage Facilities							27.5	7.0		8.0		7.0		5.5	27.5
Chemical Toxicology Facilities—Light Laboratory							16.3	1.6		13.0		1.7			16.3
Health and Safety Instrumentation Laboratory-Light Laboratory							3.0	3.0							3.0

Table A.5 (continued)
Expressed in millions of dollars[a]

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		
	BA[b]	BO[c]	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	TEC[d]
Modification to Core Flow Test Loop							10.0	2.0		4.0		3.0		1.0	10.0
Radioactive Ducts Replacements Project—Utilities/Other							10.0	2.0		6.0		2.0			10.0
Transuranium (TRU) Waste Packing Facility—Heavy Laboratory							40.0	8.0		12.0		14.0		6.0	40.0
Melting Smelting Facility							8.0	2.0		5.0		1.0			8.0
Multiprogram general purpose Facilities projects															
FY 1983															
Laboratory Emergency Response Center—Service Building					4.2	1.0		2.5		0.7					4.2
Upgrade Electrical Service for Research Facilities at Y-12—Utilities/Electrical					5.0	2.5		2.0		0.5					5.0

Table A.5 (continued)
Expressed in millions of dollars[a]

	FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		
	BA[b]	BO[c]	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	TEC[d]
FY 1984															
Cooling Water Facilities Restoration—Utilities/Mechanical							7.5	4.0		3.5					7.5
Primary Electrical Distribution System Restoration							3.3	0.5		1.2		1.0		0.6	3.3
Environmental and Effluent Monitoring Upgrading—Utilities/Other							5.0	2.5	5.0	6.0	1.0	2.5			11.0
Utilities Restoration Phase I Piping—ORNL Facilities at Y-12 Utilities/Mechanical							3.0	2.5	3.0	4.0	1.7	1.2			7.7
Water Pollution Control—Phase I Utilities/Other							5.3	1.5		3.0		0.8			5.3
Central Chilled Water System—Utilities/Mechanical							5.5	2.5		3.0					5.5

[a]Dollars shown escalated to midpoint of construction using established DOE rates (i.e., 10%/year).
[b]Budget authority.
[c]Budget outlay.
[d]Total estimated cost in millions of dollars.
[e]Some of the projects represented in this table began prior to 1981; however, figures given here are for expenditures from FY 1981 through FY 1987 only.
[f]Only FY 1981 funding for design has been approved.

Table A.6. General purpose facility line-item projects—beyond FY 1984
Expressed in millions of dollars

Project title	Total estimated cost
Water Pollution Control—Phase II	8.9
Materials Warehousing	2.5
Primary Electrical ORNL Distribution System Upgrade	2.7
Relocate Bethel Valley Road and Provide Entrance to ORNL	7.2
General Analytical Laboratory Restoration	1.7
Alternate Water Supply	3.1
Utilities Upgrade—Phase II, ORNL Facilities at Y-12	7.5
Sanitary Sewage System	1.1
Increase Steam Plant Production	11.0
Maintenance Facilities	7.5
Utilities Upgrade—Phase III, ORNL Facilities at Y-12	7.5
Utilities Upgrade—Phase IV, ORNL Facilities at Y-12	7.5
Machine Shop Facilities	8.0
General Engineering Facility	6.7
Multiprogram Support Shop Facilities	1.7
Upgrade Steam Distribution System	3.0
General Laboratories Replacement	9.3
Personnel Service Facilities	1.7
Physical Science Area Office Building	1.2
Refrigeration Equipment—ORNL at Y-12	2.5
Replace 1943 Substations, 70 (secondary) at Y-12	11.3
Replace 1943 Substations, 3 (primary) at Y-12	16.4
Replace Main Reservoir	4.0
Realign Lagoon Road	1.7
Replace Rolling Mill	1.3
Total	137.0

Table A.7. Proposed construction—descriptions and justifications

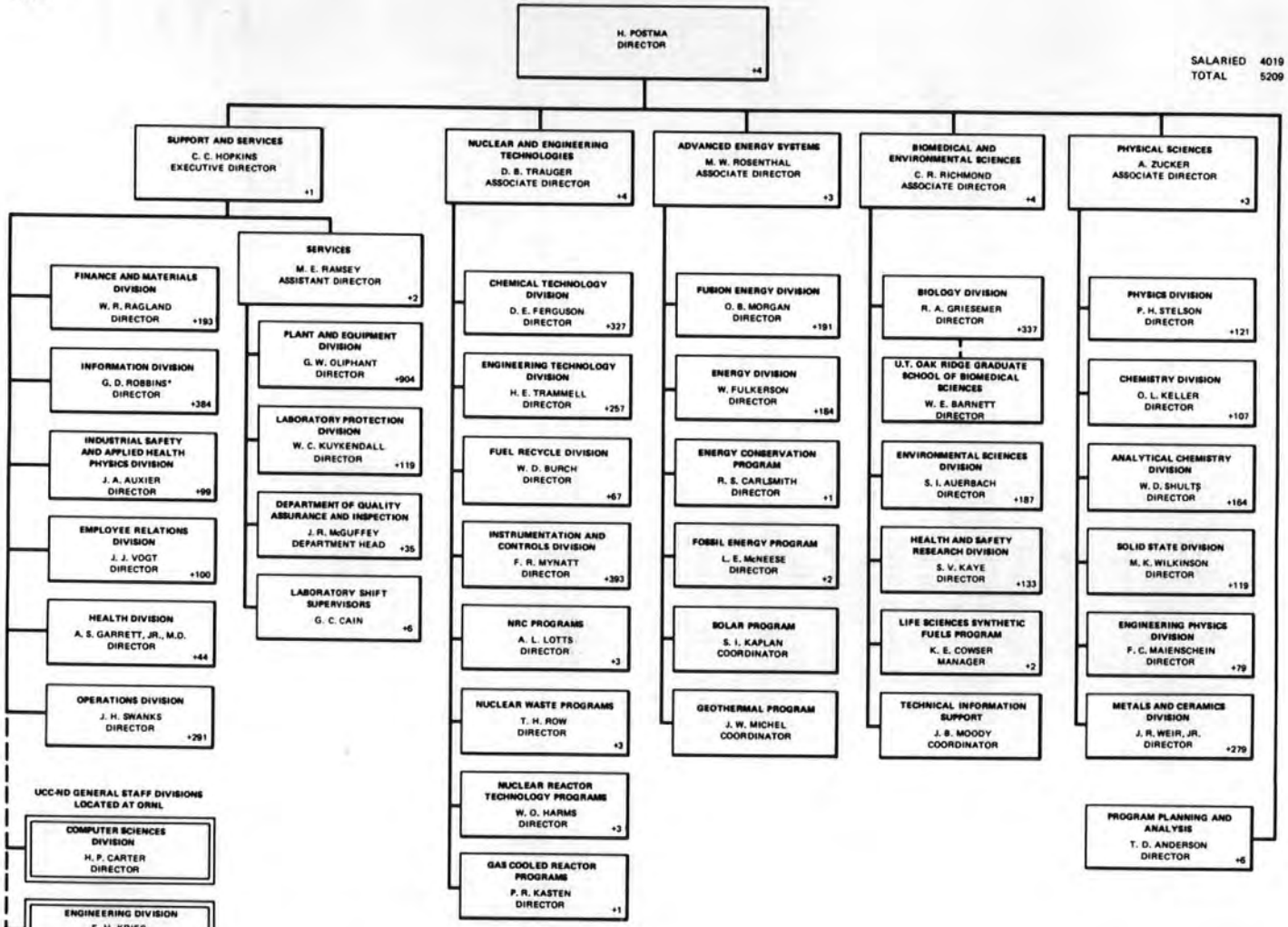
Program	Project title and description	Justification
	Proposed program facilities	
	FY 1982	
HA	*Teratogenic (Embryonic) Effect of Fossil-Related Chemicals Laboratory.* Conversion 93-m² (1000-ft²) storage area into biological laboratories, including structuring of walks, ceiling, electrical and other special utilities, filtered, and air handling systems.	Will provide laboratories to study the possible teratogenicity of energy-related chemicals on early embryos and tissue cultures.
KB	*Accelerator and Reactor Improvement Project—HHIRF.* Will provide improvements as required.	Will continue the required improvement program at the HHIRF to maintain state-of-the-art technology in heavy-ion research.
	FY 1983	
KC	*High Temperature Materials Laboratory* (HTML). Will be a 3,995-m² (43,000-ft²) multistory building of steel and masonry construction, including laboratories, offices, and service areas, with brick finish and special high-temperature equipment.	Will provide a comprehensive research center having capability for testing a variety of new materials for energy-related applications at temperatures >2,000°C under a variety of conditions.
AF	*CFRP Hot Experimental Facilities (Partial Title I and II—Engineering Only).* Design of a major new facility for a receiving, storing, and completely reprocessing a variety of nuclear fuels.	Will provide the only nuclear fuel reprocessing R&D facility being planned in the United States. It will be an integral part of all long-range nuclear options, including fuel cycles for breeder reactors.
AT	*Improvements to Fusion Energy Facilities.* Building additions and modifications and the rehabilitation of existing facilities required to support the growing fusion energy research and development program at ORNL installations located within the Y-12 plant.	Will provide for additions, renovations, and modifications to existing outdated buildings and utilities such that they become functional and will provide the facilities needed by the Fusion Energy Research Program under way at the Laboratory.
HA	*Mutagenic Screening and Testing Facility.* Modification and renovation of existing 511-m² (5,500-ft²) structure for highly specialized biological laboratories.	Will provide additional laboratories for studying mutagenic effects of coal-related energy generation.
HA	*Hazardous Waste Incinerator Facility—Biology Area.* Single story 139-m² (1,500-ft²) steel-frame and masonry structure with 8-m (25-ft) high clearance.	Will be required for the safe disposal of wastes, including animal carcasses, bedding, and filters used in biological studies.
HA	*Toxic Substances Laboratory and Animal Facility.* Construction of a 2-story steel-frame and masonry structure with a 3,252-m² (35,000-ft²) area for highly specialized biological laboratories and animal space, which will safely contain toxic materials.	Will be required for experimental studies of the effects of toxic materials used in nonnuclear energy technologies.

Table A.7 (continued)

Program	Project title and description	Justification
KB	*Superconducting ORIC Conversion HHIRF.* Replacement of aluminum coils with superconducting coils and the addition of a new beam extraction system.	Will increase the beam energies of the HHIRF by as much as a factor of three by providing superconducting main magnet coils and a new beam extraction system.
KC	*Accelerator Improvements and Modifications —EN tandem.* Refinements of spectrometer installation.	Will enhance the Atomics Collisions Program experiments.
	FY 1984	
AR	*Waste Collection Tanks Project.* Replacement of selected radioactive waste collection tanks and associated transfer lines.	Will be required to prevent further leaks to the environment because many of the collection tanks are at or near the end of their respective design life, and some are leaking.
HA	*Chemical Toxicology Facility.* Modifications and renovations to about 1,858 m^2 (20,000 ft^2) of existing floor area.	Will provide for specialized laboratory and animal space needed for studying the effects of toxic chemical compounds and metals resulting from new nonnuclear energy technologies.
HA	*Health and Safety Instrumentation.* A 975-m^2 (10,500-ft^2) building having one special and six general-purpose environmental laboratories and space for storing and handling carcinogenic chemicals and radionuclides.	Will provide state-of-the-art capability for monitoring technology and instrumentation needs related to pollutants that result from new alternative energy systems being developed.
AG	*Modifications to Core Flow Test Loop.* Major changes and improvements to the Core Flow Test Loop as required.	Will provide for modifications to accommodate new problem areas as different experiments are completed.
AP	*Radioactive-Ducts Replacement Project.* Will include replacement of a variety of sizes of carbon steel and concrete central system ducting used to contain and process radioactive gases.	Will replace badly deteriorated central off-gas system ducting serving a large number of buildings at ORNL.
AP	*Transuranium (TRU) Waste-Packaging Facility.* An integrated facility with full capability to process highly radioactive wastes from the transuranium processing laboratory.	Will provide a required facility to safely handle highly radioactive wastes prior to their disposal.
AP	*Metal Smelting Facility.* This project will include the required building and specialized equipment for smelting metallic scrap.	Will provide a means of decontaminating large amounts of open-stored metallic scrap. Contaminants will be removed during smelting in highly concentrated slag and may enable the reuse of the "cleaned" base metals.

Table A.7 (continued)

Program	Project title and description	Justification
	Proposed multiprogram general purpose facilities projects	
	FY 1983	
WD	*Laboratory Emergency Response Center.* Provide approximately 372 m^2 (4,000 ft^2) for receiving security and operation alarms that supply information needed in emergencies and for routine operations.	Will supply information required during emergencies to the control center. No space is available to house personnel-directing operations to cope with emergencies. (PCM B029)
WD	*Upgrade Electrical Service for Research Experiments.* Install new 50-MVA transformer south of building 9201-2 to replace present unreliable service to research facilities in that building and remove pulsed loads from regulated 161-V buss currently serving other ORNL facilities at Y-12.	Will replace the existing transformer which, because of its age, is unreliable and only marginally meets load requirements for the Fusion Energy Program. (PCM B128)
	FY 1984	
WD	*Cooling Water Facilities Restoration.* Replace existing 50-MW cooling tower serving research facilities in buildings 9201-2 and 9201-3.	Will replace cooling water tower installed in 1945 and currently operating at about 50% of original capacity. (PCM B128)
WD	*Primary Electrical Distribution System Restoration.* Replace worn poles, transformers, and switches in the plant-wide electrical system.	Will ensure dependability and reliability by replacing much of the electrical distribution system, which must be replaced because it has exceeded its design lifetime.
WD	*Environmental and Effluent Monitoring System Upgrade.* Modernize existing liquid and gaseous environmental monitoring stations and add new stations to provide improved coverage. Includes a 464-m^2 (5,000-ft^2) structure for sample preparation laboratories and data handling facility.	The modernation is necessary because present monitoring stations are obsolete and deteriorated and do not provide complete coverage. Will provide for additional and more nearly accurate information needed to verify that a proper effluent control exists. (PCM B116)
WD	*Utilities Restoration Phase I—ORNL Facilities at Y-12.* First phase for piped distribution systems for replacing liquids and gases.	These systems have seriously deteriorated since installation in 1944. Will begin replacement of systems that are unreliable and subject to high maintenance cost. (UT38, 39 and others; B128, 129, 130 and others)
WD	*Water Pollution Control—Phase I.* Provide facilities to treat sewage and coal-yard runoff prior to their release to streams.	Will provide a system to treat wastes, which meets present accepted standards. (PCM UT02)
WD	*Chilled Water System Restoration.* Replace three 600-t chiller units with a 2,000-t unit and add additional cooling tower capacity.	Will replace chiller units that are unreliable because of their age and condition. The units cool the Central Research and Administrative Complex, which has about 1×10^6 ft^2 of floor space. (PCM UT11)



*REPORTS TO C. R. RICHMOND FOR INFORMATION CENTER COMPLEX PROGRAMMATIC WORK.

OAK RIDGE NATIONAL LABORATORY
ORGANIZATION CHART

CONTRACTOR: UNION CARBIDE CORPORATION
NUCLEAR DIVISION

CONTRACT NO. W 7405-ENG-26

APPROVED: Herman Postma DATE: 8-1-81

Acknowledgments

The Program Planning and Analysis Office gratefully acknowledges the help of many ORNL staff members in the preparation of this *Institutional Plan*. In particular, we would like to thank those people who have contributed greatly to the production of this document: D. S. Barnes and R. W. Sharpe, for editing; K. S. Davis, A.D. Richardson, and L. H. Wyrick, for graphics; J. H. Wright, for secretarial assistance; the Technical Publications Department Composition Unit, for composition; and G. G. Turpin and R. A. Eldridge, for makeup.

S. R. McNeany

Rec. No. 2306