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OAK RIDGE NATIONAL LABORATORY INSTITUTIONAL PLAN FY 1981 – FY 1986

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
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December 1980

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

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coal	plasma	rotary drum dryer	fauna
transmission tower	radioactive	radiative and absorptive transition	particle spin
atom	pressure storage tank	laboratory	wavefronts
steam power	fluidized-bed reactor	insolation	flora

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OAK RIDGE NATIONAL LABORATORY INSTITUTIONAL PLAN FY 1981 - FY 1986

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OAK RIDGE NATIONAL LABORATORY
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TABLE OF CONTENTS

Director's Overview ix

Laboratory Trends and Future Development 3
- Resources 3
- DOE Programs 4
- Non-DOE Programs 6
- Program Management 7
- Subcontracting and Procurement 8
- Regional Programs 8
- Isotopes Production and Distribution 9
- General-Purpose Funding 9
- University Interactions 10
- Industry Interactions 11

Scientific and Technical Activities 15
- Director of Energy Research 15
  - Overview 15
    - Basic Physical Sciences 15
    - Fusion Energy (AT) 16
  - Lead Missions 18
    - Experimental Program Management for the HFIR 18
    - Experimental Program Management for the HHIRF 19
- Assistant Secretary for Nuclear Energy 19
  - Overview 19
    - The Liquid-Metal Fast Breeder Reactor 20
    - Consolidated Fuel Reprocessing 20
    - Gas-Cooled Reactor Programs 21
    - Commercial and Defense Waste Management 21
    - Light-Water Reactor Safety and Technology 22
    - Advanced Nuclear Systems 23

ornl

Lead Missions 23
Consolidated Fuel Reprocessing Program 23
Materials and Structures Technology Management Center 24
Nuclear Standards Management Center 24
Low-Level Waste Management Program 25
Assistant Secretary for the Environment 26
Overview 26
Overview and Assessment (HA 01) 27
Biomedical and Environmental Research (HA 02) 27
Life Sciences Research (HB 01) and Biomedical Applications (HB 02) 29
Lead Missions 29
Environmental Research for Gasifiers in Industry, H-Coal, and Coal Liquids Evaluation 29
Regional Ecological Analysis and Modeling 30
Integrated Regional Assessments for Regions 4 and 6 30
Environmental Impact Assessment for Nuclear Fuel Cycle and Waste Management 31
Hazardous Solid Waste Technology 31
Environmental Effects of Producing and Using Wood for Energy 32
Assistant Secretary for Conservation and Solar Energy 33
Overview 33
Conservation 33
Solar Energy (AN, EA) 33
Lead Missions 34
Buildings and Community Systems 34
Thermal Energy Storage 35
Assistant Secretary for Fossil Energy 35
Overview 35
Coal Preparation (AA 75) 36
Coal Liquefaction (AA 25) 36
Direct Combustion (AA 35) 37
Materials (AA 15) 37
Environmental Impact Evaluation (AA 45) 37
Heat Engines and Heat Recovery (AA 55) 37
Environmental Control Technology (AA 05) 37
Enhanced Oil Recovery (AC 15) 37
Lead Mission 37
Fossil Energy Materials Program 37
Assistant Secretary for Defense Programs 38
^{233}U Program (GE 03) 38
Nuclear Materials Security and Safeguards (GD 01) 39
Assistant Secretary for Resource Applications 39
Overview 39
Geothermal Energy (AE) 39
Electric Energy Systems (AK) 39
Uranium Enrichment (CD) 39
Small Hydroelectric Development (CE 01) 40
Multi-Resources (CG) 40
Lead Mission 40
Power Systems Technology 40

Other DOE Program Offices 41
Administrator, Energy Information Administration 41
Overview 41
Lead Mission 41
Administrator, Economic Regulatory Administration 42
Assistant Secretary for Policy and Evaluation 42
Isotope Production and Distribution 42
Stable Isotopes 42
Radioisotopes 43
Nuclear Regulatory Commission 43
U.S. Department of Defense 44
Non-DOE Sponsors (Excluding NRC and DOD) 44
Life Sciences Work 44
Environmental Protection Agency 44
National Institutes of Health 45
National Science Foundation 45
Others 45
Other Work 45
U.S. Department of the Interior 46
U.S. Department of Housing and Urban Development 46
Nonfederal Organizations 46

New Initiatives 49
The Director of Energy Research 49
Expanded High Temperature Materials Program 49
Applied Science/Technology Base 50
Resource Recovery from Unconventional Sources 50
Social Science Research 51
The Assistant Secretary for Nuclear Energy 52
Light-Water Reactor Safety and Technology 52
Major Decision Points 52
Major Milestones 52
The Assistant Secretary for the Environment and Others 53
Biotechnology Development 53
Biogeochemical Cycles and Carbon Dioxide 53
Eastern Shales 54
Environmental Geoscience Research 55
Life Sciences Instrumentation Development 56
Laser-related Analytical Techniques 56
Coal Effluent Measurement and Monitoring 56
Reservoir Research and Water Resource Management 56
Risk Assessment 57
Toxicology 58
The Assistant Secretary for Conservation and Solar Energy 58
Technical Assistance to the Office of Alcohol Fuels 58
Biomass Conversion 59
Materials Development for Conservation and Solar Technologies 59
National District Heating Program 59
The Assistant Secretary for Resource Applications 60
Coal Land Leasing Study 60

Personnel Resources 63
Personnel Trends 63
Personnel Requirements 64

Site and Facilities Development 69
Laboratory Site Development 69
Construction 70
General-Purpose Equipment and General Plant Projects 71
Automated Data Processing Requirements 71
Planning Process 71
Current Equipment 71
Major ORNL Computers 72
Projected Demand and Capacity 73
Appendix A—Organization Chart 77
Appendix B—Resource Projections 81

DIRECTOR'S OVERVIEW

DIRECTOR'S OVERVIEW

The primary objective of Oak Ridge National Laboratory (ORNL) is the development of new energy technologies that contribute to the solution of the nation's current and future energy problems. To support this objective the Laboratory seeks technology development problems to which it can apply its many resources. In addition to strong basic research programs in engineering and in the physical, environmental, social, and biological sciences, ORNL's activities include numerous efforts in the applied sciences (e.g., materials sciences, chemical engineering, measurement sciences, impact analysis, biological testing, and environmental assessment). The coordination of activities in the basic and applied sciences, a crucial constituent of ORNL's approach, makes the Laboratory particularly able to bring many new technologies to practical application.

In the last several years, the emphasis of ORNL programs has shifted dramatically. Once almost totally devoted to nuclear technologies, the Laboratory's development efforts now include many activities supporting the nonnuclear technologies. Similarly, the emphasis within the basic physical and life sciences programs supporting the technology development has changed from nuclear to nonnuclear. Within the constraint of very limited growth, this shift has been effected through changes of people, approaches, and management directions.

Another important trend is that recent growth in Laboratory effort has occurred mainly in the technology-oriented programs rather than in the basic sciences programs. Thus, the basic sciences programs, though remaining constant in actual size (in real dollar terms), now represent a much smaller proportion of the Laboratory's total effort. This change of balance should be remedied.

Furthermore, the future of some of the Laboratory's fission energy work is quite uncertain. The president's budget deleted work on the high-temperature gas-cooled reactor (HTGR) and the gas-cooled fast breeder reactor (GCFR) and greatly reduced funding for the liquid-metal-cooled fast breeder reactor (LMFBR) fuel cycle and base program, all of which have been important areas of work for ORNL. Although congressional committees have recommended restoring some of these deletions, the detailed outcome remains uncertain, as do plans for future budgets.

The Laboratory has made a deliberate attempt in recent years to increase its interaction with the Tennessee Valley Authority, universities, and industry through increases in research and development (R&D) subcontracting, collaborative and cooperative programs, and participation in advisory groups. In particular, the Laboratory would like to provide more liaison between federal [especially Department of Energy (DOE)] R&D programs and the long-term research needs of industry to facilitate industry's efforts to make use of DOE technologies in solving energy problems. This role is becoming more and more important as U.S. industry increasingly shifts toward research aimed at fulfilling regulatory

requirements and away from long-term, high-risk research aimed at developing innovative, competitive new products.

Increased emphasis is being placed on long-range planning not only by the Laboratory as a whole but also by each of our research divisions and major programs. In addition, we are developing and implementing methods of measuring the Laboratory's performance that we hope will prove equally beneficial.

Herman Postma

Herman Postma, Director

LABORATORY TRENDS AND FUTURE DEVELOPMENT

LABORATORY TRENDS AND FUTURE DEVELOPMENT

The main objectives of the Laboratory determine, in a broad way, the activities it undertakes. Currently, ORNL's primary objective is to develop new and environmentally acceptable energy technologies that will offer the nation safe energy supply options and efficient energy use systems. We also seek to contribute to the solution of other national technological problems by performing research and development (R&D) in areas of Laboratory expertise. A third goal, which provides additional support to these technological development efforts, is to generate, analyze, and systematize new scientific knowledge.

During the next five years, the Laboratory will continue many of its current efforts supporting these objectives. We shall continue to respond to the full range of Department of Energy (DOE) programs by seeking to apply the Laboratory's multidisciplinary capabilities to problems in energy technology development, particulary those technical problems that pose too high a risk for private industry to undertake. We shall assume a "lead laboratory" role in appropriate areas of technology development. Necessary support will be provided through the continuation of our basic research programs in the physical and life sciences that are related to energy problems or that use unique Laboratory facilities. The programs not only contribute to other national development efforts as well as to DOE's efforts, but they also support our objective of generating new scientific knowledge. The new technologies will continue to be transferred to industry, for example, through industry's participation in Laboratory programs. During this planning period, we shall also work (1) to achieve a balance of near-, middle-, and long-term programs; (2) to maintain high-quality support organizations and facilities in engineering, computer science, instrumentation and controls, analytical chemistry, fabrication, maintenance, and industrial health and safety; and (3) to maintain a staff of exceptional quality through selective recruiting and careful personnel development.

In addition to these continuing efforts, several new directions have been defined during the last year or so that will provide support to our major objectives. Specifically, these are (1) to provide more liaison between DOE R&D programs and long-term research needs of industry in order to facilitate industry's use of DOE technology, (2) to establish closer collaboration with universities, and (3) to work more closely in more areas with the Tennessee Valley Authority (TVA).

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. The trend has again changed, however; current and projected levels reflect little growth. The planning levels authorized by DOE must not exceed 5180 full-time equivalents (FTEs) for 1981, and we project only slight growth (about ½% per year) from 1981 to 1986. For the most part,

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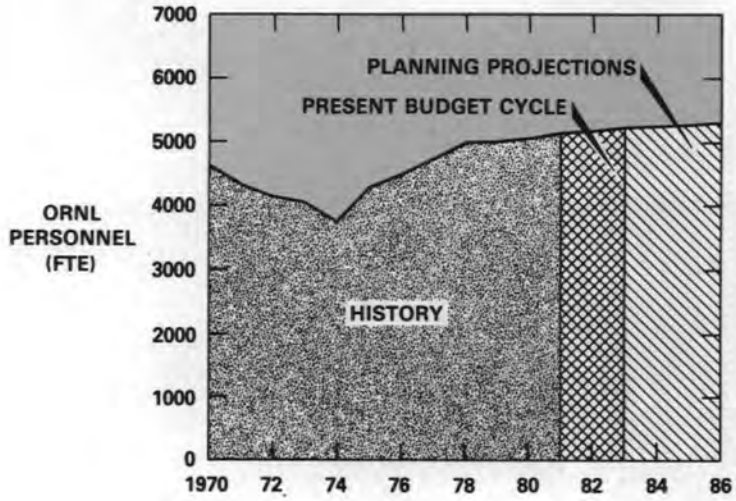

Fig. 1. Projected ORNL personnel levels show little further growth.

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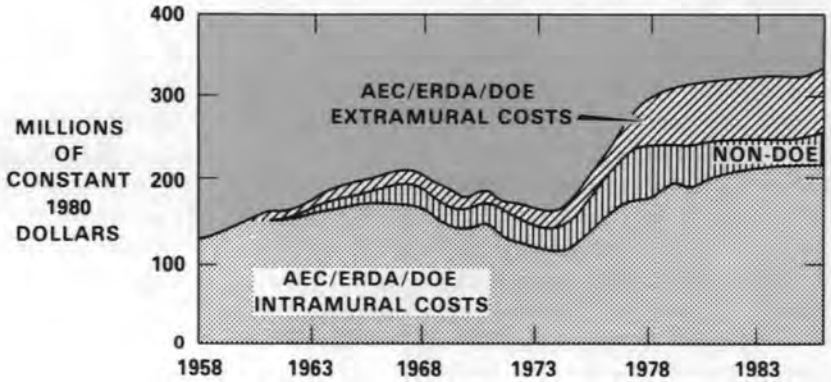

Fig. 2. Following a rapid increase since the midseventies, Laboratory operating costs are expected to be almost constant over the next several years.

the leveling of personnel numbers should not adversely affect ORNL programs, but some increase in these levels may be sought if substantial new programs are undertaken for DOE or the Nuclear Regulatory Commission (NRC).

ORNL's operating costs (in constant dollars) also fell from the midsixties to the midseventies (Fig. 2). Since that period operating costs have increased substantially but are now leveling off.

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 new, separate secretarial offices (Fig. 3). Its director now has overall responsibility for the Laboratory.

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. 4). Most of these areas receive support from several sources. For example, in 1980 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

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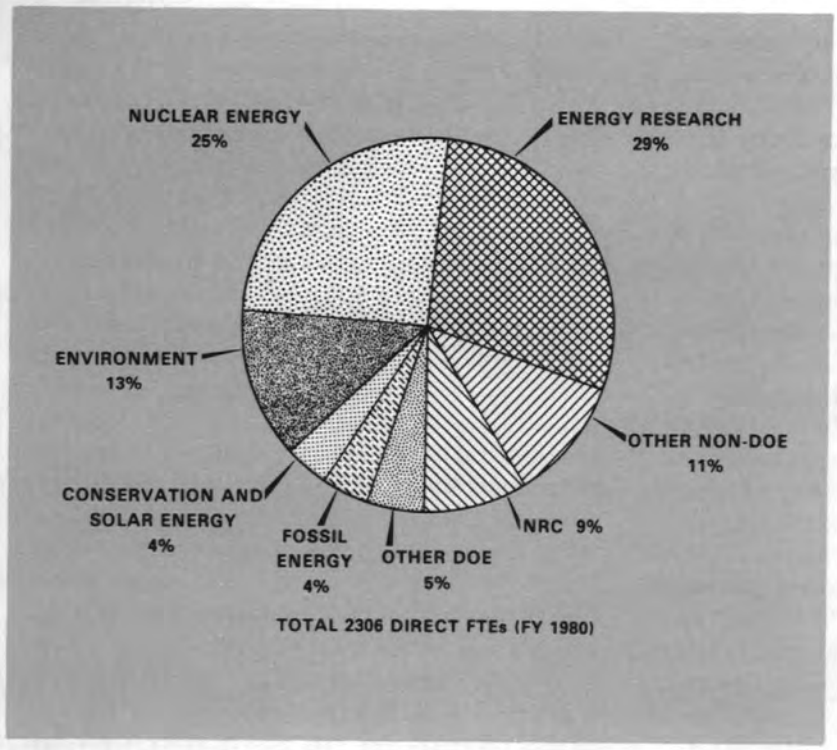

Fig. 3. The Director of Energy Research is the largest single supporter of ORNL's program's, but the Assistant Secretaries for Nuclear Energy and for the Environment also support very large efforts at the Laboratory.

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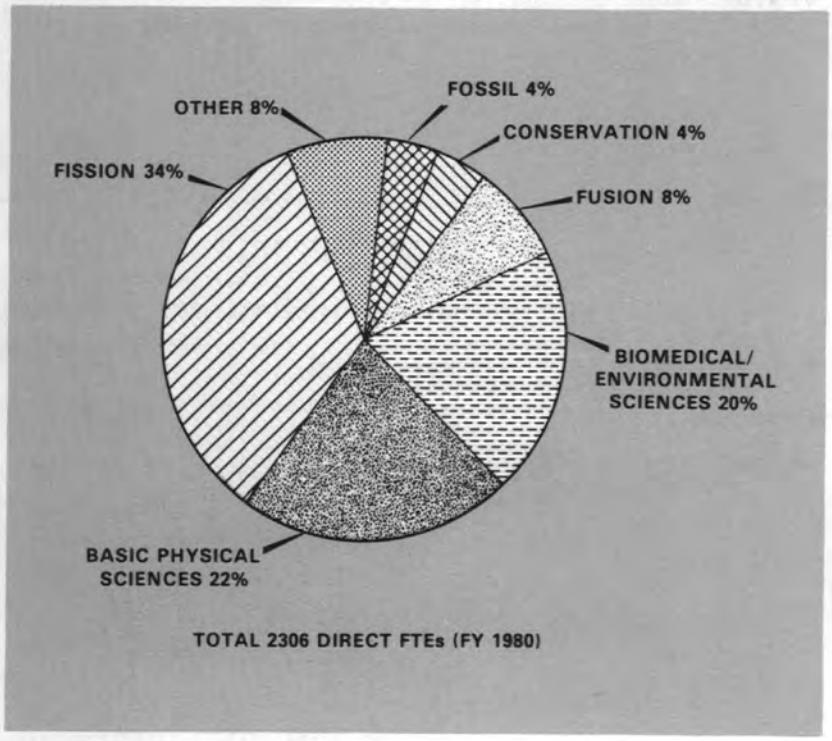

Fig. 4. The largest area of activty at ORNL, as a percentage of direct FTEs for FY 1980, is still fission energy, but work is also carried out in many other program areas.

Electric Power Research Institute (EPRI), and several other organizations.

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

The past ten years have seen a major increase in the proportion of funds allocated for the Laboratory's major technology-oriented programs (fission, fusion, fossil, and conservation) and a strong decline in the percentage of Laboratory funding devoted to programs in the basic physical and life sciences (Fig. 5). During the next five years, this pattern is likely to be the same; the largest increases are projected for the conservation and fossil programs, although some actual growth in the basic sciences programs should also occur. In the longer term (beyond 1986), we would like to reverse the trend of the seventies and regain a better balance between the research and technology programs. To help the Laboratory evaluate the very long-range future of energy research, we are currently engaged in 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. Until this study is completed, it is not clear what distribution of research effort among the various technologies we would like to aim for.

Non-DOE Programs

About 20% of the Laboratory's direct 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 programs, which are funded primarily by the Environmental Protection Agency (EPA) and the National Cancer Institute (NCI) of the U.S. Department of Health and Human Services.

This non-DOE work often has been the vehicle for entering or developing new areas of research and will continue to be extremely valuable to the Laboratory in many ways. Recently, it has been invaluable in augmenting declining DOE support in several basic research fields: about one-third of our life sciences program is supported by federal agencies other than DOE. Several decisions in the past few years have transferred program responsibilities from DOE to EPA. Thus, two years ago the responsibility for certain ORNL programs (funded at $1.3 million) was transferred from the Assistant Secretary for the Environment (ASEV) to EPA as part of a larger ($14 million) program shift. In FY 1980, EPA transfer monies were $2.4 million. In addition, more than $2 million has been made available to ORNL annually as part of a Federal Interagency Pass-through Program for which EPA has management responsibility. In general, these sponsors have proved to be stable, reliable sources of funding. The work undertaken for other non-DOE sponsors

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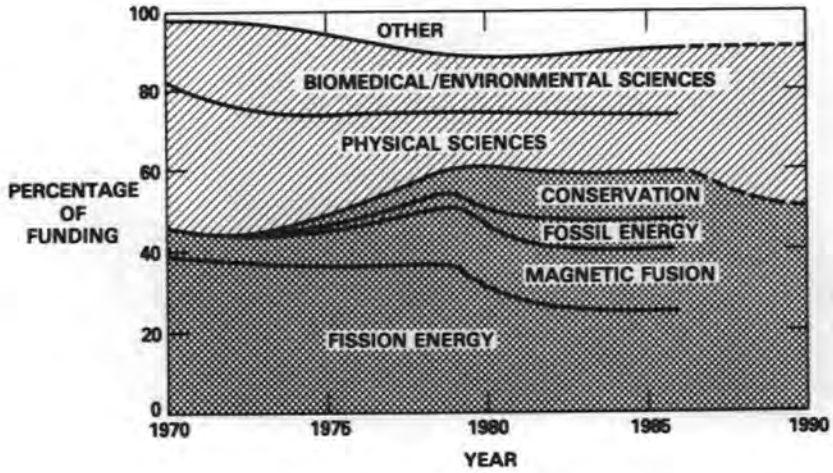

Fig. 5. The basic sciences programs now account for a much smaller proportion of the Laboratory's funding than formerly, whereas the technology programs have expanded considerably. We would like to reverse this trend eventually and achieve a better balance between these activities.

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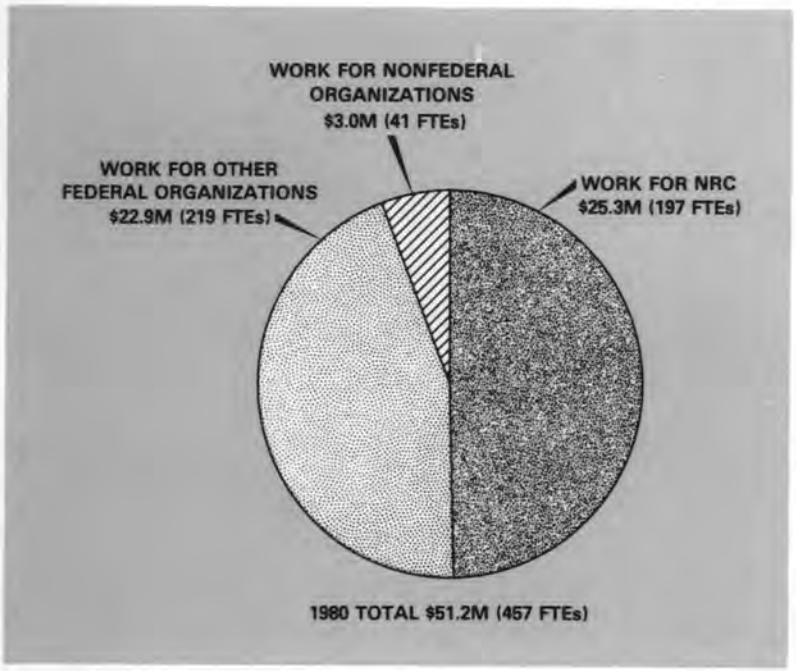

Fig. 6. Non-DOE work is supported by more than 30 federal and nonfederal supporters.

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 by DOE directly as being an appropriate activity for the Laboratory to undertake.

Overall, some reduction in the proportion of non-DOE work is currently predicted for the next few years (see the table below). This projection is based primarily on a decline in NRC funding for work related to environmental impact statements and safety research. This reduction will be only partially offset by a modest increase in support for life sciences research from EPA, the National Science Foundation (NSF), EPRI, TVA, and NCI. Thus, non-DOE work is projected to fall to less than 17% of the Laboratory's effort during this period. In fact, however, there may be no overall decline in NRC support: new NRC programs probably will be implemented and the Laboratory may be asked to undertake new tasks for them.

Non-DOE Sponsored Work

	'80	'81	'82	'83	'84	'85	'86
Total Laboratory effort, direct FTEs	2306	2437	2455	2512	2536	2566	2594
Effort supported by non-DOE sponsors, direct FTEs	457	496	439	432	429	431	431
Percentage of effort supported by non-DOE sponsors	19.8	20.4	17.9	17.2	16.9	16.8	16.6

Program Management

The Laboratory is becoming increasingly involved in managing programs in support of DOE. In fact, program management last year accounted for 50 direct FTEs (Fig. 7).

ORNL plans to limit future growth of this activity to avoid a commitment of more than a few percent of the Laboratory's professional staff, or about 30% of the total funds, but it may engage the equivalent of 100 or more FTEs by the end of this planning period. Studies at other institutions have shown this level of subcontracting activity to be nearly optimal.

In general, the Laboratory will accept program management only when at least 15% of the associated R&D can be, and is, done in house. This

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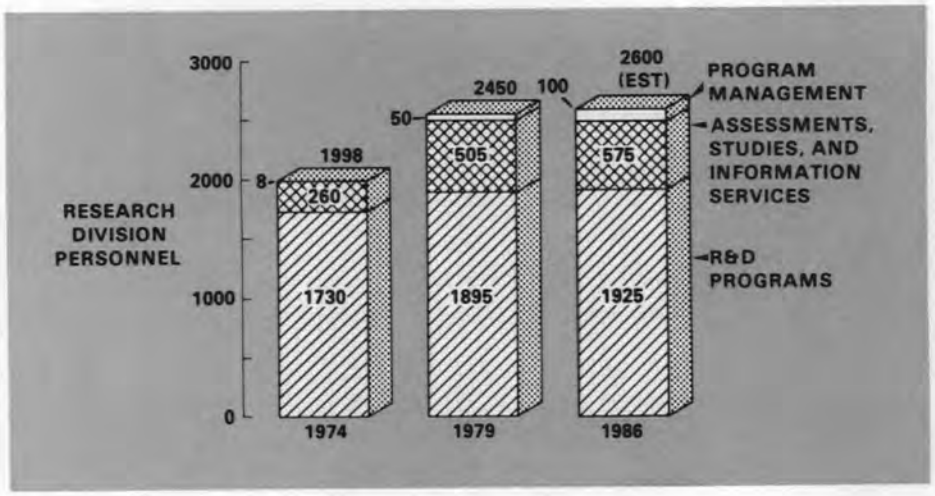

Fig. 7. The number of research staff engaged in assessments and program management continues to increase more rapidly than the number of researchers in the R&D program.

ensures that we have at least the minimum appropriate level of technical expertise to manage the program satisfactorily. Furthermore, the responsibility and authority for letting, monitoring, and managing the Union Carbide Corporation—Nuclear Division (UCC-ND) subcontracts must lie with ORNL, rather than with DOE, if we are to have responsibility for the program management.

Subcontracting and Procurement

One of the two major extramural expenditures is R&D subcontracting; the other is procurement. As Fig. 8 shows, there has been very substantial growth in extramural expenditure since a Laboratory policy of increased subcontracting was authorized in 1974 by DOE. Universities receive about 15% of the subcontracted funds (Fig. 9).

Regional Programs

The Laboratory has managed various regional programs for DOE and is undertaking regional policy and environmental assessment work; the Regional Studies Program is a good, and successful,

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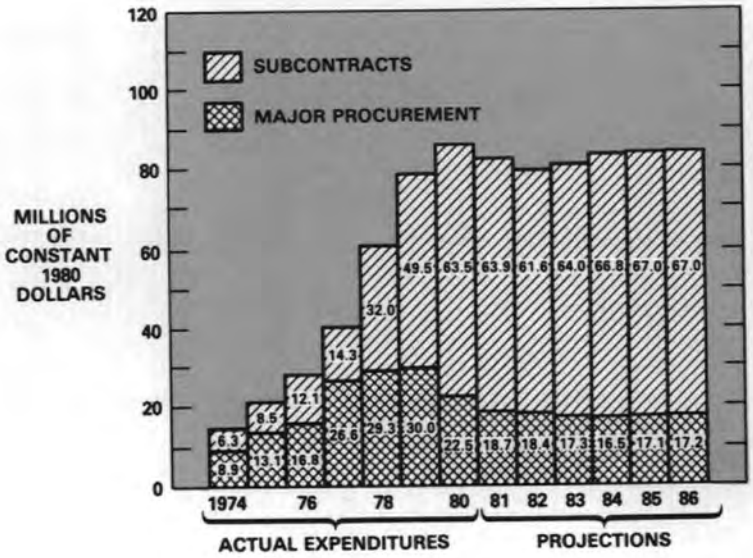

Fig. 8. The amount of R&D subcontracting has increased rapidly in the last several years, but little further growth is expected during this planning period.

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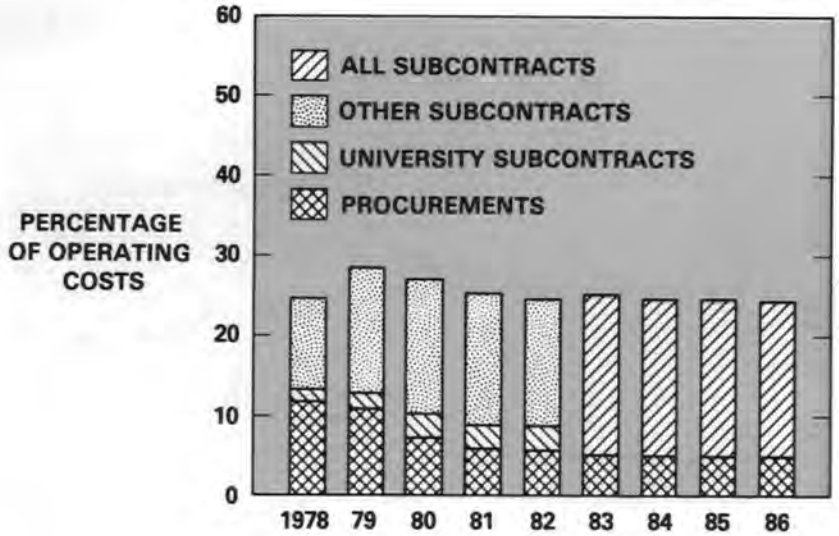

Fig. 9. Subcontracting and procurement are expected to represent close to 25% of ORNL's operating costs through 1982. R&D subcontracting by all three Oak Ridge plants to minority or disadvantaged businesses amounted to $4.9 million in 1977, $2.5 million in 1978, and $6.8 million in 1979. It is estimated that the corresponding 1980 figure will be $9.0 million.

example of such an activity. Each of the multiprogram laboratories is responsible for assessments involving the regional impacts of proposed federal activities. There are also a number of technologies with particular relevance to the southeastern and south-central states, including passive solar systems, biomass, coal, oil, and gas. Certain environmental issues and planning for emergencies (e.g., oil cutoffs) are regional in nature. We plan to give particular emphasis to technologies and studies appropriate to the Southeast.

Isotopes Production and Distribution

The Laboratory administers DOE programs for the production and distribution of enriched stable isotopes, radioisotopes, and heavy elements. The programs offer the materials for sale or loan and provide some associated services. They supply over 300 products and services—none of which are commercially available from the U.S. private sector—to about 1200 domestic and foreign customers in the fields of education, medicine, research, and commerce. At ORNL, distribution of these products and services is made by the Isotope Sales Group in the Operations Division. The Chemical Technology, Solid State, and Health and Safety Research divisions are also routinely involved, and circumstances may require the participation of other divisions.

Responsibility for this area of work is shared by several organizations. The Director of Energy Research is responsible for work relating to enriched stable isotopes and most heavy elements; ASEV is responsible for the part of the program concerned with radioisotopes and their by-products. The Assistant Secretary for Defense Programs is responsible for the production and distribution activities for certain heavy elements.

Two issues related to isotopes production and distribution need to be considered. The first (which was also raised during this year's and last year's site review) concerns the required pricing policies, which work to prevent the stable isotopes sales operation from breaking even financially and thus necessitate additional DOE funding. This funding uncertainty is a serious concern because the enriched isotopes from this program play an essential role in the nation's nuclear medical health care delivery system. The Laboratory, in concert with DOE, is continuing to explore methods of overcoming this problem. The second issue involves the provision of capital funding for the maintenance and upgrading of the facilities and equipment used in these programs.

General-Purpose Funding

General-purpose facility (GPF) funding has, according to DOE studies, been lagging far behind needs. This problem is now being addressed by DOE.

However, other general-purpose funding has also decreased. Thus, general plant project (GPP) and general-purpose equipment (GPE) funding, as a fraction of operating costs, has declined very rapidly in the last 15 years (Figs. 10 and 11). To return to the levels of only a decade ago, GPP funding would

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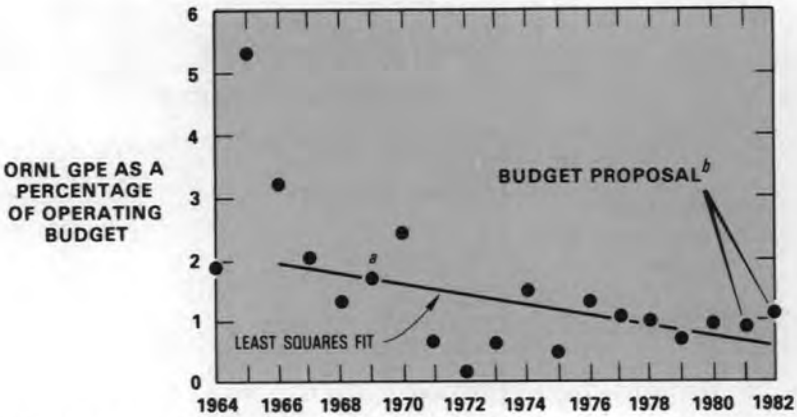

[a] EXCLUDES $5 M COMPUTER
[b] $3.0 M BUDGETED FOR 1981; $4.0 M FOR 1982

Fig. 10. The Laboratory's GPE funding as a fraction of the operating budget has decreased over the last decade.

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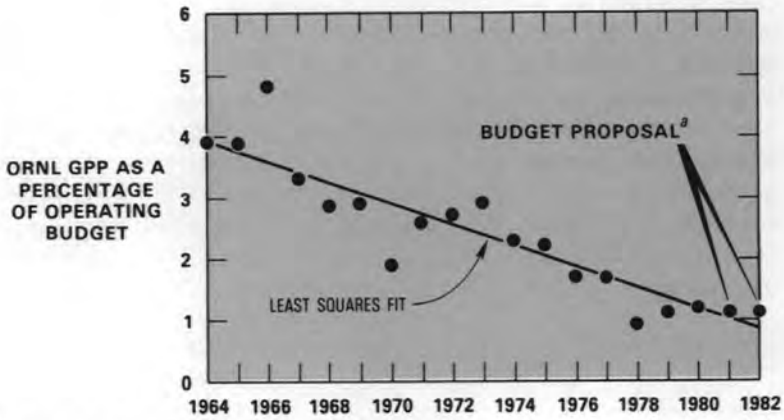

[a] $4.0 M BUDGETED FOR 1981; $4.5 M FOR 1982

Fig. 11. The Laboratory's GPP funding as a fraction of the operating budget has decreased over the last 15 years.

have to be raised to $11.5 million for 1982, although ORNL's proposal for that year is a more realistic $6 million. Similarly, it is most important that ORNL be granted the modest increase to $4 million requested for GPE funding for FY 1982.

University Interactions

The Laboratory's interactions with universities have been increasing, at least in part because of our efforts to seek closer relationships with the university community through expanded cooperative research and training programs. Most of the guests assigned to ORNL are from universities (Fig. 12), and subcontracting of R&D to universities and others has increased, as we have seen. Another very important area of university interaction is the use of the Laboratory's unique research facilities by qualified university representatives; these facilities include accelerators, reactors, small-angle neutron-scattering facilities (partially funded by NSF), fusion energy experiments, and testing facilities. The Oak Ridge National Environmental Research Park (NERP), officially established in June of 1980, has 5,500 ha of wooded and open areas available for university research projects. Furthermore, the new

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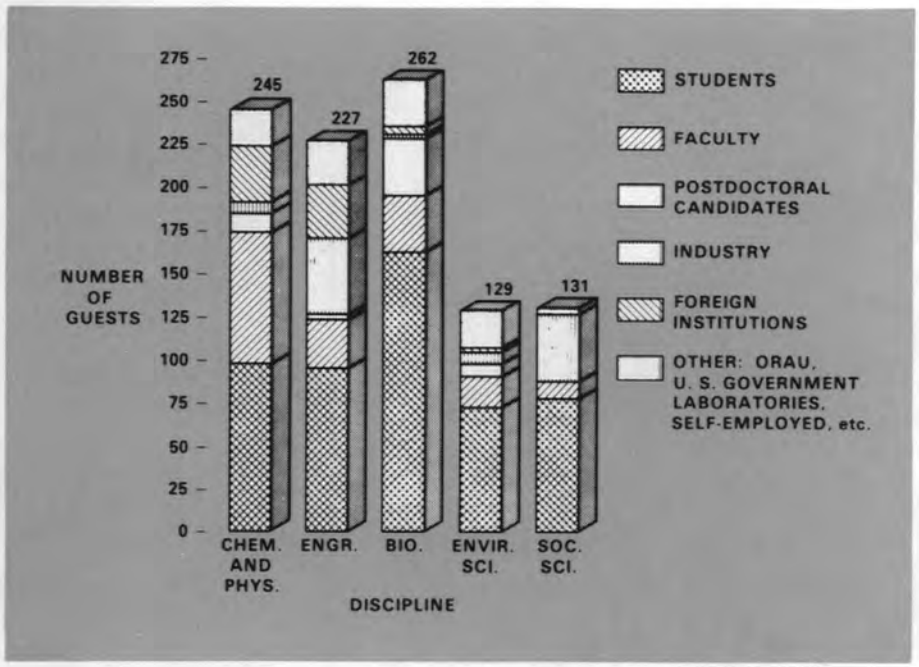

Fig. 12. In 1979, most of ORNL's guest assignees were university staff or students.

Holifield Heavy Ion Research Facility (HHIRF) will be operated as a users' facility and will involve researchers from more than 70 universities. University involvement with ORNL facilities, however, extends beyond use. Indeed, universities have also provided funding for some facilities, for example, UNISOR (1975), the Joint Institute for Heavy Ion Research (1979), and the expansion of the Joint Institute for Heavy Ion Research (proposed for 1980).

Industry Interaction

Through subcontracting, cooperative programs, and assignments, ORNL interaction with industry is also being increased, although much progress remains to be made in this direction. The proposed High Temperature Materials Laboratory (HTML) will be operated as a users' facility for both industry and universities. ORNL has entered discussions with representatives of the Industrial Research Institute (IRI) to seek additional routes for collaboration. Patent and proprietary data provisions are among the stumbling blocks. Initiatives to remove some of these blocks are being undertaken by DOE, and we expect industry to increase still further its use of our results and facilities.

SCIENTIFIC AND TECHNICAL ACTIVITIES

SCIENTIFIC AND TECHNICAL ACTIVITIES

Director of Energy Research

Overview

The Director of Energy Research is the main supporter of programs at ORNL. Conducted on his behalf are programs in magnetic fusion energy and basic physical sciences, including basic energy sciences and nuclear physics. This section provides a description of each program, focusing on the technical thrust of the work and including major changes, issues, or results anticipated.

Basic Physical Sciences

The basic physical sciences programs at ORNL, which account for approximately 20% of the Laboratory's effort, have operated at a fairly constant funding level during the past several years. Within this constant overall level, however, the emphasis has shifted from fission-related work to nonfission-related work (Fig. 13). This trend will probably continue, but at a slower rate.

The staff levels associated with the basic physical sciences programs are expected to grow slightly, reflecting DOE's increasing emphasis on basic research. In recent years, however, the proportion of technology-oriented work at the Laboratory has increased considerably, while funding for basic research has remained nearly constant. This trend, along with DOE's practice of turning increasingly to universities rather than the national laboratories for basic physical research, endangers the maintenance of an appropriate balance at the Laboratory between research and development. The Director of Energy Research should study these trends carefully and review DOE policy in this area.

Some growth is expected in materials sciences research related to the High Temperature Materials Laboratory (HTML), in chemical sciences research concerning waste disposal and coal chemistry, and in nuclear physics research at the Holifield Heavy Ion Research Facility (HHIRF). It is significant that two of the facilities receiving increased funding, the HHIRF and the HTML, are both national users' facilities: that is, they are intended for use by outside organizations (including universities and industry) for proprietary research as well as by ORNL. (Further discussion of the HTML is given in the next chapter of this report.)

One of the Laboratory's important tasks is its participation in the planning of the energy technology base. ORNL has the responsibility for assessing technology-base needs for the nation's fossil energy research programs and also participates, when its capabilities are required, in studies of other areas.

Major Issues. Texas Instruments, Inc. (TI) has been the only manufacturer of fuel for the High Flux Isotope Reactor (HFIR) since the reactor began operation in 1966. The corporate management of TI has decided to discontinue the manufacture of research reactor fuel elements when the current contract ends in December 1981. The lead time required for an inexperienced fabricator to produce a HFIR fuel element is two to three years, but this period can probably be reduced to one-and-one-half to two years if the next manufacturer's personnel are trained at TI before the current contract expires. A new fuel manufacturer must be

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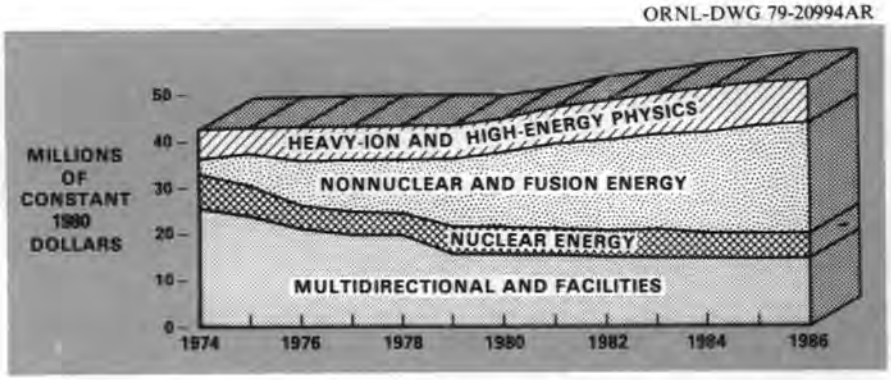

Fig. 13. The funding emphasis for basic physical sciences research has shifted from nuclear energy to nonnuclear-related activities.

found soon to preclude a shutdown of the HFIR by a lack of fuel. If the current rates of fuel production and use continue, the HFIR fuel supply will be exhausted in February 1984. To ensure continuity in the reactor's operation, a new fuel supplier should begin delivery in October 1983 to allow time for preoperational inspections and criticality tests. The cost of establishing a new fuel supplier, whether in-house by DOE or in the private sector, is estimated at several million dollars of "new" money. This problem is currently being addressed by DOE's Oak Ridge Operations Office (ORO).

Basic Energy Sciences. The basic energy sciences program at ORNL includes research in nuclear, materials, chemical, and engineering sciences; in mathematics and statistics; and in atomic physics.

In nuclear sciences, the major activities are the production and separation of actinides, investigation of the chemical properties of actinides, and measurement of neutron cross sections that are related to fusion. In the chemical sciences, emphasis is given to the chemistry and structure of coal, to free radicals, and to separations processes related to energy technologies. In materials sciences, high-temperature materials and processes will receive increasing attention, as will important programs in ion-solid interactions, neutron scattering, microstructural analysis, corrosion, and ceramics. We expect a growing effort in geosciences, focusing first on geochemistry but broadening gradually over the next five years. Mathematics research will continue to deal with sparse matrices and moving boundaries, among other problems. The embryonic program in engineering sciences should grow both because of the Laboratory's talents and ideas and because of the needs that ORNL's technology programs (fusion, fossil, conservation, nuclear, and solar) have for basic information.

Nuclear Physics. ORNL's nuclear physics program, in both its experimental and its theoretical components, is dominated by the topics related to heavy-ion physics. The development of Phase I of the HHIRF, for instance, constitutes a significant advance in DOE's nuclear physics program. Installation of the 25-MV tandem electrostatic accelerator has proceeded well; preliminary voltage tests, performed without acceleration tubes, attained 32 MV. Installation of the remaining accelerator components and beam transport systems was completed in FY 1980, and nuclear physics research should follow early in FY 1981. At that time, the nuclear physics program will emphasize experiments using projectiles with energies of up to 25 MeV/amu and will include plans to upgrade the facilities later in the decade—through Phase II of the HHIRF—to produce energies of up to 400 MeV/amu. A formal proposal for Phase II will be submitted to the Nuclear Science Advisory Committee early in FY 1981.

Currently, more than 300 scientists representing over 120 institutions are involved in planning for HHIRF operation through a formal users' organization. A new facility, the Institute for Heavy Ion Research (funded by DOE, Vanderbilt University, and the University of Tennessee), is under construction and will provide office, laboratory, and dormitory space for HHIRF users.

Fusion Energy (AT)

Since 1969, the fusion program at ORNL has emphasized tokamaks and the technologies supporting them. The Laboratory has played a leading role in the development of neutral beam heating for tokamaks, including its demonstrations on the Oak Ridge Tokamak (ORMAK) and the Impurity Study

Experiment (ISX) at Oak Ridge, and on the Princeton Large Torus and the Poloidal Divertor Experiment (PDX) at Princeton. The ISX-C device and the associated neutral beam program, both of which are now under consideration by DOE's Office of Fusion Energy (OFE), will allow this strong role to continue. We have major responsibilities for large superconducting coils and materials and for the Engineering Test Facility (ETF) Design Center. The ELMO Bumpy Torus (EBT), an ORNL concept, has recently been designated as the leading alternative to tokamaks and mirrors, and we have been assigned the management responsibility for securing strong industrial participation in the design, construction, and operation of the proof-of-principle experiment, the EBT-P. The ORNL fusion budget is expected to expand, largely because of the EBT-P and subcontracts, but the growth in staff will be modest.

Elmo Bumpy Torus (AT 10 20). As a result of the decision to advance the EBT concept to the next stage of development, the first-scale program, EBT I/S, has been substantially expanded. Emphasis is being given to supportive activities, such as higher-power confinement scaling and auxiliary-heating studies. The overall level of diagnostic capability has increased and will continue to do so. In order to allow ORNL both to broaden its involvement in EBT development and to accomplish the expanded program without major staff increases, industrial subcontracts have been let for the ion cyclotron resonant heating and divertor projects.

McDonnell Douglas Astronautics Company has been selected to design, construct, and check out the EBT-P. The firm will also participate in the facility's experimental operations.

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 the EBT configurations. In the tokamak area, emphasis will be given to refinement of our understanding of high-beta tokamak stability as indicated by the ISX-B experiments, to further refinement of the existing disruption models, and to a more complete analysis of the impact of nonaxisymmetric magnetic fields on confinement and equilibrium. In the EBT area, the efforts to model confinement will continue, making use of more-complete transport models that have better transport coefficients. Analyses of ring-core stability, ring power balance, and plasma heating theory will also be important.

As a result of the successful use of Faraday rotation to measure poloidal magnetic fields on the ISX-B, work has begun on a joint Confinement–Applied Plasma Physics project to develop and install a system for multichord measurement by means of far-infrared Faraday rotation.

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. Important advances were made in the attainment of high beta; significant electron-cyclotron heating was demonstrated; and substantial plasma fueling with pellets was achieved. During FY 1981 and FY 1982, these programs will be continued at the higher neutral-beam injection power levels now available and will be extended to noncircular plasmas. In addition, a bundle divertor will be installed in mid FY 1981.

The early work by the International Tokamak Reactor (INTOR) and ETF groups reinforced our belief that a flexible facility could demonstrate our ability to produce high-beta discharges for long pulses (~30 sec) and could serve as a vehicle for testing advanced impurity-control systems. The ISX-C device—a low-field tokamak somewhat larger than ISX-B but capable of producing long pulses—is intended to meet those needs. Attention to access and conservative design, features which have allowed ISX to produce unusually good results in light of its intrinsic parameters, will continue on ISX-C.

Development and Technology (AT 15). The major development activities in this area will continue to be in the areas of superconducting magnetics and neutral beams. Even though progress on the Large Coil Program has been constrained by funding problems, we now expect delivery of the first two coils in mid FY 1981, with testing to begin about the end of the fiscal year. The remaining U.S. coil and the three international coils will be delivered in FY 1982, with full six-coil testing to be conducted in FY 1983.

The PDX–ISX-B neutral beam effort is nearing completion, with systems now operational on both devices. All development objectives have been met, and record neutral-beam powers have been produced on schedule. A preliminary program, now under discussion with DOE-OFE, has been initiated for the development of the long-pulse beam lines required for ISX-C and other confinement devices.

In addition, significant work is in progress on (1) the development of materials for fusion reactors, (2) the development of accelerators for solid hydrogen pellets for fueling plasma devices, (3) the characterization of the plasma-wall interaction, and (4) the development of techniques for calculating neutron transport in complex geometries and for checking the calculations against experimental results. For both the plasma physics experiments and the technology development, design studies for tokamak and EBT demonstration power reactors and for the ETF serve as a focus. Work is currently under way on a generic environmental impact statement for magnetic fusion power systems.

Finally, the ETF Design Center has reached its initial staffing level; the staff, an integrated team that includes participants from industry and from other national laboratories, is now functioning.

Lead Missions

Experimental Program Management for the HFIR (current role)

The HFIR provides the most intense thermal-neutron flux and neutron beams currently available for research. The facility is used mainly for such DOE activities as neutron-scattering studies and the production of transplutonium isotopes but is also used, in cases approved by DOE, by commercial users and the scientific community. The Laboratory is responsible for the technical direction of portions of this program and provides technical support to DOE Headquarters staff concerning coordination with other contractors or with private users. Use of the irradiation and beam facilities is allocated by technical management.

Because of its exceptionally high flux, the HFIR is used to produce a large portion of the national requirements of certain radioisotopes that commercial facilities cannot produce in the required amounts or types. The transplutonium isotopes produced at the HFIR and distributed by the Transplutonium Committee compose the main supply of these heavy elements for use in research and in various branches of science and industry. We are currently investigating the feasibility of providing about 40 μg of 276-day ^{254}Es (about ten times the current production) for use in the search for superheavy elements. In addition to the significant quantities of berkelium, einsteinium, and fermium produced at the HFIR, ^{252}Cf is separated at the adjacent Transuranium Processing Facility (TRU). Since the fission-energy-related programs at ORNL also make use (and share the cost) of the TRU, the cutbacks proposed by DOE in the Laboratory's fission energy programs would severely affect the financial feasibility of continuing the operation of the facility.

Excellent facilities are available at the HFIR for various types of elastic and inelastic neutron-scattering expermients using either polarized or unpolarized neutrons. These facilities are used not only by ORNL staff members but also by about thirty scientists per year from universities and other laboratories. Through an interagency agreement between DOE and the National Science Foundation (NSF), NSF has established a user-oriented National Center for Small-Angle Neutron Scattering at ORNL. As part of this program, we have completed a sophisticated facility at the HFIR for small-angle neutron scattering; operation of the facility is funded by NSF.

Through the efforts of DOE, preliminary negotiations have been made with the government of Japan to establish a U.S.–Japan cooperative program on neutron scattering. This program would involve the construction of one or two advanced instruments at the HFIR; in return for modest use of all HFIR neutron-scattering facilities by Japanese scientists, their government would fund the instruments' construction.

A significant fraction of the HFIR's operating funds is furnished by programs other than Energy Research. Occasionally one of these programs withdraws support from the HFIR with very little notice; when this occurs, other sources of support must be

Summary of resources—Experimental Program Management for the High Flux Isotope Reactor[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	5.0	5.7	6.4	6.7	7.2	6.6	6.6
Capital equipment	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fuel cost[b]	1.2	1.4	1.8	2.1	2.6	2.0	2.0
Direct FTE	42	43	43	43	43	43	43

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b]These costs are based on the current fuel contract with Texas Instruments, which expires December 31, 1981. The added costs of setting up a new supplier, shown in 1982 and beyond, are for preparing a new facility, amortizing approximately $1.0 million of equipment costs over a three-year period, and training a staff. All these costs inflate the operating and fuel-inventory costs for the first few years.

found to avoid a temporary shutdown of the reactor. If the needed support could not be obtained, this lack of dependable funding might necessitate a long shutdown for the sake of saving only a small amount of money.

Experimental Program Management for the HHIRF (current role)

The objective of this program is to provide a broad selection of accelerated heavy ions and the related experimental facilities required to support a national program in heavy-ion research. The program is charged with operating the 25-MV tandem electrostatic accelerator and the Oak Ridge Isochronous Cyclotron (ORIC) and with providing state-of-the-art experimental devices required by experimenters using ion beams from these accelerators.

As part of this program, the Laboratory seeks continual improvement of the performance capabilities of the facility. In FY 1983, it is proposed to modify the ORIC—which provides a second stage of acceleration for ion beams for the 25-MV tandem electrostatic accelerator—by replacing the aluminum magnetic coils with a superconducting coil system and adding a new beam extraction system. This modification will increase the energy constant (K) of the cyclotron from the present value of 100 to a value of 300. In addition to providing research benefits, the conversion will reduce the facility's electricity consumption from about 16,000 MW/year to 9,000 MW/year, with attendant cost savings of about $25,000/year.

The Laboratory is responsible for the program's technical direction and management. The technical direction closely follows the recommendations of a Laboratory-appointed Program Advisory Committee, which represents all facets of the user community. The management is monitored and evaluated by a Policy Review Committee composed of nationally recognized experts in this field. Operation of this facility is coordinated with the Executive Committee of the Users Organization.

The Laboratory's accomplishment of this mission will involve interaction with other institutions and participation in programs with industry. We have subcontracted with university-based users to provide design and fabrication of specific experimental devices and plan to continue this practice. The program has technology transfer and commercialization responsibilities to manufacturers of both nuclear equipment and particle accelerators. A related DOE program—Experimental Program Management for the Super-HILAC/BEVALAC—will afford another opportunity for interaction.

Summary of resources—Experimental Program Management for the Holifield Heavy Ion Research Facility[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost							
HHIRF	3.2	3.7	4.2	4.2	4.3	4.3	4.3
ORIC Upgrade				0.2	0.3	0.3	
Line items, ORIC Upgrade				7.0			
Capital equipment	1.0	1.1	1.5	1.1	0.8	0.8	0.8
Subcontracting and procurement	0.2	0.2	0.2	0	0	0	0
Direct FTE	35	36	39	41	42	42	42

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Assistant Secretary for Nuclear Energy

Overview

In 1980, approximately 25% of the Laboratory scientific and technical staff [674 full-time equivalent personnel (FTEs)] were engaged in DOE programs for the Assistant Secretary for Nuclear Energy. These programs, in decreasing order of size, are fuel reprocessing, radioactive waste management, the liquid-metal fast breeder reactor (LMFBR), the high-temperature gas-cooled reactor (HTGR), advanced nuclear systems, and the gas-cooled fast breeder reactor (GCFR).

ORNL maintains its position that expansion of nuclear power production is urgent as a mechanism for reducing dependence on imported oil. The president's budget for FY 1981, however, proposed major cuts in nuclear research and development (R&D). At ORNL, the greatest impact would be on the reprocessing and the gas-cooled reactor programs. The effect on staffing in these areas would be serious: expertise that has been built up over a number of years would be dispersed.

The apparent inconsistency between the nation's nuclear energy needs and the administration's proposed budget cuts confuses planning for FY 1981 and beyond. Because the administration and elements of Congress disagree on nuclear issues and funding levels, choosing a basis for planning is

especially difficult. Faced with the necessity of doing this, however, ORNL, with the concurrence of the Oak Ridge Operations Office (ORO), has chosen as the planning basis the House Appropriations Committee's action as it stood at midsummer. The situation in each program is developed more fully in the paragraphs that follow.

The Liquid-Metal Fast Breeder Reactor

This program continues to stay on the forefront of science and technology in the areas of materials and structures, safety, physics, fuel cladding, and measurements and controls. Examples of important achievements include the development of advanced ferritic alloys for heat transport systems and of new shielding materials, such as boron carbide, that could dramatically lessen the cost and increase the seismic stability of commercial-size plants.

The program's projected funding for FY 1981 is essentially the same as that for FY 1980. The personnel level will experience a net loss of five FTEs: three will be lost from materials and structures tasks and four from safety tasks, but two will be added to physics tasks [for shielding analysis and for experiments for the Conceptual Design Study (CDS) developmental plant].

Some indication of a commitment by DOE to build a demonstration or development plant is needed in order to focus and to give substance to this base-technology effort. Most of the participants in this effort are highly specialized professionals who are dedicated to the concept of the fast fission breeder. Evidence of strong support of the breeder on a schedule that will allow commercial deployment in the period from 2010 to 2020 will be needed if this cadre is to be retained. Continued efforts in this regard by DOE officials are strongly urged.

Given the present level of support for the LMFBR program, our base-technology specialists must become more prominently involved in foreign exchange programs. These programs are increasingly important as this country attempts to retain the breeder option without conducting a concerted prototype research reactor program to focus R&D and to ensure timely acceptance of LMFBRs by utilities.

Consolidated Fuel Reprocessing

This program performs a major part of the nation's R&D pertaining to fuel reprocessing and also manages related efforts elsewhere in the country through the Consolidated Fuel Reprocessing Technology Management Center at ORNL. A relatively small program five years ago, this effort has grown to be a comprehensive program directed eventually toward a hot demonstration (i.e., with radioactive material) of reprocessing technology associated with the demonstration breeder reactor. Related activities address reprocessing in alternative fuel cycles that might eventually be implemented. The program is a multiphase effort encompassing flow-sheet development, equipment component development, and integrated testing of that equipment in a cold, or nonradioactive, facility [the Integrated Equipment Test (IET) facility, which is now under construction at ORNL]. Because the pace of the work reflects the perceived schedule for the introduction of the LMFBR, the continued indecision and lack of commitment to the reactor demonstration have resulted in budget cuts for FY 1981 in the fuel reprocessing program.

These cuts will primarily affect the work on flowsheet development both at ORNL and at Savannah River Laboratory (SRL), where staff levels will be reduced by about 30 and about 15 FTEs respectively. Most of these cuts will be accommodated by the switching of personnel to other programs. While the program will remain viable at the reduced level, the effects of the cuts will be quite serious and are likely to jeopardize the continuity of important phases of the program. Emphasis will be focused on the IET and on the development of equipment needed for the facility, which is to begin operation late in FY 1981. Some slippage in the IET schedule will result from the operating dollar cuts and the constrained capital equipment funds. Every effort should be made in future years to maintain the IET schedule; this will require careful DOE attention to ensuring the availability of the requisite capital funding.

Efforts are under way to establish appropriate interfaces with related fuel-cycle programs. Reprocessing can be completely demonstrated only when there are clear understandings of, and programs to provide, a mixed-oxide fuel form for refabrication, waste handling systems, and disposal schemes. A joint program was begun in FY 1980 with Hanford Engineering Development Laboratory (HEDL) to examine and compare the merits of powdered and particle fuels for pelletization. The currently projected schedule for breeder reactor development provides time for potential fuel-cycle improvement. We believe that development of both the sphere-cal and sphere-pac concepts should continue through the irradiation testing stage in order to allow an informed evaluation.

Out of this coordination of effort must evolve appropriate agreements on forms of fuel, on programs for the confirmation by irradiation, and on the development of equipment for both the conversion step in reprocessing and the subsequent fuel-refabrication step. It is very important that continuity be maintained and that the agreed-on programs and schedules for this activity be kept current; consequently, support and monitoring of these programs by DOE is essential.

Common efforts with the waste programs are only now in the early stage of planning. The SRL High-Level Waste Program will broaden existing programs by incorporating R&D aimed at establishing acceptable forms for breeder-reprocessing wastes; additional funding requirements for this work are being identified. In the near future, joint programs with the Transuranium Waste Program at Rocky Flats, Colorado, will be identified. The Transportation Technology Center at Sandia National Laboratories (SNL) has outlined an R&D program to develop casks for shipping spent fuel from breeders, but currently the program is not being funded; interface meetings involving reactor groups, SNL, and the Consolidated Fuel Reprocessing Program have been held, but the program needs strong support from DOE if it is to yield results.

Gas-Cooled Reactor Programs

The gas-cooled reactor programs cover HTGRs and GCFRs; ORNL has contributed substantially to both programs. Both of these national programs have been supported at modest levels in recent years, with HTGRs generally receiving substantially greater support than GCFRs. Future DOE support for HTGRs is anticipated; support for the GCFR program, however, is not expected in FY 1981.

An important issue in the development of HTGRs, concerns the reactor type that should be emphasized. Steam-cycle HTGRs (SC-HTGRs) represent the nearest-term system; process-heat HTGRs (PH-HTGRs) utilize higher coolant temperatures at the outlet, permitting nuclear power to be applied to high-temperature processes; gas-turbine HTGRs (GT-HTGRs) are particularly appropriate for use with dry cooling towers or for district heating or for low-temperature process-heat applications. Generally, utilities favor GT-HTGRs and SC-HTGRs; however, they increasingly perceive that the PH-HTGR should be emphasized. It is important that all parties agree on the specific HTGR program to be supported. Further, that program should lead to the development of the various systems in a timely manner; for example, the SC-HTGR could be the first step on the way to PH-HTGRs and GT-HTGRs, with the program including the key developments required for the advanced systems, yet also providing a near-term demonstration reactor.

Another important issue, one that especially relates to the ORNL program, is how to make use of the work that has been done on the GCFR program. During the past years, the GCFR effort has focused on prestressed concrete reactor vessel (PCRV) closures; on GCFR shielding and physics studies; and on the fluid flow–heat transfer and structural-behavior characteristics of GCFR cores [the Core Flow Test Loop (CFTL) is designed to investigate these questions]. Efforts are being made to transfer key portions of this work to the HTGR program, with emphasis changing so as to address technical problems pertinent to the HTGR. Use of the CFTL may be shared by the fusion energy program, but the specific nature and the timing of the facility's support to fusion research have not been determined.

The Laboratory's HTGR Base Technology Program has included HTGR chemistry, fuel development, graphite development, structural materials studies, and PCRV development. More recently, ORNL has also been performing reactor physics analyses and general evaluations and assessments. The Laboratory's unique expertise is the reason for its planned participation in HTGR project evaluation, in assessments of PH-HTGR applications in comparison to alternative energy sources, and in the writing of a generic environmental impact statement for the HTGR. Also, ORNL is planning to increase HTGR support in the areas of PCRV closures, shielding design (making use of the Tower Shielding Facility for experimental measurements), and fluid flow–heat transfer experiments and associated analytical development (making use of the CFTL). A primary issue is how deeply ORNL should become involved in the HTGR program in the face of budget uncertainties and of needs to expand other programs.

Commercial and Defense Waste Management

The ORNL Radioactive Waste Management Program includes two categories of work: management of wastes generated at ORNL and R&D directed toward the resolution of social and technical issues in nuclear waste management. The total effort of the program under categories AP, AR, and AS is 130 FTEs in FY 1980. If funding permits, the Laboratory plans to increase this commitment to waste

management to 140 FTEs in FY 1981, to approximately 170 in FY 1982, and to 210 thereafter.

The Waste Management Operations Program supports the operations, process development, engineering studies, and conceptual design efforts required for successful management of ORNL-produced radioactive wastes and for improvement of the waste management systems. The program's long-term objective is to ensure that new technology and improved facilities will enable compliance with future regulations. This improvement of ORNL waste management practice will require (1) the development of methods for handling stored and newly generated transuranic waste, (2) the implementation of programs aimed at reducing the amounts of waste generated, (3) the application of technology that will reduce waste volumes and produce improved waste forms, (4) expanded use of hydrofracture to reduce ORNL's reliance on shallow land burial, (5) further implementation of methods to stabilize waste in ORNL burial grounds, and (6) the performance of field research efforts that are required in R&D programs. In addition, decontamination and decommissioning will become an increasingly important part of the future effort.

ORNL's waste management systems are being extensively improved. Projects in various stages of design or construction have a combined total estimated cost of about $70 million. These include the new Hydrofracture Facility, a Radioactive Waste Facilities Improvement Project, a Waste Tank Project, and the Low-Level Waste Pilot Facility. Projects beyond these will be defined by a comprehensive waste management operations plan that takes into account DOE's new directions and new approaches with respect to waste management. Plans for ORNL's in-house waste operations program include the expenditure of considerable General Plant Project funding for facility improvements.

The main issues related to Waste Management Operations involve the need for a policy identifying remedial action in regard to ORNL burial grounds and other formerly utilized waste disposal sites and the question of the amount of decontamination and decommissioning that should be done. A comprehensive planning effort for decontamination and decommissioning has defined extensive and costly work required for the decommissioning of such facilities as reactor experiments, components, tanks, storage gardens, and processing facilities. Because of the impending delay in the availability of a geologic repository for transuranic wastes, it will be necessary for ORNL to continue to add to its capacity for their storage; it may also need to consider placing the transuranic wastes in a more stable waste form. In addition to the need for increased transuranic waste storage capacity, increased burial ground disposal capacity will be needed in 1985; ORNL and other Oak Ridge plants may work cooperatively to meet their disposal requirements.

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 on technology for waste processing and for disposal of low-level wastes. This activity also supports data- and information-gathering functions, such as the preparation of an integrated data base on which national waste management planning and analysis can be done by DOE Headquarters and lead Field Offices.

One important issue related to waste management technology is the lack of a long-term plan for ORNL's involvement in waste management programs, which makes it difficult to foresee what the organizational and staff requirements will be toward the end of this planning period. This problem results partly from limited delegation to ORNL of secondary roles within the waste management programs; thus, much of the work is performed on a job-shop, or entrepreneurial, basis. This approach would not appear to be the most desirable way to take maximum advantage of a multidisciplinary, comprehensive laboratory. In addition, programs have been delayed by a lack of geologic samples because permission has not been obtained to gather such samples in any state. Although the present emphasis on field demonstration efforts is warranted, additional emphasis is needed on R&D, particularly for land disposal in wet climates, where the complex geology and hydrology create situations that are poorly understood. Inadequate funding has eliminated the evaluation of some potentially desirable technologies, including alternative waste forms for high-level waste and alternative methods of shallow land burial.

Light-Water Reactor Safety and Technology

It has become increasingly apparent that light water reactors (LWRs) will have to play an important role in electricity generation in this country. It is also evident that the LWR industry faces significant

technical problems, which must be resolved if the full potential of the LWR generating system is to be realized. Some of these problems affect plant availability and productivity; others impact the current national debate over LWR safety; and others fall into the important category of plant-worker radiation exposures.

Some of these problem areas are clearly design or economic problems that either the reactor-owning utilities or the reactor manufacturers must address; these do not require the commitment of national R&D resources for satisfactory resolution. Others, on the other hand, are of a generic nature and will require a definite commitment of R&D programs in order to establish the necessary data base to permit competent resolution of the problems by industry. Some of these generic problems are in areas in which ORNL has demonstrated its expertise, both through broad historical imvolvement in reactor system development and through more recent efforts on advanced reactor concepts, such as the fast breeder. These areas include analyses of man-machine interactions, development of radwaste treatment equipment, enhancement of accident-recovery operations, and improvement of reactor availability through better instrumentation and reactor fuel systems. We consider it very important that the resources represented by the national laboratories be applied to the resolution of these generic problems.

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 detailed data base has been developed that characterizes the various nuclear power plant options and their fuel cycles; this data base was an important element of DOE's nonproliferation studies program. ORNL's contributions to the nonproliferation studies have been completed, but it is anticipated that continuing studies at a reduced level of effort will focus on intermediate-term problems of LWRs. Topics to be investigated include the transfer of technology from advanced reactor programs to the LWR industry and assessment of the relative risks from electricity-generating plants.

Advanced Systems. In this area, for which ORNL is a lead laboratory, activities in the promising field of cogeneration/district heating will be expanded, and programs on energy centers and industrial energy will be maintained. A district-heating demonstration program in the Minneapolis–St. Paul area is being supported as the first step in what may become a major DOE commitment to the increased use of district heating. Currently, a significant number of studies and assessments are being carried out through R&D subcontracts.

Space and Terrestrial Systems. The Laboratory's role in this area includes characterizing, evaluating, and developing new and improved materials for use in current and future space missions and in terrestrial applications. Activities directly supportive of U.S. space programs continue to focus on developing materials for the isotope fuel cladding and for low-density structures and thermal insulation; these materials will be used in the Galileo and Solar Polar space missions. The Space and Terrestrial Systems Branch, Advanced Nuclear Systems and Projects (ANSP), has requested that we take the lead role in the development of materials technology and in coordination with systems contractors on current and future missions. Despite this increased involvement, the total effort in support of space systems may decline after FY 1982 unless planned missions beyond FY 1984 are approved.

Lead Missions

Consolidated Fuel Reprocessing Program (current role)

At the beginning of FY 1980, ORNL was formally designated as the technical management center that would support ORO in the execution of the Consolidated Fuel Reprocessing Program, a role that the Laboratory had essentially been performing earlier. The program's primary objective is to develop the technology for reprocessing spent breeder fuels, which ultimately will lead to the demonstration of that technology and to recycling of fuel from the first U.S. breeder demonstration reactor. Because the lead mission schedules are meshed with the reactor schedule, they are currently indefinite, reflecting the uncertainties in the U.S. breeder strategy. As we perceive it, recycling of the reactor fuel must begin within one to two years after fuel discharge in order to demonstrate the technology adequately and to minimize the external plutonium requirement in the breeder program. Since the breeder's initial plutonium fuel will be obtained from reprocessed LWR fuel, planning must consider the possibility that the demonstration facility would be used to reprocess LWR fuel as well as breeder fuel.

Summary of resources—Consolidated Fuel Reprocessing Program[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost							
National program	38.2	28.0	24.0	26.0	28.5	31.3	32.5
ORNL	34.1	23.5	24.0	26.0	28.5	31.3	32.5
Capital equipment	3.0	5.0	4.2	4.5	4.5	4.5	4.5
Subcontracting and procurement	13.6	7.4	11.1	11.8	12.6	13.5	14.8
Direct FTE	207	160	134	145	160	175	191

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Materials and Structures Technology Management Center (current role)

The objective of the Materials and Structures Technology Management Center (MSTMC) is to support ORO in the management of the national program aimed at developing the structural design and associated materials technologies required for LMFBRs. Activities of this lead mission include developing structural design analysis methods and failure criteria and conducting confirmatory behavior and properties tests for structural and related materials. In support of these activities, manufacturing and in-service nondestructive testing techniques are developed to ensure component reliability for demonstration and commercial plants.

The Laboratory is currently a leader in research related to structural design methods, materials properties, and nondestructive testing; its in-house programs provide expertise for management of these technology areas. To fulfill the Laboratory's role in this mission, the MSTMC prepares the National Program Plan under the direction of ORO and with the concurrence of DOE Headquarters and managers of participating laboratories. It also coordinates key milestones with other DOE technology management centers and projects.

The DOE responsibility for the MSTMC was shifted in June 1980 to the Office of Light Water Reactors for the stated purpose of enlarging its scope to include LWR materials and structures work. At the same time, selected sodium technology tasks related to cleaning and decontamination were added to the LMFBR tasks to be managed by the MSTMC. As a result, the R&D managed by the center may, over time, become more generic, although all work now continues to support LMFBRs. The small projected increase in personnel partly reflects anticipation of a general broadening of the MSTMC's scope to include other nuclear reactor concepts.

Contractor participants for MSTMC include (1) DOE laboratories—Argonne National Laboratory (ANL), HEDL, Idaho National Engineering Laboratory (INEL), and ORNL; (2) the Naval Research Laboratory; and (3) industrial contractors—Agbabian Associates, General Electric Advanced Reactor Systems Division, Rockwell International, and Westinghouse Advanced Reactors Division. The ORNL portion of the national program, managed by the MSTMC, is about 38%.

In addition to managing mission-related contracts, the MSTMC maintains coordination with other technology management centers that administer fission programs, such as the centers associated with the Nuclear Standards and Consolidated Fuel Reprocessing programs at ORNL, the Reactor Fuels and Materials Program at HEDL, and the Fast Reactor Safety and Components programs at ANL. We also effect technology transfer through consolidated periodic technical summary reports (highlights). Additional technology transfer is effected through appropriate subcontracting to industry by MSTMC contractors for product development.

Summary of resources—Materials and Structures Technology Management Center[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost							
National program	11.8	14.0	16.0	16.0	16.0	16.0	16.0
ORNL	4.9	6.1	7.2	7.2	7.2	7.2	7.2
Capital equipment	1.2	1.3	1.3	1.3	1.3	1.3	1.3
Subcontracting and procurement	1.1	1.3	1.3	1.3	1.3	1.3	1.3
Direct FTE	51	53	55	55	55	55	55

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Nuclear Standards Management Center (current role)

The Nuclear Standards Management Center (NSMC) has been established at ORNL to provide technical management of the Nuclear Standards Program for DOE's Division of Quality Assurance and Standards. The key objective of the NSMC is to ensure that information and experience gained in

the nuclear programs are documented in standards suitable for use in future programs and activities in both the public and private sectors. Under the leadership of the center, ORNL's Nuclear Standards Office provides technical support staff for the production of standards and operates a standards information center.

The NSMC has a number of critical objectives. These include (1) collecting standards information and providing outreach to program managers, (2) acting as a liaison with national consensus standards organizations, (3) fostering the development and application of program standards, (4) operating the Nuclear Standards Program Information Center, and (5) interfacing with related organizations associated with nuclear standards. Furthermore, the NSMC assists DOE in the evaluation and supervision of nuclear standards activities; maintains, distributes, coordinates, and catalogs nuclear program standards; and maintains a working group on standards.

Informal guidance received from the Assistant Secretary for Nuclear Energy indicates that the NSMC will probably be asked to include waste management technology in its standards activities. Should this occur, appropriate fiscal and organizational modifications to the NSMC's level of activity must be identified and implemented.

Summary of resources—Nuclear Standards Management Center[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.9	1.0	1.1	1.1	1.1	1.1	1.1
Subcontracting and procurement	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct FTE	12	11	11	11	11	11	11

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Low-Level Waste Management Program (associate lead mission, current role)

This program seeks to develop cost-effective and environmentally sound techniques for the safe, efficient disposal of all types of low-level radioactive waste generated by such activities as energy production, manufacturing, and the use of radioisotopes in medicine and other fields. One program activity focuses on the development and improvement of waste treatment and packaging technologies. Others emphasize shallow land burial. Their objectives are to define problems in current shallow land burial practices and subsequently to develop and demonstrate remedial measures for stabilizing and improving the performance of existing burial grounds. Furthermore, we are attempting to develop and demonstrate improved techniques for future shallow land burial operations, including site selection, waste emplacement, and site stabilization. Yet another facet of this program is the development, evaluation, and demonstration of alternative methods of low-level waste storage and disposal.

The initial detailed overall program plan, which defined milestones for the development and demonstration of low-level waste management technologies, was completed in FY 1980. It will be modified yearly to reflect any change in program direction and level of effort. We expect additional milestones related to the assessment of current practices for site waste management to be incorporated in the plan.

The Laboratory is responsible for supporting ORO, the associate lead field office for the National Low-Level Waste Management Program, in the management of selected parts of the national effort. In this capacity, it interfaces with INEL/EG&G, which is the lead support contractor for the program's lead field office, Idaho Operations. Although ORNL will generally assist INEL/EG&G in the total program, we will emphasize the development of a base technology and concepts for alternative systems of processing and disposal, as well as other assigned supporting functions. ORNL also provides technical staff input to the program and full services support in all business management areas.

In the associate lead role for the INEL/EG&G program, the Laboratory, in support of ORO, will direct and coordinate technical activities in low-level waste management at other DOE multiprogram

Summary of resources—Low-Level Waste Management Program[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost							
National program	9.3	17.8	19.0	21.0	23.0	25.0	25.0
ORNL	2.5	2.4	2.8	3.1	3.5	3.5	3.5
Capital equipment	0.2	0.3	0.3	0.1	0.1	0.2	0.2
Subcontracting and procurement	0.9	0.8	0.9	0.8	0.5	0.3	0.3
Direct FTE	29	25	25	26	27	27	27

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

laboratories, including Los Alamos National Scientific Laboratory, Mound Laboratories, Battelle Pacific Northwest Laboratories, Rockwell International, HEDL, and Savannah River Laboratories. We also anticipate subcontracts with universities, commercial firms, and consultants. To fulfill a primary goal of the program, the Laboratory will make the low-level waste management technology derived from these R&D activities available to industry and to federal, state, and local governments.

Assistant Secretary for the Environment

Overview

A major objective of the biomedical and environmental research at ORNL is to provide environmental, health, and safety information that can be used in formulating and implementing energy technology decisions. Research is directed at securing information necessary to understand both the short- and long-term consequences to man and to the environment of energy production and use, particularly of coal conversion processes. A necessary component of this research is the investigation of the substances associated with energy production that are responsible for biological and ecological damage and of appropriate repair mechanisms.

Funding to ORNL from the DOE biomedical and environmental sciences programs has remained essentially constant in the last few years; however, the basic biomedical and environmental sciences research and development funding continues to decrease. Though not readily apparent, funding for the basic life sciences program is being redirected from basic research toward applied research efforts supporting site-specific evaluations of synthetic fuel technologies. The success of future work depends upon new knowledge gained from basic science research; accordingly, those working in applied science programs regularly call upon researchers in basic science to assist them in problem solving. Although needed increases in basic research funding can now be seen in planning by ASEV staff, the Laboratory requests that ASEV continue to be concerned about and to review policy in this area.

ORNL must also be allowed to continue its work for other agencies to maintain its basic life sciences capabilities. This work helps provide for overall institutional and program flexibility; therefore, the Laboratory must continue to supplement ASEV-supported programs with complementary work elements supported by grants and interagency agreements with other federal agencies.

The emphasis in DOE biomedical and environmental sciences programs continues to shift from nuclear energy programs to fossil and other nonnuclear energy programs and to multitechnology-related programs (Fig. 14). The programs in fossil energy are primarily related to coal and coal conversion but also include oil and oil shale research. Including oil and oil shale samples in this research enables us to develop comparative data on new fossil technologies and to fulfill for ASEV our

ORNL-DWG 80-13824

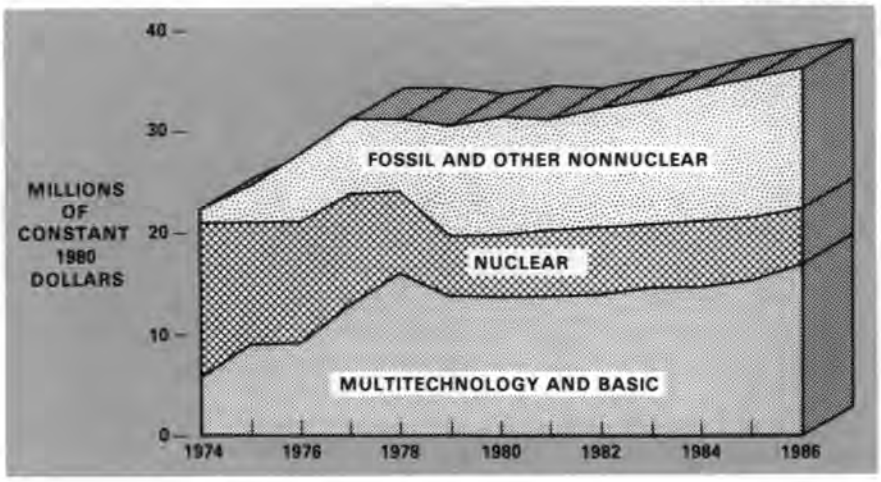

Fig. 14. The emphasis in DOE biomedical and environmental research programs at ORNL has changed from nuclear to nonnuclear.

lead responsibility in researching Gasifiers in Industry, H-Coal, and coal liquids. We anticipate new initiatives for developing data to assess the environmental costs of exploiting eastern shale deposits. Other nonnuclear programs include studies in solar energy, geothermal energy source development, and energy conservation. The fission energy programs in the biological area have decreased so much as to be in danger of becoming ineffective. Radiation ecology research programs are currently nonexistent at ORNL, and biological research programs are seriously reduced. Further, no significant growth is expected in our modest fusion energy program.

Growth is expected, however, in the toxicology (systems damage) and the life sciences synthetic fuels programs. Funding increases are recommended for ongoing programs that were initiated for identifying specific chemical products and by-products that could have adverse health and environmental impacts. Expansion of these programs would allow for the development of a sound research and development (R&D) program and for applications to process-specific work (e.g., H-Coal). Studies providing information on the formation, mobility, toxicity, detectability, and character of pollutants that might affect man have had and should continue to have funding continuity. We also recommend that ASEV pursue multiyear funding for support of some of the site-specific programs. There is a need to understand the long-term environmental considerations related to land use and facility siting, waste management, resource constraints (availability of gas, oil, timber, fiber, etc.), and climate change caused by carbon-dioxide; programs investigating these long-term effects should grow moderately during this planning period.

ORNL is giving increased emphasis to tasks that are (1) investigating biotechnologies for waste treatment, resource recovery, and fuel production; (2) designing advanced instrumentation to assess the impact of pollutants from the emerging energy industries; (3) developing methods of health risks assessment; (4) concentrating on toxicological studies; (5) assessing the health and environmental impacts of eastern shale development; (6) researching reservoir and water resource management; (7) investigating biogeochemical cycles; and (8) involving environmental geoscience research.

Overview and Assessment (HA 01)

ORNL provides technical support to the National Environmental Policy Act (NEPA) Affairs Division of the Office of Environmental Compliance and Overview and the Regional Impacts Division, Technology Assessment Division, and Regulatory Impacts Division of the Office of Environmental Assessments. Tasks for these offices include preparation of a generic guidelines document for environmental reports; assessments of water for energy; technology assessments for solar, transportation, industrial energy end use, and synthetic fuels; and regional assessments.

In addition, environmental control systems for coal conversion processes are being developed for the Environmental Control Technology Division. Laboratory-scale work is directed at providing the initial information needed to develop and evaluate the feasibility of alternative control technologies for application to coal conversion processes. Also, we are conducting investigations designed to identify the key environmental parameters affecting the mobility of trace organic contaminants in solid residues from fossil technologies in order to ensure the timely development of cost-effective control and management strategies. Field investigations are designed to obtain information on the performance of control technologies as they are applied to large-scale facilities.

Biomedical and Environmental Research (HA 02)

This activity encompasses a wide-ranging effort to understand the interaction of energy-related pollutants, including radiation, with living organisms and ecosystems. This information is then applied to ongoing DOE activities to ensure that they can be conducted safely and effectively; that possible hazards to humans can be identified, evaluated, and anticipated; and that the overall environmental costs of the various energy options can be meaningfully assessed.

Because of the nation's and DOE's interest in increased coal utilization, we expect increased effort in this research area over the long term. For example, a two-year effort in support of the H-Coal process will cost approximately $8 million and will come from DOE and other sources. Evaluation of the hazard potential of chemicals associated with coal combustion or with coal conversion processes includes (1) the development of faster, more sensitive, and less expensive methods of biological testing; (2) validation of bioassays; and (3) analysis, at the cellular and molecular levels, of the mechanisms underlying toxic effects or the capacity of

chemicals to alter normally programmed development. The interactions of chemical and physical agents in producing disease in mammals are particularly emphasized. Current toxicology studies emphasize skin, lung, and cardiovascular systems, which are all important targets of pollutants; the studies also focus on the toxic effects of metals. We urgently need new programs in neurotoxicology and immunotoxicology. Germ cells as well as somatic cells are also studied, permitting the analysis of their effects on fertility, heritable genetic damage, and fetal malformations.

Environmental research will continue to focus on identifying and quantifying the effects of energy-related products and effluents on various ecosystems and their components and on determining the persistence and fate of these materials within the environment. Completion of the Gaseous Effects Laboratory (GEL), which is being assembled within the greenhouse complex of Building 1506 at ORNL, will enable us to evaluate the effects of exotic hydrocarbons on important agricultural and forest species. Interactions between various gases (such as NO_x, SO_x, and ozone), including regional air pollutants such as acid precipitation, will be investigated using the GEL and our field exposure chamber system. Subcontractors will conduct some of these investigations.

Determining the persistence and fate of contaminants provides important data for research on effects and for assessment. When our modeling activities on polycyclic aromatic hydrocarbons (PAHs) and nitrogen- and sulfur-substituted heterocyclics in the aquatic environment are completed, we shall shift emphasis toward examining the dynamics of the dissolution and transport of synthetic oil spills. Terrestrial transport studies of the potential for vegetational uptake of PAHs will continue. Our environmental research will also investigate two phenomena that result from coal utilization: increased atmospheric CO_2 and acid precipitation, both highlighted in the Energy Security Act as major areas of interest.

Identifying and mitigating the adverse impacts of energy technologies require the development of monitoring methodologies, trial implementation of monitoring protocols, and a continuing review of research results on significant environmental concerns. New instruments are being developed, fabricated, field-tested, and evaluated: they are designed to assess and predict the impacts on the health of operating personnel and the exposure of operating personnel to potentially carcinogenic and mutagenic PAHs from the products, effluents, and emissions of an emerging fossil energy coal conversion industry. These efforts include the development and successful field testing of two portable instruments that will detect and measure the fluorescent emission of PAHs at low concentrations on most surfaces (wood, metal, plastic, etc.) and on human skin. One of these instuments, the spill spotter, is based on the use of modulated excitation light in the near-ultraviolet wavelength band; the light pipe luminoscope, also being tested, uses low-level ultraviolet radiation. A new proposal is directed toward identifying and measuring specific metabolic products of the P-450 mixed-function oxidase catalyzed reaction with PAH, using a radio-labeled substrate (such as benzo[*a*]pyrene) to measure enzyme induction. From these data, the susceptibility of individuals to carcinogenesis by PAH would be determined.

Research efforts are directed toward elucidating the physics and chemistry of the following pollutant interactions: atmospheric pollutants, radiation chemistry and physics, and direct applications of the behavior of toxic pollutants and radiation in biological media. The work includes efforts to identify important natural and man-made ionic and neutral reactive atmospheric species, to investigate their basic properties, and to understand their reaction sequences. The investigations include measurements of ion-molecule reaction rates; molecular electron affinities; and reactive species production by the impact of electrons, ions, and neutral particles on molecules.

Increased amounts of carbon dioxide being released into the atmosphere by fossil fuel combustion and by significantly increased oxidation of organic matter currently being produced by forests and soils have raised the concentration of CO_2 in the atmosphere. Understanding the global carbon cycle, man's influence on the cycle, and the ecological consequences of elevated atmospheric CO_2 concentrations requires a broadly based program of research and integrated assessment. The purpose of the task on climate and the global carbon cycle is to develop continuing assessments of this issue. Three major assessment areas are considered: development of mathematical models and an analysis of data sets that reflect the dynamics of carbon, assessment of changes in carbon cycle dynamics expected to accompany climate change, and an analysis of the impact of climate change on the world's ecosystems. A new research task, Bioclimatology of Energy Impacts, is proposed to increase our understanding of northern hemisphere climate variation in the past

and present and to consider credible possibilities for the future.

Life Sciences Research (HB 01) and Biomedical Applications (HB 02)

Investigations of fundamental mechanisms of the biological damage caused by various chemical and physical agents associated with energy production provide a potential means for generalizing from specific results to whole classes of compounds. In some cases they provide insight into the ways in which such damage is, or can be, repaired. Understanding these mechanisms will ultimately allow the generic employment of mitigation efforts to prevent potential impacts.

This work provides information that can be used to develop sensitive and reproducible assays of the biological damage caused by energy products, thus increasing our ability to measure that damage. The mechanisms by which mutagenic chemicals and radiation cause damage to genetic material are also being investigated. Knowledge of these fundamental mechanisms, gained by studying model systems in microorganisms and animals, will facilitate our understanding of similar events in man and will strengthen extrapolations made between animal and human systems. Further, knowledge of these fundamental cell processes contributes to a more thorough and logical understanding of the molecular events that occur during the transformation of cells by carcinogens and during the production of damaged cells by multiple toxic agents (e.g., products of fossil fuel and nuclear energy technologies).

Other projects currently under way are concerned with defining the mechanisms that control the active transport of biologically important materials between cells and their environments, the regulation of various physiological processes, and the structure of biologically active molecules. Structurally modified organic compounds needed for investigations of mutagenesis and carcinogenesis are being synthesized.

The Nuclear Medicine Applications Program consists of three integrated tasks that function in response to DOE's role in promoting the beneficial applications of nuclear technology. The principal purpose of this program is to develop new radiopharmaceuticals for evaluating clinical feasibility under the medical cooperative programs.

Lead Missions

Environmental Research for Gasifiers in Industry, H-Coal, and Coal Liquids Evaluation (current role)

This mission's objective is to develop a data base that will allow the determination of the environmental and health acceptability of synthetic fossil fuel technologies. The program focuses primarily on coal conversion technologies (i.e., gasification and liquefaction), but our comparative study activities also include chemical characterization and biological testing of shale oil products and natural crudes. Our site-specific coal conversion research currently emphasizes studies of the low-Btu gasifier at the University of Minnesota–Duluth (UMD) and of the H-Coal liquefaction process. The latter study involves initial tests of products from the process development unit at Trenton, New Jersey, and program implementation for the pilot plant at Catlettsburg, Kentucky. We are able to support DOE initiatives in either of these coal conversion technologies.

Major milestones include program development and implementation. Implementation of the Environmental and Health Monitoring and Testing Program at UMD began in FY 1978. In FY 1979, program plans were complete for the Pike County and H-Coal projects, and implementation of these anticipated three-year projects has begun. If requested, program development for other liquefaction projects, such as the solvent-refined coal (SRC) demonstrations or the Exxon Donor Solvent (EDS) pilot plant, can also begin. Program plans for the SRC projects currently include only one specific activity: collecting substantial volumes of aqueous effluents from the SRC-I pilot plant at Wilsonville, Alabama, for testing in the ORNL bioreactor.

Components of this lead responsibility are identified in the reporting requirements for the site- and process-specific studies listed by ASEV in September 1979 as UMD gasifier, Pike County gasifier, H-Coal, Coal Liquids Evaluation, and End Use (PARAHO-Navy). The Laboratory is responsible for identifying problem areas and support requirements; for directing onsite and offsite programs, including subcontractor activities, in cooperation with DOE Headquarters' Program and Operations offices and for coordinating ORNL work with related fossil energy activities being performed by other DOE contractors.

Summary of resources—Environmental Research for Gasifiers in Industry, H-Coal, and Coal Liquids Evaluation[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	7.2	7.6	7.2	6.6	5.9	5.9	5.9
Capital equipment	0.3	0.5	0.3	0.3	0.3	0.3	0.3
Subcontracting and procurement	2.4	2.4	1.9	0.5	0.1	0.1	0.1
Direct FTE	88	93	88	81	72	72	72

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years. The decline after FY 1981 reflects the completion of current projects. Dollar levels may vary depending on actual facility operations and on DOE requests to investigate other facilities. Because of the current interest in developing synthetic fuels technologies, effort in this activity should not decrease in the future.

Regional Ecological Analysis and Modeling (current role)

The objective of this program is threefold: to formulate scientific constructs, to assemble regional data bases, and to develop models that can be applied to regional environmental and energy resource conflicts. The conceptual framework is being formulated in order better to address the broad spectrum of regional environment and resource questions. The data bases are being developed to provide the information necessary for these large-scale analyses. And, finally, technical simulation models are being developed that will (1) analyze energy resource utilization and environmental risks, (2) provide optimization strategies for developing energy resources (fossil, nuclear, solar, geothermal, hydro, and biomass), and (3) simulate different mitigation plans to ensure the maximum utilization of the nation's energy resources while maintaining a high standard of ecological integrity at the regional systems level.

Regional ecological analysis can be divided into four basic categories: assessment, suitability, optimization, and theory development. Though ORNL has not been designated the lead laboratory in regional ecological analysis, it is a demonstrated leader in this research area. ORNL assessment activities, at one time including the National Coal Utilization Assessment, currently include the Regional Issues Identification Assessment project, which predicts the environmental impacts associated with the National Energy Plan. Peripheral to the assessment work is the Environmental Protection Agency multimedia modeling project, which characterizes the entire United States by regions with similar ecological attributes, for the purpose of modeling toxic chemical transport. Earlier, regional optimization studies have dealt with a variety of DOE projects ranging from the siting of power plants to the location of areas having the greatest potential for solar biomass. All of the above studies have interacted with past and current DOE-funded efforts associated with the National Environmental Research Park on regional environmental resources and ecological data for the continuous updating of the ecology data base.

Summary of resources—Regional Ecological Analysis and Modeling[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	1.4	1.6	1.7	1.8	1.9	2.0	2.2
Capital equipment	0.2	0.1	0.1	0.1	0.2	0.2	0.1
Subcontracting	0.2	0.2	0.3	0.3	0.3	0.3	0.3
Direct FTE	13	13	14	14	15	15	16

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Integrated Regional Assessments for Regions 4 and 6 (current role)

ORNL has been given lead laboratory responsibility in this mission, with respect to siting projections, water availability studies, and regional energy and economic disaggregations. The basis for this lead role assignment is Program Guidance for FY 1978 and FY 1979.

ORNL responsibilities in the assessments and policy analysis area include the management of subcontracts and the technical coordination of this activity with related DOE programs. The Laboratory itself conducts several related programs, including regional studies activities and programs on environmental policy analysis, technology assessments, and environmental impacts. This mission provides direct input to similar, integrally related programs of other DOE contractors. Other related programs include surveys of inactive uranium mills and formerly used Manhattan Engineering District and Atomic Energy Commission sites, environmental assessments of advanced breeder fuels, model evaluation of breeder reactor activity releases, modeling of atmospheric radionuclide releases, and environmental assessment modeling for shallow land disposal of radioactive waste.

Summary of resources—Integrated Regional Assessments for Regions 4 and 6[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	1.5	1.6	1.6	1.6	1.6	1.6	1.6
Direct FTE	7	8	8	8	8	8	8

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Environmental Impact Assessment for Nuclear Fuel Cycle and Waste Management (proposed role)

The objective of the proposed program is to provide overall management responsibility for the National Environmental Policy Act (NEPA) activities required to support DOE programs in the nuclear fuel cycle and waste management areas. ORNL will be responsible for technical management of the environmental impact assessments and statements required by NEPA for DOE nuclear fuel cycle activities. This role will involve defining requirements and coordinating in-house activities and the work of other contractors, including universities, private consultants, and other national laboratories. Major ORNL milestones will be (1) to develop and coordinate activities, (2) to procure major subcontracts, (3) to produce NEPA documents on schedule, and (4) to coordinate mission activities with existing DOE programs in waste management.

Further interaction on the part of ORNL will be required in managing subcontracts, coordinating mission activities with related programs, and effecting technology transfer. For this program, subcontracted support will come from universities, private consulting firms, and other national laboratories. We are currently involved in several related programs that provide major assistance to DOE and the Nuclear Regulatory Commission in areas pertaining to the nuclear fuel cycle and could readily coordinate these programs with the proposed mission; these areas include environmental assessment of mining and milling, fuel fabrication, reactor construction and operation, and waste handling.

Summary of resources—Environmental Impact Assessment for Nuclear Fuel Cycle and Waste Management[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	3.2	3.4	3.9	4.1	4.2	4.2	4.2
Subcontracting and procurement	1.2	1.3	1.5	1.6	1.7	1.7	1.7
Direct FTE	21	21	24	25	25	25	25

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Capital equipment funding requirements will be less than $50,000 per year. Personnel numbers are in full-time equivalent (FTE) person-years.

Hazardous Solid Waste Technology (proposed role)

This program's objective is to develop environmentally sound techniques for managing the solid wastes produced by our society, including those from nonnuclear energy production and from manufacturing and municipal activities. This program will provide a focal point for the various ongoing programs studying solid waste management. During the past few years, considerable attention has been given to shallow land burial of nuclear wastes, and much of what is being learned is directly applicable to hazardous wastes. Because of increasing emphasis on nonnuclear energy production and, in particular, on expanding the role of coal as an energy source, proper management of the wastes produced by these technologies will increase as a public concern. In this lead mission role, ORNL anticipates that it will develop mitigating waste management procedures, select appropriate liner materials to adsorb and retard the transport of toxic substances from waste disposal sites, characterize the chemical stability and physical properties of solid wastes, and assess the potential health and environmental effects of the dissolution products from various solid wastes. As this program will emphasize, waste management includes not only disposal of wastes but also the recovery of reusable resources.

A draft of the national research plan, completed by ORNL in the first quarter of FY 1979, was presented to DOE. Major milestones include (1) designing environmentally and economically acceptable waste disposal procedures for coal conversion facilities and implementing them at demonstration sites, (2) screening solid wastes in accordance with Resource Conservation and Recovery Act testing regimes, and (3) establishing generic research that addresses disposal alternatives and emphasizes resource recovery management.

Numerous DOE programs not specifically directed at researching solid waste disposal pertain to this program, and ORNL will be responsible for applying the programs' results to the solid waste mission. Included are several programs in low-level nuclear waste management (activity migration in soils, waste

volume reduction, etc.); several under the Director of Energy Research in the coal program (resource recovery from fly-ash and coal conversion residues, ash disposal, etc.); and several under ASEV in such areas as environmental control R&D, environmental monitoring, and environmental data base development.

Summary of resources—Hazardous Solid Waste Technology[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	1.2	1.5	1.9	2.4	3.0	3.7	4.6
Capital equipment	1.0	1.0	1.0	1.0	1.1	1.1	1.1
Subcontracting and procurement	0.5	0.7	1.5	1.6	1.7	1.8	1.9
Direct FTE	13	13	15	19	23	28	35

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Environmental Effects of Producing and Using Wood for Energy (proposed role)

This program's goal is to identify the type and extent of local and regional environmental effects related to the production and use of wood for energy. This mission focuses on providing essential information regarding the effects of the use of wood for energy on soil, water, vegetation, air, land use, and the wood market. The proposed work will estimate wood energy potential; ultimately, ways of minimizing negative environmental (and ecological) effects will be developed.

The program goals are best expressed as a series of cumulative milestones.

Milestone	Date
Assessments of land suitability and wood resources	FY 1982
Quantifications of the resource demands and residuals (atmospheric and water emissions) of wood energy conversion technologies	FY 1982 or 1983
Examination of environmental effects of producing woody crops for energy, including the planting, maintaining, and harvesting of wood resources	FY 1983
Land use displacement impacts and land availability studies for energy production	FY 1984
Economic evaluations of influence on wood markets of wood energy development	FY 1985
Regional evaluation of affected environmental resources	FY 1986
Recommendations for controls to ameliorate negative environmental effects (e.g., atmospheric emissions, undesirable effluents, erosion hazards, and soil nutrient drain)	FY 1987

Areas needing further research will be identified, and the balance between the amount of wood energy this country uses and the consequential environmental, ecological, and wood market effects will be described.

We propose that ORNL be designated lead laboratory for evaluating environmental effects of an increased use of wood as an energy source because of ORNL's long involvement in research related to the environmental effects of energy technologies and ecosystem productivity. Further, we have more recently had an active role in DOE research on the production of wood for energy and are currently providing technical management for twenty-four research contracts in the Biomass Energy System Division's Fuels and Chemicals from Woody Biomass Program (AN 0510). Work in these projects, which is being performed at universities and U.S. Department of Agriculture (USDA)– Forest Service research stations across the country, covers a wide range of methods for increasing the production of

Summary of resources—Environmental Effects of Producing and Using Wood for Energy[a]

	'81	'82	'83	'84	'85	'86
Operating cost[b]	0.7	1.2	1.6	1.7	1.3	1.1
Capital equipment	0.1	0.2	0.2	0.1	0.1	*
Subcontracting and procurement	0.2	0.4	0.8	0.8	0.5	0.4
Direct FTE	8	12	16	16	13	11

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; other funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years. The asterisk indicates funding of less than $50,000. Peak funding occurs in FY 1983-84, when most field work, modeling, and contracting will be necessary. After FY 1984, decreasing costs reflect completed contract work and a concentration on information integration and modeling.

[b]Cost includes $250,000 annually from the USDA-Forest Service to perform environmental research in support of the DOE/USDA Forest Service Fuels and Chemicals from Woody Biomass Program. Operating costs include both in-house and subcontracting and procurement activities.

wood for energy, including species screening; stand establishment; management strategies; and collection, transport, and storage. We are working closely with the Forest Service to arrange an orderly transition of this project to the USDA by the end of FY 1981. Additionally, our working relationship with the Forest Service and the active investigators in wood energy research will provide an excellent base for our assuming lead laboratory responsibility for evaluating environmental effects.

Assistant Secretary for Conservation and Solar Energy

Overview

In its programs for the Assistant Secretary for Conservation and Solar Energy, ORNL has undertaken several lead mission roles for the Office of Building and Community Systems and the Division of Energy Storage Systems; our efforts in these areas have helped the Laboratory earn national stature. We believe that solar energy must play an important role in the nation's energy future and that ORNL should become more involved in research and development (R&D) in this area. Even with limited funds ORNL has made substantial contributions; its talents should be further utilized.

Conservation

Both the size and diversity of conservation work at ORNL has grown rapidly over the past few years. ORNL now manages major portions of the research, development, and demonstration (RD&D) programs of the Office of Buildings and Community Systems and the Division of Energy Storage Systems. Programs are also under way for the Office of Industrial Programs, the Office of Program Planning and Evaluation, and the Office of Transportation Programs. Further, we propose to assume a lead mission role in materials development for the newly formed Division of Energy Conversion and Utilization Technology.

The staff level for the conservation programs now stands at 72 FTEs; the expenditure rate is about $22 million. Our projections indicate a continued increase in the staff size and spending rates during the next two years but about constant levels in subsequent years. In FY 1981 and in FY 1982, several on-going projects, currently understaffed, will reach full strength. Concurrently, spending rates will increase (notably in the heat pump and energy storage projects) as full activity is reached on development subcontracts. The 50,000 gpd ANFLOW (anaerobic, upflow, packed-bed bioreactor) demonstration plant in Knoxville, Tennessee, is currently under way. A new thrust for the Office of Transportation Programs will be its research on the optimal operation of light-duty vehicles to conserve fuel. This work will be started in FY 1980 and will be developed into a comprehensive testing and analysis program in the following years. ORNL is assuming management responsibility for industrial applications of thermal energy storage in addition to our previously assumed responsibility for buildings applications. The Division of Energy Conversion and Utilization Technology has informally requested that we participate in the planning and assume a lead mission role in the area of conservation and solar materials requirements. The planning process for this program is expected to start in FY 1981, with research projects to be initiated in the latter part of FY 1981 or in FY 1982.

Analysis and technical assistance in implementing energy conservation in buildings (the Residential Conservation Service and the Buildings Energy Performance Standards programs) may continue for several years at current levels. Numerous technical issues continue to arise regarding the design and retrofit of energy-conserving structures. The appliance program effort is likely to decrease after FY 1981 because a number of the current projects have moved to commercialization. Increased emphasis on district heating is projected by the Division of Community Systems, following the development this year (by ORNL and others) of a comprehensive program. We expect to participate substantially in this program, drawing on the expertise gained in earlier U.S. Department of Housing and Urban Development (HUD) programs and from the Twin Cities district heating studies.

Solar Energy (AN, EA)

ORNL maintains a relatively small but highly diverse program in this area, involving projects oriented to the physical and social sciences. We conduct laboratory and field studies on environmental aspects of biomass use, biotechnology, photovoltaic (PV) cell fabrication, ocean thermal energy conversion (OTEC), high-temperature materials, and passive solar structures. Additionally, we serve

as program managers or technical monitors on external projects in several areas, including community studies regarding conversion to alternate energy systems.

Prior to FY 1980, the Laboratory's work related to PV mechanisms and biotechnology was confined to fundamental research. This year, however, 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 PV cell manufacture and (2) the light-induced splitting of water using extracted green plant matter (chloroplasts).

ORNL manages biomass studies conducted by several universities and U.S. Department of Agriculture (USDA) field stations and also performs on-site research to investigate the environmental effects of harvesting crop and field biomass for fuel production. Management of the Woody Biomass Program will be transferred to the USDA in FY 1982, but ORNL will continue its in-house research.

The OTEC Program also combines contract management and in-house work to study alternate (i.e., water-based) cycle concepts.

Current studies in passive solar building include the areas of design, construction, and future data collection from an earth-sheltered, passively heated structure, use of foliage in cooling structures, heat transfer in drainage rock beds, and the development of reflective insulating blinds.

Technical monitoring of PV demonstration projects will continue and will include a new project at Georgetown University in FY 1981. ORNL is building a new facility for the study of atmospheric contaminant effects of PV cells in concentrating applications. We will continue to monitor farm-based solar heat applications for USDA and will continue to evalute ceramic materials for high-temperature, solar-based fuel synthesis processes.

Lead Missions

Buildings and Community Systems (current role)

The Office of Buildings and Community Systems has assigned ORNL a lead mission role for five projects: Annual Cycle Energy System (ACES), Building Thermal Envelope Systems and Insulating Materials, Residential and Commercial Appliances, Heat Pumps, and Residential Conservation Service. Each of these projects addresses a different aspect of energy use efficiency for residential and commercial buildings. An innovative concept, the ACES provides building heating and cooling as well as water heating through a unidirectional heat pump with thermal storage. The Building Thermal Envelope Systems and Insulating Materials project provides the technical data, guidelines, and consensus standards needed by manufacturers, designers, builders, and government agencies to produce energy efficient buildings. The Residential and Commercial Appliance project provides RD&D to reduce appliance energy consumption to below otherwise obtainable levels. The Heat Pump project seeks to stimulate the development and commercialization of high-efficiency heat pumps. Through the Residential Conservation Service project, ORNL provides administrative and technical support to the states and utilities, which in turn provide conservation assistance to homeowners as the National Conservation Policy Act requires.

In each of the five projects, ORNL works through appropriate organizations to make the most effective use of government funding. Thus, the Heat Pump project devotes the bulk of its financial resources to competitive, cost-shared subcontracts with the heat pump manufacturing industry. This minimizes barriers to commercialization of the resulting hardware. A portion of the funding (nominally 15% of the total) is used for in-house R&D, thereby ensuring that ORNL has the expertise to manage the program competently and providing an independent check on industry results.

The energy conservation potential of the ACES has been demonstrated during two complete annual cycles in the Knoxville ACES house. Economic analyses indicate that the concept is attractive for some regions of the country on a life-cycle cost basis. However, it may not be economically attractive enough to appeal to a large market. The program plan calls for continued design R&D so as to make possible lower first costs and to aid commercialization efforts aimed at establishing a manufacturing and marketing capability.

The Building Thermal Envelope Systems and Insulating Materials project has sponsored research on a wide variety of insulating materials problems. Considerable progress has been made in establishing standards for insulation effectiveness, fire safety, and corrosion resistance. Future activities will give more emphasis to integrating structural components into an effective thermal envelope.

The Residential and Commercial Appliances project has addressed the problem of improving the energy efficiency of all home and business appliances

that use large amounts of energy. Promising results are being achieved in this area for both electric and gas water heaters, refrigerator-freezers, small compressors, and ranges. At the same time as more energy-efficient models of these appliances are being marketed, the project will examine the efficiency potential of other appliances.

The Heat Pump project is concerned with the development and commercialization of units having higher efficiency and, therefore, greater acceptability. Subcontracts have been let to develop several types of gas- and oil-fired heat pumps. Improved versions of electrically driven heat pumps are also being developed. Increased attention will be given in the future to concepts such as ground-source and groundwater-source heat pumps.

ORNL has provided technical assistance to the Residential Conservation Service project in formulating the regulations and issuing the environmental impact statement and the regulatory impact statement. Current tasks include preparing a planning guide and an auditor's training manual. The project's expansion as a result of recent legislation will necessitate that commercial as well as residential buildings be considered.

Summary of resources—Buildings and Community Systems[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	13.5	19.2	16.7	16.5	16.3	16.3	16.3
Capital equipment	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Subcontracting and procurement	10.2	15.5	13.2	13.4	13.9	14.5	14.5
Direct FTE	33	35	35	31	24	18	18

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Thermal Energy Storage (current role)

The Division of Energy Storage Systems has assigned ORNL the responsibility for two principal areas: thermal energy storage in building heating and cooling applications and thermal energy storage in industrial applications. The research is concerned with developing both sensible and latent heat storage technologies and with developing technology transfer capabilities to facilitate commercialization of the technology by the private sector. The program's scope includes making performance improvements to existing systems, developing advanced devices, and field-testing at prototype scale.

Building heating and cooling applications encompass residential and light commercial applications for electric load management, solar heating, and energy conservation. A recently added task covers commercialization in residential applications. The industrial area is concerned with heat recovery and reuse on the plant site for space heating or generating electricity. A specific task in the industrial area is the recovery of waste heat from an aluminum smelter (Intalco) for use in a prototype district heating system in the city of Bellingham, Washington.

Much of our effort on this project to date has been directed toward identifying, testing, and making economic assessments of suitable thermal energy storage media—particularly media that utilize a phase change to store large amounts of heat in a small volume. Future work in the buildings area will concentrate increasingly on the commercialization of known materials and systems. Future work in the industrial area will emphasize the utilization of industrial waste heat in energy cascading systems and in industrial cogeneration. Funding levels are expected to peak in 1984 or 1985 when several large demonstration projects will be under way and will decline thereafter.

Summary of resources—Thermal Energy Storage[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	2.4	4.0	5.0	5.5	6.0	5.0	5.0
Capital equipment	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Subcontracting and procurement	1.9	3.1	3.8	4.1	4.6	3.6	3.6
Direct FTE	5	9	12	14	14	14	14

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Assistant Secretary for Fossil Energy

Overview

The Laboratory has given coal-related work a high priority and its Fossil Energy Program offers the opportunity to integrate 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. Our work in the fossil energy area has grown rapidly since the program began in 1974 (as shown in the table below) and the

future expansion of this work is a high priority area for the Laboratory. Some specific areas in which work is being conducted are coal preparation, coal liquefaction, materials, environmental impact evaluation, direct combustion, environmental control technology, heat recovery, and enhanced oil recovery.

The staff level associated with the programs carried out for the Assistant Secretary for Fossil Energy is expected to remain nearly constant during FY 1981. However, the staff level is expected to grow after FY 1981 as a result of increased support for demonstration projects and the energy technology centers.

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.

Funding to ORNL by the DOE Office of Fossil Energy[a]

	'74	'75	'76	'77	'78	'79
Process technology	0.4	0.7	1.3	1.9	1.6	1.5
Studies and evaluations	0.1	0.4	1.3	2.8	3.8	3.7
Combustion	0	0	1.0	1.7	1.1	1.2
Environmental impacts	0	0	0	0.8	1.0	1.6
Materials	0	0	0.2	0.6	0.6	1.2
Total funding	0.5	1.1	3.8	7.7[b]	8.1	9.2

[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 Center as well as through funding in ORNL's own financial plan.

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

Coal Preparation (AA 75)

Coal preparation activities concentrate on the magnetic beneficiation of dry coal and the automation of conventional coal preparation plants. Experimental development on magnetic beneficiation of dry coal has been demonstrated to be technically feasible at a commercial scale using high-gradient magnetic separation (HGMS), and work is proceeding that will better define process economics. Open-gradient magnetic separation (OGMS) is considered to have ultimately greater potential but is at an earlier state of development.

During the past year, we have demonstrated the HGMS approach at the 1 ton/h scale in continuous equipment that is available commercially for coal throughputs of up to 150 tons/h. The tests were carried out by Sala Magnetics, Inc., a subsidiary of Allis-Chalmers, under subcontract; this work was funded jointly by DOE/FE, the Tennessee Valley Authority (TVA), and Pennsylvania Power and Light. Significant industrial interest has developed with respect to HGMS technology for a variety of applications. During 1979, we developed the capability to model OGMS separation systems mathematically, and we have experimentally verified particular OGMS designs at coal throughputs of up to 0.33 ton/h. Several industrial organizations have reviewed the Laboratory's OGMS work, and General Dynamics, among others, has expressed a desire to work with the Laboratory and intends to market OGMS equipment as a new product line.

A multiyear program on coal preparation plant automation, initiated during FY 1980, will identify and demonstrate cost-effective instrumentation and control equipment through work in existing commercial coal preparation plants. In the work thus far, we have had numerous discussions with coal preparation plant operators and have identified several suitable commercial plants willing to work with the Laboratory in adapting, developing, and testing instrumentation and control systems for automating coal preparation plants. This approach ensures that technology transfer will occur readily and that there will be significant industrial feedback as the work progresses.

Coal Liquefaction (AA 25)

ORNL activities in the coal liquefaction area emphasize direct liquefaction and include studies on coal conversion chemistry and measurement of physical properties of characteristic coal-derived liquids and slurries under process conditions. In addition, the Laboratory provides technical support to the Oak Ridge Operations Office for the major pilot and demonstration plant projects (the H-Coal pilot plant and the SRC-I and -II demonstration plants). This support includes engineering design review, process analysis, materials and components performance review, and environmental and health-related impacts assessment.

The Laboratory's work in support of the pilot and demonstration plant projects presents a unique opportunity for our interaction with the industrial organizations involved, thereby giving us a valuable perspective on research and development (R&D) needs in the direct liquefaction area. The assignment of Laboratory staff to technical staff positions at the

operating pilot plants further augments these industrial interactions. During the past year we have provided significant assistance in solving the catastrophic corrosion problems observed in the fractionation columns at both the Ft. Lewis and Wilsonville pilot plants.

Direct Combustion (AA 35)

Efforts in direct combustion are largely focused on atmospheric fluidized bed combustion (AFBC) of coal for both utility and industrial applications. In the utility area, the Laboratory is providing substantial technical support to TVA on the design and operation of a 20-MW(e) AFBC pilot plant and a 200-MW(e) AFBC demonstration plant. This involvement improves our perspective on R&D needs in the AFBC area in general. Some generic development work is also being conducted that is applicable to both these uses. A cogeneration-based AFBC system is being developed for industrial applications; this activity involves (1) the development of a generic design for a typical system in order to characterize the status of design-base information and (2) the construction and operation of a test unit for the development of additional design-base information. During the past year, subcontracts were negotiated with Westinghouse, Babcock and Wilcox, and Stone & Webster for their assistance in carrying out the generic design and the design and construction of the test unit. We anticipate that the test unit, which is to be located in Oak Ridge, will be completed by September 1982.

An overall systems evaluation for pressurized fluidized bed combustion (PFBC) is also being conducted to identify preferred PFBC system configurations and remaining R&D needs.

Materials (AA 15)

The Laboratory's materials work for Fossil Energy involves providing program management and in-house R&D support to ORO. The major portion of the Advanced Research and Technology Development Materials Program is managed by ORO with support from ORNL, as a lead laboratory assignment; this program and others fund various in-house experimental R&D projects.

We have continued our strong interaction with the direct liquefaction pilot plants by continuing to examine in-plant corrosion specimens and to analyze failed components. We have developed extensive industrial contacts in the materials-related areas and will continue these important interactions.

Environmental Impact Evaluation (AA 45)

Environmental impact statements are being prepared for all the Fossil Energy demonstration plants (i.e., two direct-liquefaction plants, two high-Btu gasification plants). In addition, environmental assessments and support are being provided for various Fossil Energy areas and projects.

Heat Engines and Heat Recovery (AA 55)

Work in this area addresses the recovery and utilization of heat energy at both 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. ORNL has been designated project manager of this effort.

The objective of the high-temperature heat utilization project is to develop technology applicable to the use of ceramic heat exchangers. Other work includes technical and economic studies of cogeneration concepts, systems, and components.

Environmental Control Technology (AA 05)

Work related to flue gas desulfurization is aimed at defining the aqueous process chemistry for magnesium-sulfur-oxygen systems involved in regenerable sulfur dioxide removal systems. Other activities include the development and evaluation of processes for the environmentally safe disposal of coal-derived solid wastes.

Enhanced Oil Recovery (AC 15)

Most of our efforts are directed toward the micellar flood approach to oil recovery. They consist of work to produce chemicals, to determine ion exchange characteristics for typical formations, and to select multiple tracers.

Lead Mission

Fossil Energy Materials Program (current role)

This program oversees the technical aspects of the major portion of the Advanced Research and Technology Development Materials Program, which covers the national program of advanced R&D of construction materials for various fossil energy

applications. Examples of these applications are mining and extraction technology; fossil fuel processing (gasification, liquefaction, and refining); fossil fuel utilization (heat engines, heat recovery, combustion, fuel cells, turbines, coal cleaning and preparation, and environmental control); magnetohydrodynamics; and supportive systems engineering.

ORNL is responsible for assessing the materials needs of fossil energy programs, developing plans in support of the program to meet those needs, and coordinating plans with support organizations. In line with this responsibility, the Laboratory develops program plans to meet DOE program objectives and identifies the facilities, program milestones, decision points, and cost schedules required to meet program needs.

To achieve the objectives of this program, we will subcontract much of the work and will interact with related programs as appropriate. About 20% of the proposed work will be done at ORNL; the remainder will be subcontracted to other organizations, including other national facilities, industrial laboratories, and universities. In addition, we will assume the responsibility for overseeing publications and such activities as workshops, technical meetings, and interaction with professional societies and codes and standards organizations. These activities ensure full use of the data generated. This program is covered by Field Task Proposal/A No. 0028.

Summary of resources—Fossil Energy Materials Program[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	4.8	5.2	7.2	8.9	12.0	12.0	12.0
Capital equipment	0	0.2	0.3	0.4	0.5	0.5	0.5
Subcontracting and procurement	3.7	4.0	6.0	7.5	8.5	8.5	8.5
Direct FTE	11.4	11.8	13.6	22.7	31.8	31.8	31.8

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Assistant Secretary for Defense Programs

^{233}U Program (GE 03)

The ORNL ^{233}U Program encompasses three 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 the Department of Energy through the Oak Ridge Operations Office (ORO)] and to recover ^{233}U from scrap generated by these experimenters. The second is the design and fabrication or procurement of equipment and 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 third task is preparation and submission of a management plan that includes an estimated funding level. If implemented, the plan would result, over the next five years, in the recovery of 306 kg of ^{233}U from the 15,000 unirradiated fuel rods remaining from the Light-Water Breeder Reactor (LWBR) Demonstration Program.

The effort for repository operation is expected to remain steady during the next five years. The demand for ^{233}U should not increase or decrease substantially but should remain at several kilograms per year. The bulk of the funding for this task is expended for equipment replacement and maintenance, safeguards, and accountability because the facility uses components that were installed as part of the THOREX Pilot Plant in 1954.

The objective of CEUSP is to design and install, in an existing process cell, equipment that will enable conversion of the uranium to a solid to begin in FY 1983. The program schedule proposes a peak in the engineering effort in FY 1980, a sizable fabrication effort in FY 1981, installation of equipment in FY 1982, and completion of facility operation in FY 1985. Currently, we are progressing as planned and expect to meet the above schedule while staying within the allotted funding.

The management plan for recovery of ^{233}U from excess LWBR fuel rods will be issued in early FY 1981. Recovery of this material is important because recent demands for high-isotopic-purity (>97%) ^{233}U, which contains <10 ppm ^{232}U, have dwindled the inventory of this material, and it would take several years to produce and process additional ^{233}U. The 306 kg of unirradiated ^{233}U, currently stored at Bettis Atomic Power Laboratory, has a "book value" of about $25 million. We propose to process this material in FY 1984, FY 1985, and FY 1986. The program will involve the design and fabrication of shielded equipment for handling and dismantling the fuel rods since the fuel, although unirradiated, emits significant gamma radiation because of the

high-energy daughters of ^{232}U, which have formed since purification of the ^{233}U.

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 research and development is being carried out to improve the mass spectrometric isotopic analyses of elements of interest to safeguards (i.e., uranium, plutonium, and thorium). Further applications of the resin-bead sample-loading technique are being explored, and methods for enhancing isotope ratio measurements with respect to reliability, precision, and sample size are being investigated.

Procurement of a quadrupole mass spectrometer for use as an on-site analytical device is under way. Transfer of the resin-bead technology to other installations will be effected at the request of the Office of Security and Safeguards. Furthermore, we will continue to evaluate the resin bead as an archival storage device and to explore the application of resin-bead technology to alternate fuel cycles.

Assistant Secretary for Resource Applications

Overview

ORNL is assisting the Assistant Secretary for Resource Applications in a growing number of activities. Principal areas of involvement are electric energy systems and geothermal energy, but others include the Uranium Resource Assessment Program, small hydroelectric development, and evaluation of energy resource potential of proposed wilderness areas. Anticipated new initiatives include computer simulation of the U.S. fuels transportation network and data and methods for making decisions about coal land leasing and production.

Geothermal Energy (AE)

Our role in geothermal energy is concentrated on the development of high-efficiency heat exchangers, the problem of heat rejection from power plants, and the preparation of environmental statements and analyses. We anticipate some increase in our reject heat activities.

Engineering R&D (AE 01). Currently, we are studying heat transfer and power conversion systems, placing emphasis on experimental and analytical work on heat rejection systems as it 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 for cooling.

Environmental Control and Institutional Studies (AE 06). Over the past three years, the Laboratory has prepared some 25 environmental assessments and statements for specific geothermal programs and facilities, many of which result from the federal Geothermal Loan Guarantee Program. Current responsibilities include preparation of assessments for two demonstration power plants and one commercial plant that are under the federal program. Also, assessment work on the geopressured resource and on several direct use projects is continuing.

Electric Energy Systems (AK)

The work in this activity consists of support to the Oak Ridge Operations Office (ORO) in the lead mission role for DOE in two programs: Load Management and New Technology Integration, and High-Voltage Technology. These programs are part of an effort to accelerate the introduction into the electric utility industry of new source and delivery technologies that can improve efficiency and reliability and that can conserve scarce fuels. The Load Management and New Technology Integration Program seeks to demonstrate the usefulness of technologies such as energy storage by consumers, distribution automation, and dispersed generation. The High-Voltage Technology Program involves research and development (R&D) that will lead to increasing the ability to wheel power from region to region; this program focuses on dc transmission, land use reduction, and high-voltage equipment featuring improved gaseous and liquid dielectrics.

Uranium Enrichment (CD)

Uranium Resource Assessment. A process to recover uranium from phosphoric acid was developed by ORNL and transferred to industry. ORNL continues to maintain the Grand Junction Office Information System (GJOIS), which captures and stores technical data from the Uranium Resource

Assessment program to assure the availability of a permanent data base for subsequent study. Raw data are retrieved to feed back into the interpretive segments of the program to increase reliability of resource estimates and to assist in development of more qualitative and quantitative evaluation methods.

Small Hydroelectric Development (CE 01)

DOE is encouraging small hydroelectric technology development by funding feasibility studies in both the public and private sectors, for the redevelopment of existing dams with a potential capacity of 30 MW or less.

ORNL is currently providing DOE with in-depth analysis of several environmental issues that have been identified as possible generic constraints to the redevelopment effort; these are fish passage, turbine mortality, water-level fluctuation, and dredging. During FY 1981, we will examine extant water quality data and evaluate the extent to which small dam systems modify water quality; we will also conduct specific research at DOE and other demonstration sites that will address environmental issues of generic interest to the program.

Multi-Resources (CG)

Wilderness Area Withdrawal. The Laboratory is continuing to develop and apply methods for assessing potential conflicts between wilderness preservation and energy resource development. Emphasis will focus on energy resources, with other strategic material resource studies planned for future analysis.

Transportation. In addition, we anticipate that work to develop a computer-based simulation of the U.S. fuels transportation network will be initiated. The objective of this activity is to provide a methodology for assessing the capability of the transportation system to transport fuels under normal conditions as well as during energy emergencies.

Multi-Resource Development of Chattanooga Shale. ORNL is initiating an internally funded exploratory assessment of Chattanooga shale. These shales constitute a very large, but low-grade, potential source of oil, uranium, and strategic metals (including cobalt, nickel, molybdenum, and chromium). With new processes under development, the oil yield from Chattanooga shale should be about ½ barrel per ton of shale. The co-production of metals with oil could yield a significant fraction of the U.S. needs for iron and alumina as well as strategic metals. The investigation includes an overall assessment of the technical, economic, and environmental feasibility and key experiments in the process and environmental area. ORNL will seek funding from DOE if the results of the assessment are positive and if R&D tasks suited to our facilities and talents can be identified.

Lead Mission

Power Systems Technology (current role)

This mission, conducted in support of ORO, consists of two parts: the Load Management and New Technology Integration Program and the High-Voltage Technology Program, which was assigned to ORNL in February 1980. The two programs provide support to the DOE goal of implementing new source and delivery technologies in the electric utility industry.

The Load Management and New Technology Integration Program seeks to establish the feasibility of load management as an energy conservation measure and to determine its costs and benefits to utilities and their customers. Load management, especially that in which the loads are utility controlled and energy storage is available at the point of use, is beneficial in the conservation of oil and natural gas. By shifting the demand for power from peak to off-peak loads, load management limits the use of inefficient oil and gas turbines and reduces the need for additional generating capacity.

The program is also concerned with the development of distribution automation and load control technologies, including those for control of dispersed generation and storage. In addition, current work includes development of the methodology needed to assess the costs and benefits of peak shifting, dispersed generation, and energy storage.

ORNL performs in-house R&D, conducts program planning, selects subcontractors, and supervises subcontractors and demonstrations. Currently, we have 14 subcontracts, most with electric utility companies, for demonstrations to develop data for assessing the impact of load management on utility systems.

The High-Voltage Technology Program consists of R&D that will lead to increased use of existing transmission line corridors while satisfying environmental requirements. A portion of this R&D seeks to increase power transfer and to reduce land use

and environmental and safety hazards. The thrust of ORNL's work, however, is the development of substation equipment for use with 1200-kV circuits and of components and technology for use with high-voltage dc systems.

The development of liquid and gaseous materials for use as high-voltage insulators will be included in the in-house portion of the program, as will identification of potential environmental effects from use of these materials. ORNL is also assuming responsibility for planning and for technical management of existing DOE contracts. As new work packages are developed, it is anticipated that they will be subcontracted by Union Carbide Corporation—Nuclear Division.

As current demonstration programs are completed, the level of effort in the Load Management and New Technology Integration Program is expected to decrease, while the level of effort in the High-Voltage Technology Program is expected to increase. Thus, the overall effort of the Power Systems Technology mission will remain relatively constant.

Summary of resources—Power Systems Technology[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	9.8	9.8	11.1	11.6	11.6	11.6	11.6
Capital equipment	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Subcontracting and procurement	7.8	7.2	8.1	8.6	8.6	8.6	8.6
Direct FTE	22.6	28.4	29.6	30.0	30.0	30.0	30.0

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Other DOE Program Offices

Administrator, Energy Information Administration

Overview

To help meet the needs of energy policymakers for reliable and credible information, ORNL provides research and management support to the Energy Information Administration (EIA). The Laboratory's program includes the assembly, analysis, and evaluation of data on energy demand, resources, production, and technologies. Research and technical support, which are provided to each assistant administrator within EIA, are aimed at satisfying national needs for energy data and capabilities for energy analysis and forecasting. Major areas of emphasis include data and model validation, energy modeling, energy consumption data and analysis, and fossil energy technology data and analysis.

Lead Mission

Fossil Energy Technology and Consumption Data Systems and Model Validation (current role). The objective of this program, supported by EIA, is to determine the quality of DOE's statistical and analytical information. This work involves measuring and documenting the validity and accuracy of data, models, and analyses that are collected, used, and disseminated by EIA. As part of this program ORNL is responsible for modeling energy flows and validating the resulting outputs. The work involves determining what information is actually needed to describe adequately the important aspects of particular energy areas. The resulting models enable DOE to focus precisely on the information required to meet its needs.

ORNL's lead mission responsibilities include the management of subcontracts, which are issued for work that is not appropriate for a research laboratory or for research tasks that exceed the Laboratory's personnel resources. As lead laboratory, ORNL draws upon its interdisciplinary capabilities to perform technology data base development and assessment, research, and demonstration that support methodology development and application in order to provide quantitative uncertainty estimates for data and models.

Summary of resources—Fossil Energy Technology and Consumption Data Systems and Model Validation[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	5.3	6.5	6.5	6.5	6.5	6.5	6.5
Capital equipment	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Subcontracting and procurement	3.9	3.0	2.9	2.5	2.5	2.5	2.5
Direct FTE	10	14	19	21	23	23	23

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Administrator, Economic Regulatory Administration

For the Economic Regulatory Administration (ERA), ORNL provides technical assistance in analyzing and forecasting energy system performance, prepares environmental impact assessments of proposed regulations, and conducts related research. In our systems performance analyses, we are conducting reliability assessments. We are also determining the potential for cogeneration, intermittent generation, load management, and fully coordinated centralized planning and operations of groups of electric utilities. Our studies are determining the reliability level appropriate to meet the needs of consumers and the procedures required to minimize the consequences of power system failures. The results of these studies, along with others contracted directly by ERA, will be integrated into a report to Congress on power system reliability.

The impact assessments being prepared for ERA cover the environmental effects of the Fuel Use Act and the economic, environmental, and administrative impacts of emergency energy conservation policy options. In addition, we are examining time-of-day electricity pricing to determine whether such pricing affects household decisions to purchase new electricity-conserving durable goods.

Assistant Secretary for Policy and Evaluation

Our work for the Assistant Secretary for Policy and Evaluation is in the area of policy analysis and systems studies. Activities include assessments of (1) the effects of conservation policy alternatives on energy consumption, (2) the regional impacts of national energy policies, (3) the environmental and social impacts of possible national energy policy initiatives, (4) decision options related to the rising concentration of CO_2 in the atmosphere, and (5) the costs and benefits of different approaches to commercializing synfuel technologies. As appropriate, the Laboratory also provides other technical information and evaluations to support policy formulation.

Isotope Production and Distribution

The Laboratory administers DOE programs for the production and distribution of enriched stable isotopes, radioisotopes, and heavy elements. These programs must be responsive to DOE needs as well as to market requirements. Consequently, long-term projections of the demand for, or sales of, their products are difficult to make with any degree of certainty. Thus, we rely heavily on past trends to predict the programs' future activity levels.

These programs offer the above-mentioned materials for sale or loan and provide some associated services. They supply over 300 products and services—none of which are commercially available from the U.S. private sector—to about 1200 domestic and foreign customers in the fields of education, medicine, research, and commerce. At ORNL, distribution of these products and services is made by the Isotope Sales Group in the Operations Division. The Chemical Technology, Solid State, and Health and Safety Research divisions are also routinely involved, and circumstances may require the participation of other divisions.

Responsibility for this area of work is shared by several organizations. The DOE Office of Basic Energy Sciences (OBES), under the Director of Energy Research (DER), is responsible for work relating to enriched stable isotopes and most heavy elements; the Office of Management Support, under the Assistant Secretary for the Environment, is responsible for the part of the program concerned with radioisotopes and their by-products. The Office of Nuclear Materials Production (under the Assistant Secretary for Defense Programs) is responsible for the production and distribution activities for certain heavy elements.

Stable Isotopes

The Laboratory's stable isotopes separation activity, performed as part of the ORNL Stable Isotope Production and Distribution Program, uses several of the calutrons, or electromagnetic separators, that were originally constructed for wartime production of weapons-grade uranium; they are now used for the enrichment of isotopes of most of the elements in the periodic table. These isotopically enriched materials are used in the research, commercial, and nuclear medical communities. For example, they are used to determine basic nuclear properties as well as neutronic data for the design and operation of fission and fusion reactors. In addition, they serve as mass spikes for analytical determinations and as target materials for the production of commercial radiation sources and radiopharmaceuticals used in nuclear medicine.

About 24 staff members are involved in this production activity. A portion of the program's operating costs is recovered through sales to foreign and domestic customers, the U.S.S.R. being the only other major supplier of isotopically enriched materials. The remainder is recovered from OBES. The potential for substantial cost recovery is great, but the current pricing and cost-recovery policies do not allow us to make the operation financially self-supporting through sales. During ORNL's Institutional Planning Review, DOE suggested that legislative changes may be necessary to revise the accounting system and policy to allow for replacement costing, carry-over, and accumulation of funding for maintenance and development. In response to an agreement to study the alternatives and to initiate appropriate actions, DOE organized a task group to study these questions. They have made recommendations to DER that would, if approved, be responsive to many of ORNL's problems in this area.

The program also receives support from OBES for its efforts related to the Research Materials Collections (RMC), which provides isotopes for loan to those researchers (primarily in the United States) who demonstrate a need for such material and will use it only in nondestructive experiments. These activities involve maintaining the RMC, providing materials for it, and upgrading its inventory.

Radioisotopes

The ORNL Radioisotope Production and Distribution Program provides a total of 44 radioisotope products and 22 heavy element products, as well as technical services such as cyclotron irradiations and radiation source fabrication. These products and services, which are used in medical, industrial, and research applications, are not commercially available from U.S. private industry. Through the ORNL program, they are offered for sale and are purchased by about 500 domestic and foreign organizations.

The products provided by the program are produced at ORNL and at ten other DOE sites and, like the stable isotopes, are distributed by the Isotope Sales Group. The major products are tritium [produced at Savannah River Laboratory (SRL)]; ^{192}Ir (produced at ORNL); ^{241}Am (produced at the Rocky Flats plant, SRL, and Los Alamos National Scientific Laboratory); ^{85}Kr (produced at ORNL using feed from the Idaho Chemical Processing Plant); and ^{127}Xe (produced at Brookhaven National Laboratory).

The prices for radioisotope products and services are set to recover production costs; an added factor of about 30% covers depreciation and DOE and sales-group costs. From FY 1982 through FY 1986, costs and personnel levels should be relatively stable.

We foresee major problems related to funding of capital equipment items, which by current regulations cannot be charged to production operating expense. Another concern is the effect of the DOE-imposed personnel planning levels on organizing for any increased production responsibilities specified by DOE. These responsibilities have increased in recent years and may continue to do so. Since November 1977, for example, we have assumed the interim production of several radioisotopes formerly produced by the General Electric Test Reactor (GETR) before its shutdown at the direction of the Nuclear Regulatory Commission. These radioisotopes—^{192}Ir, ^{63}Ni, ^{75}Se, ^{119m}Sn, and others—are vital to the industrial and medical communities. If the GETR remains inoperative, we will be required to continue production of these radioisotopes and to assume the production of others that would otherwise be unavailable from domestic sources.

Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) sponsors about 8% of the total work at ORNL. This level of effort has been holding steady for the past few years, although the specific breakdown of the work has been changing. The major thrust of our NRC work is concentrated on medium-scale experimental facilities for confirmatory reactor safety research in areas in which ORNL has proven technical capabilities. These areas include thermal hydraulics, heat transfer, solid mechanics, fuel and cladding behavior, instrumentation, and fission product technology. The experimental efforts for several of the older programs, which are concerned with the design basis loss-of-coolant accident, will be completed within this planning period, and new work in other areas will begin.

The NRC also sponsors research at ORNL in aquatic and terrestrial ecology and in the health sciences. Technical support to licensing is provided in areas of ORNL expertise such as instrumentation, standards and codes, environmental impact statements, materials research, social science, and information management.

The budgets and staff level for NRC work will drop by about 10% in FY 1981 and by 20% in FY

1982. This sharp decrease is almost entirely due to completion of the Blowdown Heat Transfer Program and of our programs for the International 3D (Three-dimensional) Refill and Reflood Test Program. The effort in FY 1980 for these programs exceeds $10 million, but by FY 1982 the level will be less than $2 million. Although the number of research programs has grown, the trend has been toward smaller programs, and thus the collective growth of our NRC work has been surpassed by the decline of these major programs.

Despite the decrease in the overall effort for NRC, there will be many new and challenging programs. These new efforts will follow closely NRC's post–Three Mile Island (TMI) action plan and will include work in primary-system integrity, analysis of severe accident sequences, operational experience, man-machine interactions, containment performance, fission product release and transport, core melt, and advanced instrumentation and diagnostics. This new work will be accomplished by reallocation of staff. New efforts will also be started in high-level waste disposal research and in fuel cycle environmental and safety problems.

The ORNL programs funded by NRC have historically been very satisfying because they have contributed to the amelioration of the near-term energy problems and because they have been characterized by medium-scale experimental programs that produce good data. We are now developing programs in most of the important post-TMI areas.

A problem that seems to be growing is the pressure from several sources to reduce NRC work at DOE national laboratories. We feel that the work at ORNL and other laboratories fills an urgent need for the combination of technical capability and objectivity that is required by NRC.

U.S. Department of Defense

As part of its assistance to the U.S. Department of Defense (DOD), ORNL devotes about eight technical staff to work on two tasks for the U.S. Navy. The objective of the first task is to develop radiation detection indication and computation instruments, associated tools, and documentation for Navy use. Following identification of specific radiation measurement needs, instruments are developed, designed, and fabricated for testing. Subsequently, documentation is generated to allow the Navy to purchase duplicate instruments. Another facet of this first task is the development of maintenance and calibration methods and of tools to reduce costs. The second task provides manufacturing technology research to bring graphnol into production in support of the Great Lakes Research Corporation.

The Laboratory also performs work for the U.S. Army that 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 are developing laboratory-scale generators to produce materials for biological study, so that the properties of the aerosols thus produced can be compared with those 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 aerosol. In related work, we are purifying munitions compounds and marker dyes for biological testing and are identifying their impurities using spectroscopic and chromatographic methods.

Non-DOE Sponsors (Excluding NRC and DOD)

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 the Environment (ASEV) 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 ASEV. 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 more of the non-DOE supported work is becoming 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 solid waste disposal. Other efforts include radiation dosimetry, epidemiology, and information systems support to EPA. In partnership with DOE, EPA is supporting modeling work on the effect of a proposed district heating system on ambient air concentrations of pollutants in Minneapolis–St. Paul. Also, regional economic forecasting models are being evaluated, pointing toward the development of a model specifically designed to meet EPA needs.

Administrative management, coordination, and information support are provided to the EPA Gene-Tox 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 chemical-scoring method to be used in screening the EPA chemical inventory, production of a series of eight reports entitled *Reviews on Environmental Effects of Pollutants,* and development of the first comprehensive data system on chemical pollutants identified in human tissues.

Several key accomplishments in EPA-funded work are anticipated during this planning period. These include application of existing multimedia transport models for Toxic Substances Control Act (TSCA) assessments—1981, development and validation of a multiplex system for determination of chemical-induced toxicity—1981, and development and implementation of methods for use in assessing compliance with the Clean Air Act—1982. In 1982 and 1983, we expect to develop new ecological test procedures for TSCA and new multimedia transport models for assessments.

National Institutes of Health

The major efforts supported by the National Institutes of Health are in the research areas of carcinogenesis and toxicology. The subjects of studies supported by the National Institute of Environmental Health Sciences (NIEHS) include toxicity of particulates and inorganic materials and the multistep nature of neoplastic transformation. We look forward to expanded research activities with NIEHS in the mammalian genetics areas. 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 the 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, promotion, and DNA repair. Potential carcinogens being studied are chemicals, ultraviolet light, and tobacco smoke.

National Science Foundation

The major goals of our work for the National Science Foundation are as follows: (1) to perform ecosystem analysis studies including the further development of systems theory in ecology and stream nutrient kinetics 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 develop a small-angle neutron-scattering facility. Key goals include development of an international center of excellence in ecosystem modeling—1981, 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 Oceanographic and Atmospheric Administration, the Food and Drug Administration, the U.S. Department of Agriculture, the U.S. Department of the Interior, 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. Investigation of entrainment stresses using a power plant simulator is a continuing EPRI-supported project.

We shall continue to emphasize joint cooperative programs with the Tennessee Valley Authority in various environmental areas, including fish population modeling, coal gasification, and instrument development.

Other Work

When work demands the special capabilities of the Laboratory, we also undertake research for non-DOE sponsors in the areas of impact, technology,

regional, and policy assessments; conservation and community-scale integrated energy use; resource analysis; and emergency planning. We are currently doing work for several agencies including the U.S. Department of Commerce, the U.S. Department of the Interior, the U.S. Department of Housing and Urban Development (HUD), the U.S. Department of Agriculture, the Federal Emergency Management Agency, and the Water Resources Council. Two examples of ORNL work for other federal agencies follow.

U.S. Department of the Interior

In FY 1979 ORNL began assisting the Office of Surface Mining (OSM) of the U.S. Department of the Interior with the design and implementation of a national inventory of abandoned surface mines. This effort has continued into FY 1980 and is scheduled to continue into FY 1982. This activity will require less Laboratory involvement in the coming years; the heaviest commitment will occur during FY 1980 and FY 1981.

Phase I of the OSM abandoned mine lands (AML) program, which mainly consisted of a compilation and organization of existing data on AML problems, was completed in November 1979. Phase II began in October 1979 and will continue through January of 1982. ORNL is participating with OSM in the design of the AML inventory and is advising OSM headquarters, OSM regional offices, and the states concerning implementation of the federal legislation. Over 40 people are currently involved in the project, including ORNL staff, TVA personnel, and a number of subcontractors; ORNL staff together with UCC-ND Computer Sciences Division staff account for about 13 people. ORNL's involvement is principally associated with the design and implementation of the national inventory and the design of the computer production processing and production systems. Eventually an outside contractor or OSM will take over the production processing activities. The program is scheduled to be shifted over to OSM in the last part of FY 1981. ORNL will remain in the program, but only in terms of the research design elements.

The OSM project is worthy of the Laboratory's attention because it is addressing a national public safety and welfare problem and represents a program that only a national laboratory could have implemented. Such an inventory has never been attempted before.

U.S. Department of Housing and Urban Development

Under the Urban Energy Technical Support Program, ORNL will provide technical assistance to HUD in the area of urban energy problems. In its attempts to deal with the problem of energy costs to city dwellers, HUD is encouraging communities to develop long-term integrated community energy plans based on conservation of domestic resources and maintenance of an acceptable environmental quality of urban areas. ORNL will assist HUD in these efforts by providing the technical expertise for analyzing the feasibility of new district heating systems and the feasibility of waste-to-energy recovery systems. Together DOE and HUD are planning to initiate a national program on district heating, and this work is a forerunner to that activity.

Nonfederal Organizations

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

NEW INITIATIVES

NEW INITIATIVES

In this chapter, we identify important new areas of work that are not discussed in the previous section. The following program descriptions, which are grouped according to sponsoring Department of Energy (DOE) office, summarize program goals and resource requirements. In general, these new initiatives would necessitate an increase in current personnel planning levels.

The Director of Energy Research

Expanded High Temperature Materials Program

A critical need exists for high-temperature materials research that would improve the efficiency, reliability, and, in some cases, make feasible our advanced concepts for energy production or coal conversion. The new High Temperature Materials Laboratory (HTML), which ORNL is proposing for funding by the Office of Basic Energy Sciences (OBES) in FY 1982 at a total cost of $17 million, will provide the United States with a much needed laboratory designed for basic and applied research on materials at elevated temperatures. The HTML will house two-thirds of the program's professional staff, with the balance in an adjacent building. The staff will be organized according to six research areas: mechanical behavior, environmental interactions, physical properties, high-temperature chemistry, structural characterization, and materials sythesis. We anticipate a 60%/40% split of the operating funds and work between OBES and various DOE energy technology offices respectively.

With this level of staffing, the HTML will be able to provide a comprehensive description of the properties of a desired material and a better understanding of material processes at high temperatures. The HTML staff would be able to make a coordinated response to those problems requiring immediate attention. The ongoing nature of the HTML and the size of its staff would foster long-term, exploratory research programs, and the existence of other large ORNL programs with high-temperature aspects would ensure close interactions between applied and basic science researchers.

Because $3.0 million of the total cost of the HTML would be used to acquire the expensive and unique equipment needed for high-temperature research, an HTML would provide equipment as well as expertise in the specialized areas of high-temperature materials synthesis, preparation, and characterization—activities essential to successful high-temperature materials research.

Several steps have already been or would be taken to ensure the involvement of the university and industrial research communities in the planning and operation of the HTML. An HTML advisory committee, consisting of five university and two industrial representatives, has met several times and has provided many useful planning suggestions. The specialized equipment and the resident staff at the HTML would make it an attractive users' facility, and the advisory committee strongly endorses ORNL's plans to establish a users' facility program that would be similar to those already established at ORNL [e.g., the Holifield Heavy Ion Research Facility, the University Isotope Separator at Oak

Ridge, the High Flux Isotope Reactor, the Transuranium Research Laboratory, and the Small-Angle Neutron Scattering Facility]. Staff members from the University of Virginia and Vanderbilt University are currently involved in research programs using the 1-MeV electron microscope that would be part of the HTML.

Because solutions to high-temperature materials problems are so urgently needed, ORNL, with the concurrence of the HTML advisory committee, is initiating this fiscal year a coordinated program of high-temperature materials research. A budget of $5.1 million, developed through the in-house redirection of funds supporting existing high-temperature materials programs in the Solid State, Metals and Ceramics, Chemistry, and Chemical Technology divisions, would provide the financial base for our initial program. About 50 professional staff members are involved, and their research is grouped under the six general areas proposed for the HTML. Securing the funding for an HTML is vital if this program and the technological alternatives it can provide are to be fully realized.

Summary of resources—Expanded High Temperature Materials Program[a]

	'80[b]	'81	'82	'83	'84	'85	'86
Operating cost	5.1	7.0	8.4	8.8	9.1	9.3	9.3
Direct FTE	50	57	62	65	68	70	70
Line items							
Special equipment			0.5	0.5	0.5	0.5	0.5
Construction			17.0				

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b]Operating cost and personnel for FY 1980 are funded in current OBES and applied technology programs with an 80 to 20% distribution respectively. By FY 1986, it is expected that 60% of the HTML will be supported by OBES and 40% by applied technology.

Applied Science/Technology Base

We have received guidance that in the period FY 1982 through FY 1986 the Director of Energy Research (DER) would like to develop a program in Applied Science/Technology Base (AS/TB). This guidance is a response to the intensive examination of the research and development (R&D) base by DOE and the national laboratories over the past two years. This examination revealed some serious shortcomings in the applied sciences—in particular, the lack of sufficient effort on applied science research that would provide the kind of information necessary for devising a healthy, competitive set of technology options. Applied research in support of each technology is needed to solve the problems that prevent a technology's further advancement. In addition, effort should be devoted to several areas of generic research that cut across many technologies and provide an important basis for developing and demonstrating several DOE programs; these areas include materials, instrumentation development, cryogenic technology, and certain aspects of environmental protection. We recognize the importance of this endeavor and believe we can make significant contributions to applied science research in conservation, fossil, fission, and fusion. We have chosen these technologies because of our heavy involvement in R&D for all of them and consider it logical to locate an AS/TB program in the same institution as the technology. We expect our technical efforts in AS/TB to involve research in multiphase flow, instrument development, separation science, corrosion, waste fixation, systems modeling, and, especially, development of materials processes for service in hostile environments.

Summary of resources—Applied Science/Technology Base

	'82	'83	'84	'85	'86
Operating costs[a]	2.0	6.4	10.4	14.0	20.0
Subcontracting	0.6	1.7	2.9	4.0	8.0
Direct FTE	10	32	50	66	82

[a]Funding is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Resource Recovery from Unconventional Sources

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. Because these sources are generally rather dilute and of low grade, however, using them would require new extraction and concentration processes and materials-handling techniques that would treat large volumes of materials without excessive energy or reagent consumption. 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.

Initially our emphasis would be on recovering useful metals from 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 various trace metals, and to remove potential leachable pollutants so that the resulting solid waste could be disposed of economically. Other areas to be studied would include extraction processes for certain low-grade ores, the recovery of fuel values, multiple products recovery, and energy conservation.

Specific sections of the eastern shales (e.g., Chattanooga shale) are potential sources of multiple products recovery. Recovery of synthetic crude oil, uranium, and other metals from this source appears feasible.

Dilute aqueous sources would also be investigated, especially processing effluents, some mineral-rich fresh water and brines (e.g., geothermal brines), and, ultimately, sea water. Again, multiple product recovery would be emphasized, with the recovery of fuel materials such as uranium having priority.

In addition to developing new extraction and concentration processes, other efforts would be needed to characterize more completely these potential sources and to study new size reduction and separation techniques aimed at drastically improving energy and reagent requirements. Highly selective sorbents would be needed to process dilute aqueous streams, and new and improved processes must be developed for recovery of several mineral values from ores or waste streams that are too dilute to justify their processing to recover a single component. The most immediately promising of these advanced concepts would probably couple resource recovery with waste treatment or pollution control (e.g., recovery of aluminum and trace metals from coal fly ash).

Summary of resources—Resource Recovery from Unconventional Sources[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.6	0.8	1.0	1.2	1.2	1.5	1.5
Direct FTE	6	8	10	12	12	15	15

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Social Science Research

The Laboratory proposes a basic social science research program, linked to our traditional strengths in science and technology, that would fill gaps in the nation's energy R&D effort by contributing new ideas and methodologies.

Since the oil embargo of 1973, the country has made too little progress toward solving its national energy problem, but not because we lack the energy resources or technologies to do so. What we lack is sufficient understanding of the economic, social, and institutional environment in which decisions about resources and technologies are made. We need new ideas to expand our range of options for resolving issues in this environment: new social-scientific theories, methodologies, and evidence.

From its beginning, a social science research program should have a central theme to aid in the ready evaluation of the relevance of proposed research efforts to national needs. Accordingly, the Laboratory proposes to initiate both a basic research program to improve our understanding of the process of technological change and an applied research program to expand the repertoire of methodologies for conducting research on technological change. We suggest the theme of technological change for three principal reasons: it is at the heart of the energy transition the country now faces (technology transfer and market penetration of new energy supply and use technologies); it concerns tangible objects and can utilize quantitative data and thus is an appropriate field for research; and it links the social science research program with other DOE basic and applied research programs, which are generally technology oriented.

As a multidisciplinary research institution with a diverse group of professional social scientists and an unusual wealth of experience in the area of technological change in energy supply and use, ORNL is a recognized leader in identifying research needs in this area. In consultation with DOE and appropriate research communities, we would (1) identify priority areas for basic social sciences research and for applied social science methodology development; (2) undertake research programs in these areas that would involve university scholars as well as Laboratory staff; (3) provide support services to participating scientists, including data base support and access to experts on particular technologies; and (4) periodically review and reevaluate program priorities and assist DOE in utilizing research reports. Priorities that could be set include understanding the relationship of technology to energy use decisions, develop-

ing new approaches to analyzing the commercialization potential of new technologies, and understanding the process of technological change in the transportation sector.

Summary of resources—Social Science Research[a]

	'81	'82	'83	'84	'85	'86
Basic social science research						
Operating cost	0.2	0.8	1.3	1.5	1.6	1.7
Subcontracting[b]		0.4	0.8	0.9	1.0	1.1
Direct FTE	1	3	5	6	6	6
Applied social science methodology development						
Operating cost	0.2	0.6	1.0	1.1	1.2	1.3
Subcontracting[b]		0.3	0.6	0.7	0.8	0.9
Direct FTE	2	3	4	4	4	4

[a]Funding for FY 1981 and FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b]Subcontracting refers to the funding of research by individual scholars on the basis of responses to requests for proposals.

The Assistant Secretary for Nuclear Energy

Light-Water Reactor Safety and Technology

The light-water reactor (LWR) industry is facing significant technical problems. Because many of these problems are in areas of ORNL expertise—demonstrated by our broad historical involvement in reactor system development and by our more recent efforts in advanced reactor concepts, such as the fast breeder—we have introduced a number of new initiatives for LWR technology. Many of these initiatives address problems that affect plant availability and productivity (e.g., failures in steam generator tubing, cracks in primary-system pipes, and fuel pellet cladding interactions). Others focus on potential technological developments intended to effect long-range reductions of radiation doses to plant employees. Yet others address possible ways to upgrade accident prevention (or safety) technology [e.g., by revising technology control system equipment, by improving control room procedures, and by developing acoustic leak detection to aid in determining the location and severity (leak rate) of cracked boiling-water reactor primary system piping].

We have also recently submitted several initiatives to DOE's Three Mile Island Examination Program in the areas of waste management, fission product distribution, in-core instrumentation, core damage assessment, and fuel examination.

In formulating the initiatives described above, we have taken maximum advantage of existing R&D facilities. None of these initiatives would require a major new facility commitment for its implementation.

Major Decision Points

Assuming that the Laboratory will receive authorization to proceed on October 1, 1980, the following are key near-term decisions warranting high-level DOE input, review, and approval.

Decision point	Date
Establish deployment philosophy for transportable radioactive waste treatment equipment	March 1981
Select LWR plant for demonstration of the Data Verification System (to be developed under the Man-Machine Interaction Program)	May 1981
Establish deployment philosophy for mobile manipulator or other remotely operated systems to be developed to enhance LWR accident-recovery operations	September 1981

Major Milestones

The following key milestones would be targeted, if authorization to proceed on October 1, 1980 is assumed.

Milestone	Date
Complete installation of the prototype Data Verification System in a commercial LWR	November 1982
Complete conceptual design reports for generic improvements to commercial LWR onsite radioactive waste treatment equipment	June 1983
Complete conceptual design report of transportable radioactive waste treatment equipment	July 1983
Complete the prototype LWR remotely operated accident-recovery system	January 1986

Summary of resources—Light-Water Reactor Safety and Technology[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	5.1	12.8	13.6	12.3	12.5	11.3	7.4
Capital equipment	0.4	1.3	1.5	2.1	2.4	3.5	3.5
Subcontracting and procurement	0.5	3.1	2.9	4.0	3.8	3.8	2.9
Direct FTE	39	80	94	81	81	72	43

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

The Assistant Secretary for the Environment and Others

Biotechnology Development

Biological processes offer great promise for both near- and long-term production of fuels, as well as for the abatement of pollution and the recovery of valuable resources. Biological systems can also be valuable tools in the production of materials for the biomedical sciences. Innovative approaches are needed for monitoring and measuring bioprocess intermediates and products and other fluid constituents that are important in the biomedical and environmental areas.

ORNL possesses the expertise in process and engineering R&D and in the biological and environmental sciences to contribute significantly toward (1) the development of efficient bioprocesses for fuel production from biomass; (2) the development of efficient waste treatment techniques, especially for those wastes associated with energy production; (3) the recovery of such valuable resources as energy fuels and other metals; and (4) the development of advanced concepts for measuring biologically important constituents in complex mixtures.

Four major areas of concentration are envisioned under this initiative. The first of these, bioengineering research, would involve investigation of advanced bioreactor concepts, high-resolution separation techniques for biological materials, and immobilization of active biological agents.

The second area of concentration, applied biological and chemical research, would involve reaction kinetics and other areas lending support to the development of specific processes.

The third major area of concentration, advanced instrumentation, would focus on the development of instrumentation either to measure and monitor important parameters in bioprocesses or to measure environmental and human exposure to energy pollutants.

Bioprocess development will be the fourth major area of concentration. In this area, the potential usefulness of various bioprocesses in environmental control technology, biomass use, and resource recovery would be investigated. This effort would involve determining the most efficient biological agents and the optimal conditions for a given biological process. Fuels, such as methane or alcohols, and other chemicals that can be derived from waste materials or biomass would be emphasized, and environmental control technology useful in energy production would have priority.

Because ORNL is now a recognized leader in the area of biotechnology development, we will investigate the possibility of forming a center for bioengineering that would serve as the focal point for this evolving area of R&D. The National Science Foundation has indicated an interest in participating in such an endeavor.

Summary of resources—Biotechnology Development[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	3.2	4.2	4.8	5.5	6.3	7.3	8.4
Direct FTE	30	36	40	46	52	60	69

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Biogeochemical Cycles and Carbon Dioxide

The biogeochemical cycling of both natural and man-produced substances is the dynamic framework on which life exists. Understanding the biogeochemical cycles of carbon, oxygen, nitrogen, phosphorus, sulphur, and calcium is essential to our understanding the biosphere as a whole. Man's activities in energy and technology development represent significant perturbations of global biogeochemical cycles having potentially important consequences for human and environmental health and for global climate. The Laboratory's long-standing major research programs in biogeochemical cycling have now been expanded to include the development of

sophisticated mathematical models that simulate global cycles. ORNL research has resulted in key contributions to the general understanding of sulfur and trace element cycles as they are influenced by acidic deposition [DOE, Assistant Secretary for the Environment (DOE/ASEV) and the National Science Foundation (NSF)]. This line of research is continuing with additional emphasis being given to vegetation canopy processes that influence the deposition of materials [DOE and the Electric Power Research Institute (EPRI)], the effects of accelerated acidic deposition on soil fertility (EPRI), and the effects of accelerated sulfur inputs on nitrogen and phosphorus cycles (DOE/ASEV). We are also studying improved measurement technology pertinent to cycling studies (Environmental Protection Agency) and are pursuing research on basic soil processes influencing anion mobility (NSF). This program relies heavily on our collaboration with universities across the country. We propose to continue a strong and diverse program of experimental research on important biogeochemical cycles (e.g., those of nitrogen, sulfur, and phosphorus) and processes and to expand this work to encompass a larger space and longer time scales—global biogeochemistry. The Laboratory is currently conducting a major research program on the global carbon cycle that particularly emphasizes the role of the biosphere and the effects of climate change on the global carbon cycle (DOE Office of CO_2 and Climate Research and NSF). Furthermore, the Laboratory's Information Center Complex established a CO_2 Information Center during FY 1980 to support the CO_2 assessment teams of Oak Ridge Associated Universities and ORNL (DOE Office of CO_2 and Climate Research). This project will be continued and expanded.

Summary of resources—Biogeochemical Cycles and Carbon Dioxide[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	1.1	1.8	1.9	2.0	2.1	2.0	2.0
Capital equipment		0.1	0.1	0.2	0.2	0.1	0.1
Construction			0.2	0.4	0.3		
Direct FTE	14	16	16	16	17	17	17

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Eastern Shales

A number of recent developments have led to increased interest in the feasibility of recovering oil and possibly selected minerals from the eastern shales (black Devonian shales). The eastern shales are estimated to contain over 500 billion barrels of recoverable oil along with significant quantities of important metals (aluminum, iron, uranium, nickel, cobalt, vanadium, molybdenum, chromium, and manganese). A new process, developed by the Institute of Gas Technology, promises to increase yields of oil to levels comparable to those obtained from western shales. The process itself involves retorting the shale in a hydrogen atmosphere.

The environmental and health impacts that could arise from this activity, however, are as important as the economic and technical feasibility of eastern shale development. Large areas of land would have to be mined (either by strip- or deep mining) and reclaimed, which could have significant impacts on land use and could possibly disrupt or degrade groundwater and surface waters in the mined area. In addition, the disposal of spent shales and the release of effluents from retorting and associated metal recovery operations could significantly affect land, air, and water quality. Further, numerous questions remain unanswered concerning the potential health impacts on workers and the general public resulting from the operations and products of the shale industry. Consequently, environmental and health issues must receive attention early in the developmental stage.

The purpose of this new initiative is to propose that ORNL, in concert with ASEV, play a major role in developing and implementing an environmental and health program that would ensure the timely and environmentally acceptable use of the eastern shales. As currently envisioned, this program would involve the following major efforts: (1) preparing an assessment of the environmental and health issues associated with eastern shale utilization, (2) developing and implementing an integrated R&D program that would resolve the environmental and health issues identified in the assessment, and (3) conducting environmental and health monitoring programs for demonstration or commercial facilities processing eastern shales to ensure that the proposed R&D program reflects actual experiences as the industry develops and to ensure that unforeseen problems are identified and resolved as quickly as possible.

ORNL is in a unique position to undertake this proposed multidisciplinary activity. The ORNL Life Sciences Program has demonstrated a broad capability for identifying and evaluating the environmental and health issues associated with developing technologies and for planning and implementing the research necessary to address these issues. Of particular importance here is our extensive experience in areas related to synthetic fuels (health and environmental research, coal liquids, Gasifiers in Industry, and H-Coal). This is especially true of our involvement in the PARAHO/Sohio shale oil project. Also, ORNL has developed an extensive base of environmental and health information about the region containing the eastern shales. This resource has been developed through our regional activities for ASEV as well as through interests stemming from our location in this region. Our location has also enabled us to develop a broad range of contacts with the state, local, and industrial entities that will be directly involved in the utilization of the eastern shales.

Another of the major advantages offered by ORNL is the extensive base of engineering and other technical resources that can be integrated with the resources of the life sciences programs to produce a truly multidisciplinary team. We have learned through our work in synfuels that involving both the life scientist and the technologist in the development of a techology ensures the timely availability of that technology. In addition, the Laboratory's ongoing efforts in the areas of resource (metals) recovery and solid waste disposal would be a major benefit to this initiative.

For additional discussion of the development of eastern shales, see the section on ORNL activities for the Assistant Secretary of Resource Applications in the preceding chapter.

Summary of resources—Eastern Shales*

	'81	'82	'83	'84	'85	'86
Operating cost	0.2	0.8	2.0	2.5	1.0	1.0
Direct FTE	3	8	10	10	8	8

*Funding for FY 1981 and FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Resource projections reflect some subcontracting in FY 1983 through FY 1985. Personnel numbers are in full-time equivalent (FTE) person-years.

Environmental Geoscience Research

Because we are increasingly aware that energy development must go hand in hand with the development of a base of fundamental information about areas to be affected, efforts are under way to strengthen and expand the scope of geoscience research at the Laboratory. The challenge to energy technologies is to acquire holistic information on the hydrosphere, lithosphere, and atmosphere in greater detail than has been available up to now. Geoscience research, sponsored by DER and the Assistant Secretary for Nuclear Energy, has been a continuing effort at the Laboratory; its focus has been radioactive waste management. The Laboratory's core group of geoscientists has contributed to the development of waste management practices. Also, from their research activities an understanding of radioelement reactions with earthen materials has developed, and site requirements for safe disposal of radioactive wastes have evolved. The impact of disturbing the earth's crust by mining, excavation, or material addition, especially its impact on the hydrologic circuit, mineral reactions, rock fracture patterns, and trace element transport, has been observed. The objectives of the expanded geoscience research are to provide the capability to predict this impact, to provide information for preventing or minimizing potential adverse impacts resulting from man's actions, and to develop methodologies for mitigating or correcting existing undesirable conditions. The knowledge being gained, particularly for the eastern United States (which is more humid than other portions of the country) would provide an information base that would be useful not only in the area of waste management but also facility siting, mineral resource utilization, water resource conservation, and other assessment areas.

Major Milestones

Milestone	Date
Issue the shallow land burial handbook (interim report)	September 1983
Issue the final report of the Engineered Test Facility	September 1985
Complete the Argillaceous Core Library (Issue Report*)	September 1986

*Assuming that coring takes place as scheduled.

Summary of resources—Environmental Geoscience Research[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	1.5	2.0	2.5	2.8	2.9	3.0	3.0
Capital equipment	0.2	0.2	0.3	0.3	0.1	0.1	0.2
Direct FTE	20	25	29	32	33	34	35

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Life Sciences Instrumentation Development

New instrument concepts are being developed, and advanced instruments are being designed to help assess or predict the impact of the emerging energy industries—their products, effluents, and emissions—on the environment and on the health of operating personnel and the surrounding population. Research efforts are focusing primarily on developing laser-related analytical techniques and methods for coal effluent monitoring and measurement.

Laser-related Analytical Techniques

Resonance ionization spectroscopy (RIS), a relatively new laser spectral concept, was developed at ORNL as a way to achieve the ultimate in sensitive analytical capability—selective detection of single atoms and molecules in the gaseous state. Laser-related techniques offer capabilities for selectively detecting any element in the periodic table (except helium, fluorine, neon, and argon) at levels of one part in 10^{14} to 10^{16} or, in special cases, at the level of one part in 10^{19} in gaseous, solid, or liquid samples. The numerous applications of these new techniques to be pursued will include environmental applications, such as (1) measuring turnover rates in large environmental pools (a scheme for measuring oceanic turnover rates will be pursued in collaboration with Scripps Institute of Oceanography); (2) tracking the fate of trace materials (e.g., heavy metals) in the environment (a scheme for detecting extremely low levels of plutonium will be investigated in collaboration with EG&G and the Los Alamos National Scientific Laboratory); and (3) using tracer materials to study the distribution of energy process effluents. Finally, an ultra-low-level counting laboratory is envisioned at ORNL that would serve the scientific community by providing solutions to a variety of problems that lend themselves to these developing techniques.

Coal Effluent Measurement and Monitoring

Several ongoing and new projects are aimed at developing instrumentation for detecting and measuring effluents from coal combustion and conversion. Four instruments for detecting polynuclear aromatic (PNA) compounds are being developed. A portable, microcomputer-controlled derivative ultraviolet absorption spectrometer (DUVAS) has been developed to take multicomponent measurements of mono- and dicyclic-aromatic vapors, such as benzene, phenol, and alkynaphthalenes.

The feasibility of using room temperature phosphorescence (RTP) for near-real-time monitoring of PNA compounds in particulate matter is also being explored. The development of an RTP instrument capable of performing on-line area monitoring of airborne PNA compounds would be a major step in creating effective industrial hygiene capabilities for coal conversion plants. Another instrument, the portable fluorescence spotter, is used to detect PNA contamination on skin by means of low-intensity, long-wavelength ultraviolet light transmitted to a stethoscopic cap pressed against the skin. Efforts are under way to find methods of monitoring coal conversion plant personnel for level of exposure to or uptake of PNAs. The program will examine methods for determining the activity of the enzyme systems involved in the metabolism of PNAs introduced into the human system.

Summary of resources—Life Sciences Instrumentation Development[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	1.4	1.9	2.1	2.6	3.2	3.9	4.8
Direct FTE	17	22	23	28	35	42	50

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Reservoir Research and Water Resource Management

ORNL has been approached by DOE's Assistant Secretaries for the Environment and for Resource Applications to assume leadership roles in planning research on southeastern reservoirs and national environmental planning for small-scale hydroelectric development. Predictions are that the Southeast will experience considerable near-term industrial growth and energy technology development. Southeastern

aquatic systems (reservoirs, tailwaters, and unregulated streams) are prime sites for such development and associated environmental impacts. Through DOE and Nuclear Regulatory Commission funding and the cooperative planning efforts of DOE, the Department of the Interior, and the Tennessee Valley Authority, ORNL has developed new initiatives in the area of reservoir ecology and water resource management. Current activities include (1) research on ecological processes in southeastern aquatic systems (DOE/ASEV), (2) research and assessment of ecological issues related to small-scale hydroelectric development (DOE, Assistant Secretary for Resource Applications), and (3) data analysis and interpretation of current information on the lower Mississippi River (U.S. Army Corps of Engineers). ORNL plans to expand this core effort between FY 1981 and FY 1985 and to develop a regional center of scientific expertise capable of addressing critical questions regarding energy development and potential environmental impacts on southeastern aquatic systems. Major components of this expanded effort identified to date include (1) increasing applied and basic ecological research on reservoirs and tailwaters, (2) joining ecological criteria and hydrologic modeling capability for river-basin-level water resource planning, and (3) expanding the current focus on aquatic ecological concerns in ongoing regional assessment activities. The unique capabilities developed through these new initiatives will enable ORNL to make a comprehensive response to the needs of DOE and other agencies concerned with water resource development and management.

Summary of resources—Reservoir Research and Water Resource Management[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.6	1.0	1.2	1.2	1.2	1.0	1.0
Direct FTE	5	6	7	7	7	7	7

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Risk Assessment

Although site-specific, regional, and generic assessments of energy technologies or assessments of generic issues have been performed by ORNL and others, there exists no organized, full-time activity that addresses the development and application of comprehensive principles of risk assessment that can gain both scientific and policy acceptance.

A risk-free state of life does not exist. Clearly, then, practical issues in risk assessment—risk apportionment, comparative risks, risk-benefit tradeoffs, and effective input to policymaking—must receive more attention.

No energy technology has been totally rejected thus far because it was too risky; rather, energy policymaking is dominated by political decisions that are often inconsistent combinations of readiness, perceived risks, economic factors, technological feasibility, and actuarial estimations of risks. Energy crises could, of course, override all other considerations. Unfortunately, public, and publicized, debates among scientists have seriously eroded their ability to influence policymaking. Still, potential health and environmental effects associated with energy technologies will continue to require control measures that will sometimes be expensive. It is not always clear whether we are reducing real impacts or simply paying for conservatism. It is clear, however, that a concerted effort on risk assessment, accompanying technology development, will be necessary if we are to surmount some of the political and perceptual problems related to energy technologies and to ensure that the best scientific documentation is available for unanimous input to energy policymaking.

ORNL staff members have discussed risk assessment with DOE staff and with other federal agencies. Many ongoing activities at ORNL relate to risk assessment, but these activities should be integrated and expanded in order to provide effective documentation and input to policy issues.

ORNL has been actively pursuing the formation of the national Society for Risk Assessment and an attendant professional technical journal. We have also organized a technical symposium on health risk assessment for October 1980. In addition, we have recruited a key leader to work in this area. This individual's primary role will be to coordinate the development of ORNL's risk assessment programs.

Summary of resources—Risk Assessment[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.2	1.0	2.0	2.5	3.0	3.6	4.1
Direct FTE	3	11	20	25	30	35	40

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Toxicology

Experimental data on acute, subchronic, and chronic toxicity of new synthetic fuels and the by-products of their production are urgently needed to provide a basis for assessing the health risks to individuals who may be exposed when these new energy systems are developed and put into full-scale use.

Confirmation and extension of initial results on acute toxicity from exposure to such materials are needed. More importantly, however, data on subchronic and chronic toxicity caused by long-term, low-level exposure are almost nonexistent, and this gap must be filled.

ORNL has already initiated a modest program to study the acute and subacute toxicity of energy-related materials and other environmental pollutants and has added a small team of toxicologists and pathologists to the existing support staff of chemists, biologists, and physiologists. Moreover, some of the needed facilities are available, particularly the disease-free quarters that are required for subchronic and chronic toxicity experimentation. The Laboratory has extensive experience in carrying out long-term animal experiments in which protection is provided to ensure the integrity of the experiment, the health of the workers, and the environment within and around the laboratory. It has been proposed that the toxicology program at ORNL be expanded so as to increase the number of substances that can be tested and to provide the capability to evaluate more completely the potential adverse health effects from intermittent or prolonged exposure.

In this program, materials obtained from various developing energy processes will be examined initially for acute toxic effects, using standard protocols. Selected materials will then be investigated more extensively for subchronic or chronic toxicity caused by long-term exposure at various dose levels. Damage at both the point of entry into the body and to other organ systems will be characterized to determine the kind and severity of disease produced, the part of the body affected, and the comparative responses of several animal species. For selected representative test materials, the uptake and fate of the substances in the body will be determined to relate the doses delivered by different routes of exposure to the adverse health effects. For the most important compounds, the mechanisms by which the materials produce their toxic effects will be investigated. The combined data on toxicokinetics, pathology, and mechanisms will be the basis of the health risk assessment.

To expand the toxicology program the Laboratory needs (1) additional staff members with expertise in toxicology, pathology, and pharmacokinetics; (2) laboratory space that has been remodeled for the safe handling of hazardous chemicals; and (3) an incinerator to be used for the safe disposal of waste test materials. Additional staff can be accommodated immediately, but achieving maximal expansion depends upon renovation and the availability of the incinerator (requested for FY 1983). The summary of resources for the level of effort proposed is based on lifetime animal experiments, which require approximately four years to conduct.

Summary of resources—Toxicology[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.5	1.0	4.5	4.5	6.0	6.0	8.0
Direct FTE	6	10	25	25	35	50	50

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

The Assistant Secretary for Conservation and Solar Energy

Technical Assistance to the Office of Alcohol Fuels

Discussions were held with the Office of Alcohol Fuels concerning an outreach program that would inform prospective alcohol producers of statutory compliance requirements. Follow-up studies on the environmental consequences of still-bottom disposal are contemplated, as is a major effort to stimulate methanol production. This project is proposed for FY 1981.

Summary of resources—Technical Assistance to the Office of Alcohol Fuels[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.1	0.3	0.4	0.6	0.8	1.0	1.1
Direct FTE	1	3	4	6	8	10	11

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Biomass Conversion

Discussions have been held with DOE and Solar Energy Research Institute staff members concerning four additional programs for funding in FY 1981 and beyond. These programs are a critical technical assessment of the available processes for converting biomass to fuels and feedstocks; an investigation of feedstock production by pyrolyzing biomass in a hydrogen environment; the reaction on column packing of biomass suspensions with enzymes fixed in films; and the recovery of ethanol from fermentation broths by solvent extraction. These activities would complement and benefit from the allied biotechnology work proposed for DOE-ASEV.

Summary of resources—Biomass Conversion[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.4	0.7	0.8	0.9	1.0	1.0	1.0
Direct FTE	4	7	8	9	10	10	10

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Materials Development for Conservation and Solar Technologies

The Division of Energy Conversion and Utilization Technology (ECUT) was recently established in Conservation and Solar Energy (CS) to develop and promote use of an expanded technology base and advanced concepts in energy conversion and utilization. Informal discussions have been held with ECUT management regarding the assignment of the lead mission for materials development to ORNL. Conservation and solar technologies are limited in many instances by the limited durability and heat tolerance of known materials during operation. It will be the objective of the Materials Development Project to assess materials needs that are critical to the success of the various CS missions and to conduct research to develop improved materials. The initial tasks during FY 1981 will be to identify and assign priorities to materials needs and to prepare a comprehensive program plan.

Summary of resources—Materials Development for Conservation and Solar Technologies[a]

	'81	'82	'83	'84	'85	'86
Operating cost	1.3	1.5	2.0	2.5	2.5	2.5
Capital equipment	0.1	0.1	0.1	0.1	0.1	0.1
Subcontracting and procurement	1.0	1.2	1.5	1.8	1.8	1.8
Direct FTE	3	3	5	7	7	7

[a]Funding for FY 1981 and FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

National District Heating Program

ORNL will assist the Office of Building and Community Systems in accelerating the implementation of district heating in U.S. cities. The Department of Energy has prepared a program strategy, and ORNL jointly with Argonne National Laboratory will aid DOE in its implementation. The strategy calls for preparation of site-specific assessments in a large number of cities, implementation of systems in cities that are already under investigation, development of state district heating plans, development of standards and codes, appointment of a federal district heating coordinator, information dissemination, and technology development.

Specifically, ORNL's responsibility would be to continue technical management of the St. Paul District Heating Demonstration Project and to assist six or seven other cities with such analysis tasks as estimating heat-load densities and developing long-term strategies. ORNL's technology development

Summary of resources—National District Heating Program[a]

	'81	'82	'83	'84	'85	'86
Operating cost	1.9	2.3	3.2	3.2	2.3	1.9
Subcontracting and procurement	0.9	0.2	0.3	0.3	0.3	0.3
Direct FTE	9	10	12	12	10	10

[a]Funding for FY 1981 and FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

role would be directed at four tasks: a scientific study on district heating distribution water temperature, distribution technology development work directed at reducing the cost of the system, assessment of the impact of large hot water district heating systems on the electric utility industry, and assessment of the industrial customers' roles in modern district heating systems.

The Assistant Secretary for Resource Applications

Coal Land Leasing Study

ORNL has been discussing with the Leasing Policy Development Office of Resource Applications (RA) the possibility of undertaking the development of data and methods required to help DOE establish priorities for future leasing of coal lands and for setting goals for future coal production from these lands. After the initial effort on coal, similar analysis methods could be developed for use by RA in establishing leasing priorities for other types of energy resources as well. This may become a lead mission responsibility for ORNL.

Summary of resources—Coal Land Leasing Study[a]

	'80	'81	'82	'83	'84	'85	'86
Operating cost	0.1	0.5	0.7	1.0	1.2	1.5	1.5
Direct FTE	1	3	4	4	4	4	4

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in millions of constant 1982 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

PERSONNEL RESOURCES

PERSONNEL RESOURCES

ORNL is one of the largest scientific and technological multiprogram laboratories in the world. Among the Laboratory's strengths is the diversity of its technical staff. Forty percent of the personnel are college graduates, of whom more than 850 hold the Ph.D. degree. There are about 650 engineers, primarily chemical, electrical, and mechanical; about 40 mathematicians; 540 physical scientists; and more than 300 biomedical and environmental scientists. Furthermore, the staff of economists and other social scientists has grown and currently numbers about 40.

The Laboratory population also includes about 1000 guest scientists on assignment for periods ranging from a few months to a year or more. About 165 of these scientists represent foreign laboratories or research centers; among the others are university faculty and scientists from U.S. industry and government. College and university visitors under a variety of research participation and advanced study programs, most of whom spend between a few days and several months at the Laboratory, number about 1200 annually. This number includes participants in ORNL's University Relations Programs (about 950 in 1979) as well as Oak Ridge Associated Universities 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 all three installations have a general engineering staff of 1280 and a computer sciences staff of 840 available to contribute to ORNL research efforts. Currently, ORNL uses about 380 of the available engineering staff and 330 of the computer sciences staff.

ORNL programs located at the Y-12 Plant use over 200 of the service and support staff located there. An additional 110 from central management services groups also provide support to ORNL (Fig. 15).

Personnel Trends

As was discussed in the chapter entitled "Laboratory Trends and Future Developments," 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 and, later, the Department of Energy (DOE), the Laboratory staff increased substantially. Although under existing planning levels the number of employees at ORNL should remain essentially constant over the next few years (Fig. 1), ORNL has been able to extend its personnel resources through subcontracting. Several notable trends related to personnel resources projected at ORNL are (1) the maintenance of a high level of subcontracting to universities, industries, and other laboratories; (2) a shift from nuclear to nonnuclear work in basic physical and life sciences research; (3) an increase in personnel involved in coal-related research and development (R&D); (4) an increase in program management for DOE; and (5) an increase in technical staff working on assessments and studies (e.g., policy studies) and in information services.

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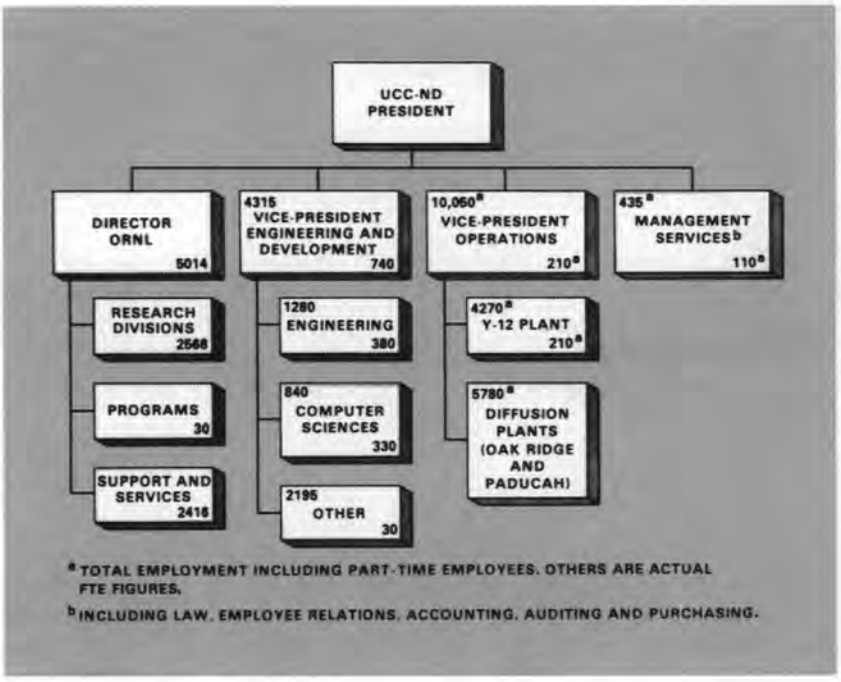

Fig. 15. ORNL receives extensive support from other parts of UCC-ND, as indicated by February 1980 employment figures. The lower figures in each box represent personnel involved in ORNL programs.

In recruiting, ORNL has an overall acceptance rate of 48%, an acceptance rate for Ph.D.'s of 61%, and an acceptance rate of 41% for B.S. and M.S. candidates. Over the last few years, the average age of employees at the Laboratory has been fairly constant at 42. It is still too early to determine how the elimination (in January 1979) of the mandatory retirement age of 65 will affect the employee turnover rate. Of the 60 employees that have become eligible for retirement since January 1979, over 30 have continued working. The Laboratory has had some difficulty recruiting people in engineering disciplines because of the high demand for engineers, especially chemical engineers. Reflecting the current planning levels, recruitment figures are up somewhat in both engineering and nonengineering fields. However, the ratio of engineers recruited to the total number of personnel recruited is about the same as it was last year. Despite leveling, the Laboratory will continue to pursue in policy and practice its strong commitment to affirmative action.

Personnel Requirements

As stated, under existing guidelines [5180 full-time equivalents (FTEs) in 1981], personnel levels at ORNL should remain essentially constant over the next few years, increasing slightly (about ½% per year) during the second half of this planning period. In 1980, the work force totaled about 5000—2306 direct FTEs and 2719 indirect FTEs. By 1986, ORNL aims (within DOE planning levels) to reach a total of 5295 FTEs, of which 2595 will be direct FTEs and 2700 indirect FTEs. Declines in nuclear work (including work for the Nuclear Regulatory Commission) will be accompanied by growth in coal-related programs. Continuing shifts in emphasis in the sciences must be accomplished, as in the past, within nearly constant personnel levels. ORNL will continue to use 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.

Several trends in ORNL personnel resources are expected to continue. The Laboratory plans to continue its substantial R&D subcontracting to industry, universities, and other laboratories. Nuclear-related activities at the Laboratory will decline compared with other programs (fossil, fusion, environment, and basic physical sciences). Further personnel increases are anticipated in the coal area

as well as in studies and assessments and in program management for DOE. Although ORNL's conservation program should continue to grow in funding and program management, few additional in-house people will be required. In the Work-for-Others area, the proportion of direct FTEs involved in non-DOE work is projected to decrease, especially during the first half of this planning period.

Although the Laboratory's total of FTEs is projected to increase by about ½% per year during the second half of the planning period, the level of indirect FTEs will be held constant. Consequently, the level of direct FTEs, which includes primarily scientific and technical personnel, will increase by about 1.0%. To support this growth in direct FTEs without increasing overhead and indirect staff, ORNL plans to maintain and increase its operating efficiency in order to use its valuable human resources most wisely.

During this planning period, the following factors could affect ORNL personnel resources: (1) proposed presidential budget cuts could delete or reduce important ORNL work in certain fission areas (high-temperature gas-cooled reactor, gas-cooled fast breeder reactor, and liquid-metal fast breeder reactor); (2) the plateau of DOE funding in basic life sciences research and the consequent need to maintain work for other agencies in this important R&D area; and (3) the uncertainty of DOE funding levels for coal programs, an area in which ORNL is projecting continued growth.

ORNL is currently updating its Human Resources Development Plan, which proposes initiatives and positions to be taken by the Laboratory in maintaining and developing the quality of the staff.

SITE AND FACILITIES DEVELOPMENT

SITE AND FACILITIES DEVELOPMENT

The future of the Laboratory site and facilities is given major consideration in the institutional planning process. The continuing utility of the facilities, in particular, cannot be ensured unless plans for modifying, updating, or constructing them are implemented before old facilities become inadequate or new ones become necessary for program activities. This planning area is crucial to maintaining the Laboratory's physical capability to perform Department of Energy (DOE) missions.

As a way of ensuring proper planning and management of its facilities, ORNL has established a General-Purpose Facility Manager's Office, which is designed to serve as a liaison between DOE and Laboratory management and to conduct internal planning and management activities. The Laboratory is striving to answer new program requirements as well as to maintain the continuity of ongoing programs by redirecting or reassigning existing facilities wherever possible and by making optimal use of its facilities (e.g., through consolidation of similar operations, elimination of obsolete or unneeded equipment and supplies, and provision of more efficient working area arrangements). Also, energy and resource conservation is being given particular consideration in the identification of site and facility modifications and of new construction projects. Costly and poorly utilized facilities are being identified so that a well-defined program for disposal or replacement 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 are continuing to rely on the eventual approval of large, expensive line-item projects for the provision of both general-purpose facilities (GPF) and specific programmatic facilities (Table B.5, Appendix B).

Laboratory Site Development

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

The completion of the ORNL Master Plan (to be published shortly), however, will make possible an accurate evaluation of the planned and proposed site and facility modifications in terms of overall plant capability. The Plan's objective is to provide a flexible, long-range scheme for the orderly development of the Laboratory's physical facilities. In addition, the document is responsive to DOE's increasing emphasis on sound facility management and planning. Based on management objectives for the next five years or more and on the requirements of the programs described here, it is designed to serve Laboratory management and DOE as an instrument for improving the effectiveness and

efficiency of planning and operating future facilities. For example, review of the zoning classifications to be established by the Plan forced reconsideration of site selections for several projects already in the early planning stages and even resulted in decisions to relocate some facilities. Other aspects of the Plan—such as its discussion of the opportunities and constraints of natural site features, documentary mapping and description of the man-made improvements, and treatment of the important operating and support activities—facilitated these decisions.

The Plan has also aided recognition of those site and facility changes requiring priority attention. As a result of the recent General Purpose Facility Survey and Report, completed during FY 1980 at the request of DOE's Office of Energy Research, many improvements and new projects were initially identified as being needed to upgrade Laboratory facilities to a more acceptable level. The guidance afforded by the ORNL Master Plan will be essential in the extensive review process now required for project identification, budgeting, planning, and execution.

In considering our facility needs, we are focusing our attention on the timely issues of environmental protection, waste management, and energy conservation. The large number of projects being identified to meet new program needs must be examined closely to determine their impact on general plant resources, as well as their ability to comply with increasingly more rigid standards governing release and control of hazardous solids, liquids, and gases. The Laboratory's involvement in many new programs has already revealed several new classes of toxic and noxious chemicals that must be dealt with and that will require new and better facilities. As additional information is gained on these materials and on others not yet identified, more improvements and additions to the general plant facilities will probably be required.

Construction

We propose to correct the GPF deficiencies cited in the General Purpose Facility Survey and Report through forty line-item projects totaling about $157.5 million. Twenty-nine of the projects provide for building space, ten cover the upgrading of utility service systems, and one covers relocation of Bethel Valley Road. Only nine of the forty projects have been included in current budget submissions, but additional items will be included in future budget submissions on the basis of guidance from the General Purpose Facility Review and of other proposals for GPF as such needs become known.

The line-item projects fall into two classes, GPF and programmatic facilities (Table B.5, Appendix B). Included are approved ongoing construction projects, budgeted new construction projects, and proposed new construction projects not yet included in the budgetary process.

The most important facility in the first class is the Energy Systems Research Laboratory (ESRL). In recent years, ORNL's staff and its programs have grown, especially in nonnuclear areas. Our laboratories often fail to meet current program requirements for height, floor loading, isolation, temperature control, and cleanliness. Office space is insufficient for the current staff: over 800 office users are overcrowded [having less than 7 m^2 (75 ft^2 each], and an additional 1100 are in substandard offices (attics, basements, trailers, or offices that are old, deteriorated, or noisy). The ESRL, submitted as a $20 million line item for the FY 1981 budget and now identified as a $15 million item in FY 1982, will alleviate some of these problems. The new 8,360-m^2 (90,000-ft^2) building will provide space for research laboratories, offices, and service areas, but the largest portion of it will house much of the fossil energy program. The structure will also house most of the geothermal, solar energy, and conservation programs and essentially all of the biotechnology program. The project is to be initiated in FY 1981 at a cost of $2.0 million. Construction, scheduled to start in FY 1982, is expected to be completed in FY 1984 at a total estimated cost of $15.0 million.

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, completed during FY 1980; the new Hydrofracture Facility, to be completed at the end of FY 1981; and the Improvements to Radioactive Waste Facilities Project, to be completed in FY 1984. The information obtained during the planning, design, and operation of these facilities will benefit the overall Radioactive Waste Management Program in implementing low-level radioactive waste management programs at DOE and other federal installations.

A more detailed description of these and all the facilities being proposed, budgeted, or funded for the Laboratory is given in the *ORNL WPAS*

*Summary, FY 1981–FY 1986,** the companion document to this Institutional Plan.

General-Purpose Equipment and General Plant Projects

The funding for general-purpose equipment (GPE) and GPP has been inadequate for many years, limiting the opportunity to update and renovate old buildings, facilities, and equipment. The problem has worsened over the last 15 years: GPP funding has fallen very rapidly compared with the other operating costs of the Laboratory (Fig. 11), and inflation has reduced the buying power of this decreased funding significantly. Current budget submissions from ORNL call for a modest increase in GPP to reverse this trend.

Automated Data Processing Requirements

Planning Process

The Computer Sciences Division (CSD) is responsible for managing 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 the Vice-President for Engineering and Development, UCC-ND, and is not a part of ORNL.

The Computer Sciences Division 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 Computing Advisory Committee, which 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 in the ORNL Institutional Plan.

Current Equipment

The following table shows the major computer systems currently installed to serve the Oak Ridge complex.

Major computer systems serving the Oak Ridge Complex

System description	Date of installation of basic computer system
ORNL	
IBM 360/91, with 2MB[a] memory and 4 channels	May 1969
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: 56 3330 disks, 14 3350 disks, 2 drums, 1 mass-storage device, and 22 magnetic tape drives	
CDC 3200,[b] to collect and analyze data at the EN Tandem Van de Graaff Laboratory	July 1980
DEC KL10, with 1280K words memory, 1 triple processor, 6 channels, 17 disk drives, and 2 magnetic tape drives	January 1977
DEC KA10[b] plus SEL and PDP, minicomputers to collect and analyze data at the Oak Ridge Electron Linear Accelerator	April 1977
ORGDP	
IBM 1800 system[b] to collect and analyze data at the barrier manufacturing plant	May 1969
IBM 360/195, with 4MB memory, 7 channels, 31 3330 disks, 2 drums, 17 magnetic tape drives, and 1 mass storage device	November 1972
IBM 370/155, with 4MB memory, 6 channels, 15 3330 disks, 1 drum, and 4 magnetic tape drives	February 1973

*Oak Ridge National Laboratory, *Oak Ridge National Laboratory WPAS Summary, FY 1981–FY 1986*, ORNL/PPA-80/13 Draft (August 1980).

† These sites are commonly referred to as X-10, K-25, and Y-12.

System description	Date of installation of basic computer system
Y-12	
CDC 3300,[b] with 80K words memory, 12 disk drives, and 6 magnetic tape drives	May 1968
IBM 360/50,[b] with 768KB memory, 3 channels, 3 2314 disk drives, and 6 magnetic tape drives	August 1973

[a]Megabytes.

[b]These systems are for special purposes and are not available for other work.

Major ORNL Computers

The IBM 360/91 and IBM Dual 3033 systems primarily serve ORNL's scientific research and development work. The 360/91 is devoted entirely to a batch environment to make the best use of its central processor unit capability. One 3033 is used during the day to provide a text-editing service and a time-sharing service to users under the Time-sharing Operation 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 the weekend. 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 have an adequate degree of reliability. Systems software supplied by the vendor is in use, although modifications have been made. Maintenance of the system is competitively bid on a periodic basis.

The IBM 3033 complex and the DEC PDP-10 complex each have extensive communication systems. Currently, the IBM 3033 computer system has four data communications processors: two CC-8s, produced and serviced by Computer Communications, Inc., and two 3705s, produced and serviced by IBM. Interactive services are divided between a time-sharing system and the RECON information system.

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 multiplexers (all based on the PDP-8 minicomputer) are interactive devices. Three high-speed circuits connect the PDP-10 complex to the 3033 complex, 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. 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 where 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 control of parameters (e.g., temperatures, pressures, flows, and pH) as well as functions for monitoring, conversion, analysis, 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 where the requirement is for 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.

Projected Demand and Capacity

The projected ADP requirements of the Oak Ridge complex during this planning period are given in the table below. They are based on Schedule C-2, Sect. E3 of the UCC-ND ADP Long-range Site Plan. The smaller ORNL program activities, not separately displayed in that schedule, have been prorated into the broader categories shown here on the basis of the actual 1979 distribution. The remaining small, aggregated programs have been allocated to Y-12 and ORGDP as indicated.

One major ORNL computer item is projected during this planning period. In FY 1984, the IBM 360/91, which will then be 15 years old, is to be retired and replaced by a scientific "number cruncher." This replacement will absorb the work load handled by the 360/91 and will provide sufficient capacity to meet the growth in computer work load projected by ORNL programs in the planning period.

The second table below shows the capacity likely to be available to the three sites if purchases are made on the schedule indicated in the long-range plan. This schedule, if adhered to, would avoid a repetition of the recent difficulties and delays caused by capacity falling below demand. Slippages in the planned replacement schedule would result in capacity falling below demand in 1984 and 1985.

Estimated ADP requirements of the Oak Ridge complex
In normalized service units

	'80	'81	'82	'83	'84	'85	'86
ORNL DOE and NRC programs							
Fission energy	1,900	2,200	2,500	2,700	2,900	3,000	3,200
Basic physical sciences	1,700	1,900	2,000	2,200	2,300	2,400	2,500
Fusion energy	1,300	1,800	1,900	2,000	2,000	2,200	2,300
Life and environmental sciences	800	900	1,000	1,100	1,200	1,300	1,400
Other ORNL DOE	800	900	1,000	1,100	1,200	1,300	1,400
Total, ORNL	6,500	7,700	8,400	9,100	9,600	10,200	10,800
ORGDP and Y-12 DOE programs	15,200	16,700	17,600	18,700	20,300	20,700	21,700
Reimbursables (excluding NRC)	3,000	3,400	3,900	4,300	4,000	4,800	5,100
General support	2,500	2,700	3,000	3,300	3,600	4,000	4,400
Total, Oak Ridge	27,200	30,500	32,900	35,400	37,500	39,700	42,000

Maximum practical computing capacity for the Oak Ridge complex
In normalized service units

	'80	'81	'82	'83	'84	'85	'86
Existing machines	30,000	38,900	38,900	38,900	32,200[a]	27,400	21,400
New machines					13,000[b]	19,500[c]	29,500
Total available	30,000	38,900	38,900	38,900	45,200	46,900	50,900
Total requirements	27,200	30,000	32,900	35,400	37,500	39,700	42,000

[a]Old capacity is retired as more appropriate equipment becomes available.
[b]New large computer at ORNL (UCC-84-1) and small production system at the Y-12 Plant (UCC-83-1).
[c]Replacement computer system at ORGDP (UCC-85-1).

APPENDIX A
ORGANIZATION CHART

SALARIED 4093
TOTAL 5331

- **H. POSTMA, DIRECTOR** +4
  - **C. C. HOPKINS, EXECUTIVE DIRECTOR SUPPORT AND SERVICES** +3
    - **FINANCE AND MATERIALS DIVISION** — W. R. RAGLAND, DIRECTOR +193
    - **INFORMATION DIVISION** — G. D. ROBBINS*, DIRECTOR +394
    - **INDUSTRIAL SAFETY AND APPLIED HEALTH PHYSICS DIVISION** — J. A. AUXIER, DIRECTOR +99
    - **EMPLOYEE RELATIONS DIVISION** — J. J. VOGT, DIRECTOR +108
    - **HEALTH DIVISION** — A. S. GARRETT, JR., M.D., DIRECTOR +41
    - **M. E. RAMSEY, ASSISTANT DIRECTOR SERVICES** +2
      - **PLANT AND EQUIPMENT DIVISION** — G. W. OLIPHANT, DIRECTOR +938
      - **OPERATIONS DIVISION** — J. A. COX, DIRECTOR +297
      - **LABORATORY PROTECTION DIVISION** — W. C. KUYKENDALL, DIRECTOR +119
      - **DEPARTMENT OF QUALITY ASSURANCE AND INSPECTION** — J. R. McGUFFEY, DEPARTMENT HEAD +36
      - **LABORATORY SHIFT SUPERVISORS** — G. C. CAIN +6
    - **UCC-ND GENERAL STAFF DIVISIONS LOCATED AT ORNL**
      - **COMPUTER SCIENCES DIVISION** — H. P. CARTER, DIRECTOR
      - **ENGINEERING DIVISION** — M. BENDER, DIRECTOR
      - **LAW DEPARTMENT ORNL PATENT SECTION** — M. J. SKINNER, P.A.
      - **PUBLIC RELATIONS DEPARTMENT ORNL SECTION** — E. D. AEBISCHER
  - **D. B. TRAUGER, ASSOCIATE DIRECTOR NUCLEAR AND ENGINEERING TECHNOLOGIES** +7
    - **CHEMICAL TECHNOLOGY DIVISION** — D. E. FERGUSON, DIRECTOR +397
    - **ENGINEERING TECHNOLOGY DIVISION** — H. E. TRAMMELL, DIRECTOR +276
    - **METALS AND CERAMICS DIVISION** — J. R. WEIR, JR., DIRECTOR +310
    - **INSTRUMENTATION AND CONTROLS DIVISION** — H. N. HILL, DIRECTOR +383
    - **CONSOLIDATED FUEL REPROCESSING PROGRAM** — W. D. BURCH, DIRECTOR +1
    - **NRC PROGRAMS** — F. R. MYNATT, DIRECTOR +1
    - **NUCLEAR FUEL AND WASTE PROGRAMS** — A. L. LOTTS, DIRECTOR +3
    - **NUCLEAR REACTOR TECHNOLOGY PROGRAMS** — W. O. HARMS, DIRECTOR +1
    - **GAS COOLED REACTOR PROGRAMS** — P. R. KASTEN, DIRECTOR +1
  - **M. W. ROSENTHAL, ASSOCIATE DIRECTOR ADVANCED ENERGY SYSTEMS** +4
    - **FUSION ENERGY DIVISION** — O. B. MORGAN, DIRECTOR +186
    - **ENERGY DIVISION** — W. FULKERSON, DIRECTOR +173
    - **FUSION PROGRAM** — L. A. BERRY, DIRECTOR +1
    - **ENERGY CONSERVATION PROGRAM** — R. S. CARLSMITH, DIRECTOR +1
    - **FOSSIL ENERGY PROGRAM** — L. E. McNEESE, DIRECTOR +2
    - **SOLAR PROGRAM** — S. I. KAPLAN, COORDINATOR
    - **GEOTHERMAL PROGRAM** — J. W. MICHEL, COORDINATOR
  - **C. R. RICHMOND, ASSOCIATE DIRECTOR BIOMEDICAL AND ENVIRONMENTAL SCIENCES** +5
    - **BIOLOGY DIVISION** — R. A. GRIESEMER, DIRECTOR +350
      - **U.T. OAK RIDGE GRADUATE SCHOOL OF BIOMEDICAL SCIENCES** — W. E. BARNETT, DIRECTOR
    - **ENVIRONMENTAL SCIENCES DIVISION** — S. I. AUERBACH, DIRECTOR +191
    - **HEALTH AND SAFETY RESEARCH DIVISION** — S. V. KAYE, DIRECTOR +144
    - **LIFE SCIENCES SYNTHETIC FUELS PROGRAM** — K. E. COWSER, MANAGER +2
    - **TECHNICAL INFORMATION SUPPORT** — J. F. BARKER, COORDINATOR
  - **A. ZUCKER, ASSOCIATE DIRECTOR PHYSICAL SCIENCES** +3
    - **PHYSICS DIVISION** — P. H. STELSON, DIRECTOR +124
    - **CHEMISTRY DIVISION** — O. L. KELLER, DIRECTOR +114
    - **ANALYTICAL CHEMISTRY DIVISION** — W. D. SHULTS, DIRECTOR +163
    - **SOLID STATE DIVISION** — M. K. WILKINSON, DIRECTOR +115
    - **ENGINEERING PHYSICS DIVISION** — F. C. MAIENSCHEIN, DIRECTOR +80
    - **PROGRAM PLANNING AND ANALYSIS** — R. S. LIVINGSTON, DIRECTOR +8

*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: H. Postma DATE: 7-1-80

APPENDIX B
RESOURCE PROJECTIONS

Table B.1. Laboratory summary

Funding summary
(in millions of dollars)

	FY 1980		FY 1981[a]		FY 1982[a]		FY 1983[b]		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
DOE effort	275.5	265.4	317.7	299.2	347.5	331.4	354.2	340.0	358.4	343.8	361.7	346.2	364.4	349.3
Non-DOE work	50.5	51.2	50.9	50.8	45.4	47.2	48.4	48.7	48.6	48.9	48.8	49.1	48.8	49.1
Total operating	326.0	316.6	368.6	350.0	392.0	378.6	401.7	388.7	406.1	392.7	409.6	395.3	412.3	398.4
Capital equipment	20.6		27.3		30.0		32.6		30.5		32.5		32.8	
Construction[c]	28.5		49.8		85.8		187.8		6.0		6.0		6.0	
Total Laboratory BA	375.1		445.7		508.7		623.0		443.5		449.0		452.0	

Personnel summary
(in FTE)

	FY 1980[a]	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986
Direct							
DOE effort	1849	1941	2016	2080	2107	2135	2163
Non-DOE	457	496	439	432	429	431	431
Total direct	2306	2437	2455	2512	2536	2566	2594
Indirect	2719	2700	2700	2700	2700	2700	2700
Total Laboratory personnel base	5025	5137	5155	5212	5236	5266	5294

[a]Escalation factors from FY 1980 through FY 1981 and FY 1981 through FY 1982 are both 8%.
[b]Figures for FY 1983 through FY 1986 are in constant FY 1982 dollars.
[c]All construction funded or included in budget submissions, including general plant projects. Escalation is included as presented by "Management of Construction Projects," Appendix AEC-6101.

Table B.2. Summary of costs by assistant secretarial level office[a]

	FY 1980		FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Director of Energy Research														
Operating[b]		73.5		77.9		90.4		91.5		90.9		91.3		92.2
Subcontracting		16.7		16.4		18.1		17.1		18.7		19.3		19.4
Major procurement		5.0		8.9		10.0		10.9		10.9		10.9		10.9
Total operating	89.9	95.2	107.0	103.2	121.0	118.5	121.0	119.5	122.0	120.5	123.1	121.5	124.1	122.5
Capital equipment	7.6		12.6		13.9		13.3		13.5		14.2		14.4	
Construction[c]	10.7		12.3		25.6		16.3							
Total	108.2		131.9		160.5		150.6		135.5		137.3		138.5	
Assistant Secretary for Nuclear Energy														
Operating[b,d]		55.6		56.3		61.9		65.0		67.5		70.1		71.6
Subcontracting		14.7		9.0		10.0		11.7		13.6		14.1		14.6
Major procurement		9.7		5.1		5.5		5.5		5.3		5.9		6.1
Total operating	71.6	80.0	72.9	70.4	78.4	77.4	82.0	82.2	86.1	86.4	90.5	90.1	92.0	92.3
Capital equipment	4.1		8.0		8.6		8.1		8.7		9.4		9.4	
Construction[c]	12.0		25.5		25.0		77.0							
Total	87.7		106.4		112.0		167.1		94.8		99.9		101.4	
Assistant Secretary for the Environment														
Operating[b]		28.4		30.5		36.9		38.4		38.9		39.4		39.9
Subcontracting		1.8		1.9		2.0		2.0		2.0		2.0		2.0
Major procurement		0.2		0.1		0.1		0.1		0.1		0.1		0.1
Total operating	40.2	30.4	44.2	32.5	51.1	39.0	52.8	40.5	53.5	41.0	54.1	41.5	54.8	42.0
Capital equipment	2.5		2.0		2.1		2.2		2.3		2.4		2.5	
Construction[c]	1.5		2.0		21.0		16.3							
Total	44.2		48.2		74.2		71.3		55.8		56.5		57.3	
Assistant Secretary for Conservation and Solar Energy														
Operating[b]		9.1		14.5		16.0		16.5		15.6		14.3		14.6
Subcontracting		11.0		20.0		18.5		20.3		19.8		18.9		18.4
Major procurement		0.2												
Total operating	20.7	20.3	32.8	34.5	35.3	34.5	37.1	36.8	35.7	35.4	33.5	33.2	33.3	33.0
Capital equipment	0.2													
	20.9													

Table B.2[a] (continued)

	FY 1980		FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Assistant Secretary for Fossil Energy														
Operating[b,c]		9.0		13.1		14.2		14.1		14.7		14.7		14.7
Subcontracting		5.6		6.5		7.2		7.1		7.4		7.4		7.4
Major procurement		0.7		1.8		0.9		0.9		0.9		0.9		0.9
Total operating	21.7	15.3	22.4	21.4	22.8	22.3	22.7	22.1	23.6	23.0	23.6	23.0	23.6	23.0
Construction	0.6													
Total	22.3													
Assistant Secretary for Defense Programs														
Operating[b]		3.3		3.7		2.9		3.3		2.6		2.0		1.6
Subcontracting		0.0		0.3		0.0		0.0		0.0		0.0		0.0
Major procurement		1.3		1.8		2.7		0.8		0.1		0.1		0.1
Total operating	5.9	4.6	5.7	5.8	5.0	5.6	3.7	4.1	2.6	2.7	2.0	2.1	1.7	1.7
Capital equipment	0.2		0.2		0.2		0.2		0.2		0.2		0.2	
Total	6.1		5.9		5.2		3.9		2.8		2.2		1.9	
Assistant Secretary for Resource Applications														
Operating[b]		2.2		4.9		5.2		5.8		5.8		5.8		5.8
Subcontracting		3.2		6.3		7.3		7.2		7.2		7.2		7.2
Major procurement		0.1		0.4		0.4		0.4		0.4		0.4		0.4
Total operating	9.5	5.5	12.1	11.6	12.5	12.9	13.5	13.4	13.5	13.4	13.5	13.4	13.5	13.4
Capital equipment	0.6		0.3		0.3		0.3		0.3		0.3		0.3	
Total	10.1		12.4		12.8		13.8		13.8		13.8		13.8	
Economic Regulatory Administration														
Operating[b]		1.7		1.9		2.2		1.9		1.9		1.9		1.9
Subcontracting		1.8		1.8		2.0		2.0		2.0		2.0		2.0
Total operating	3.0	3.5	3.9	3.7	4.0	4.2	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Energy Information Administration														
Operating[b]		1.6		3.0		4.0		4.1		4.1		4.1		4.1
Subcontracting		3.8		2.9		2.8		3.2		3.2		3.2		3.2
Major procurement		0.0		0.1		0.1		0.1		0.1		0.1		0.1
Total operating	7.5	5.4	6.6	6.0	7.3	6.9	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Capital equipment	0.0		0.2		0.3		0.4		0.4		0.4		0.4	
Total	7.5		6.8		7.6		7.8		7.8		7.8		7.8	

Table B.2[a] (continued)

	FY 1980		FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Other DOE offices														
Total operating	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DOE contractors and operations offices[f]														
Total operating	4.5	4.5	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Total DOE programs														
Operating[b]		189.6		215.9		243.8		250.7		252.1		253.7		256.5
Subcontracting		58.6		65.1		67.9		70.6		73.9		74.1		74.2
Major procurement		17.2		18.2		19.7		18.7		17.8		18.4		18.6
Total operating	275.5	265.4	317.7	299.2	347.5	331.4	354.2	340.0	358.4	343.8	361.7	346.2	364.4	349.3
Capital equipment	15.2		23.3		25.4		24.5		25.4		26.9		27.2	
Construction[c]	24.8		39.8		71.6		109.6							
Total	315.5		380.8		444.5		488.3		383.8		388.6		391.6	
Nuclear Regulatory Commission														
Operating[b]		18.9		21.5		17.6		17.8		17.5		17.7		17.7
Subcontracting		2.7		2.3		2.3		2.4		2.4		2.4		2.4
Major procurement		3.7		0.9		0.7		0.4		0.4		0.4		0.4
Total operating	24.6	25.3	24.8	24.7	18.8	20.6	20.3	20.6	20.0	20.3	20.2	20.5	20.2	20.5
Capital equipment	2.0		0.7		0.3		0.3		0.3		0.3		0.3	
Total	26.6		25.5		19.1		20.6		20.3		20.5		20.5	
Department of Defense														
Total operating	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Other federal agencies[g]														
Operating[b]		16.9		17.8		18.3		19.8		20.3		20.3		20.3
Subcontracting		2.2		1.6		1.6		1.6		1.6		1.6		1.6
Major procurement		1.6		1.1		1.1		1.1		1.1		1.1		1.1
Total operating	20.7	20.7	20.5	20.5	21.0	21.0	22.5	22.5	23.0	23.0	23.0	23.0	23.0	23.0
Capital equipment	0.4		0.3		0.3		0.3		0.3		0.3		0.3	
Total	21.1		20.8		21.3		22.8		23.3		23.3		23.3	
All other non-DOE														
Total operating	3.0	3.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Total non-DOE programs														
Operating[b]		41.0		44.9		41.5		43.2		43.4		43.6		43.6
Subcontracting		4.9		3.9		3.9		4.0		4.0		4.0		4.0
Major procurement		5.3		2.0		1.8		1.5		1.5		1.5		1.5
Total operating	50.5	51.2	50.9	50.8	45.4	47.2	48.4	48.7	48.6	48.9	48.8	49.1	48.8	49.1
Capital equipment	2.4		1.0		0.6		0.6		0.6		0.6		0.6	
Total	52.9		51.9		46.0		49.0		49.2		49.4		49.4	

Table B.2[a] (continued)

	FY 1980		FY 1981		FY 1982		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Total programmatic														
Operating[b]		230.6		260.8		285.3		293.9		295.5		297.3		300.1
Subcontracting		63.5		69.0		71.8		74.6		77.9		78.1		78.2
Major procurement		22.5		20.2		21.5		20.2		19.3		19.9		20.1
Total operating	326.0	316.6	368.6	350.0	392.9	378.6	402.6	388.7	407.0	392.7	410.5	395.3	413.2	398.4
Capital equipment	17.6		24.3		26.0		25.1		26.0		27.5		27.8	
Construction[c]	24.8		39.8		71.6		109.6							
Total	368.4		432.7		490.5		537.3		433.0		438.0		441.0	
General-purpose equipment	3.0[h]		3.0		4.0		7.5		4.5		5.0		5.0	
General plant projects	3.7[i]		4.0		4.5		6.0		6.0		6.0		6.0	
General-purpose facilities			6.0		9.7		72.2							
Total Laboratory BA	375.1		445.7		508.7		623.0		443.5		449.0		452.0	

[a]Costs for FY 1980 through FY 1982 are in millions of current dollars and reflect an 8% escalation factor; costs for FY 1983 through FY 1986 are in constant 1982 dollars.

[b]In-house operating only includes new work.

[c]Includes funded or budgeted construction only. Projects having completed conceptual designs include escalation as prescribed by "Management of Construction Projects," Apendix AEC-6101. Estimated costs for other projects are shown in FY 1980 dollars without further escalation.

[d]Includes transfers of costs to other DOE contractors and operations offices. Under present guidance from Headquarters, such funds (amounting to $6.6 million in FY 1980) would be shown in the Laboratory's financial plan in future years.

[e]Includes transfers of costs to other DOE contractors and operations offices for work on projects including SRC-1, SRC-2, and H-Coal. Under present guidance from Headquarters, such funds would be shown in the Laboratory's financial plan in future years. In FY 1980, direct funding in ORNL's financial plan from Fossil Energy amounted to $11.4 million B/O, with an additional $3.9 million transferred.

[f]Excludes transfer of costs in nuclear energy and in the Fossil Energy SRC-1, SRC-2, and H-Coal projects.

[g]A large part of these funds supports life sciences work; the Environmental Protection Agency provides most of this non-DOE life sciences funding.

[h]Includes $0.8 million specifically for computer purchase.

[i]Includes $0.7 million specifically for waste management projects.

Table B.3. Personnel summary
Expressed in full-time equivalent person-years

	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986
Secretarial Office or Agency							
Energy Research	674	704	740	755	770	780	790
Nuclear Energy[a]	586	543	558	582	601	622	636
Environment	300	335	350	360	365	370	375
Conservation and Solar Energy	84	107	111	113	104	99	100
Fossil Energy[a]	81	88	95	100	105	110	115
Defense	34	41	35	43	36	28	21
Resource Applications	21	38	39	38	37	37	37
Economic Regulatory Administration	17	24	22	22	22	22	22
Energy Information Administration	12	18	20	21	21	21	21
Other DOE Offices	8	9	10	10	10	10	10
DOE contractors and operations offices[b]	32	34	36	36	36	36	36
Total DOE programs	1849	1941	2016	2080	2107	2135	2163
Non-DOE							
Nuclear Regulatory Commission	197	212	166	159	156	158	158
Department of Defense	25	19	18	18	18	18	18
Other federal agencies	194	223	213	213	213	213	213
All others	41	42	42	42	42	42	42
Total non-DOE	457	496	439	432	429	431	431
Indirect personnel	2719	2700	2700	2700	2700	2700	2700
Total Laboratory personnel	5025	5137	5155	5212	5236	5266	5294

[a]Includes transfer of costs to other DOE contractors and operations offices.

[b]Excludes transfer of costs to other DOE contractors and operations offices for work on behalf of the offices of Nuclear Energy and Fossil Energy.

Table B.4. Resources for new initiatives[a]

	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986
Expanded High Temperature Materials Program[b]							
Operating	5.1	7.0	8.4	8.8	9.1	9.3	9.3
Line items							
Special equipment			0.5	0.5	0.5	0.5	0.5
Construction			17.0				
Total resources	5.1	7.0	25.9	9.3	9.6	9.8	9.8
Direct personnel, FTE	50	57	62	65	68	70	70
Applied Science/Technology Base							
Operating			2.0	6.4	10.4	14.0	20.0
Subcontracting			0.6	1.7	2.9	4.0	8.0
Total resources			2.0	6.4	10.4	14.0	20.0
Direct personnel, FTE			10	32	50	66	82
Resource Recovery from Unconventional Sources							
Operating	0.6	0.8	1.0	1.2	1.2	1.5	1.5
Total resources	0.6	0.8	1.0	1.2	1.2	1.5	1.5
Direct personnel, FTE	6	8	10	12	12	15	15
Social Science Research							
Basic Social Science Research							
Operating		0.2	0.8	1.3	1.5	1.6	1.7
Subcontracting[c]			0.4	0.8	0.9	1.0	1.1
Total resources		0.2	0.8	1.3	1.5	1.6	1.7
Direct personnel, FTE		1	3	5	6	6	6
Applied Social Science Methodology Development							
Operating		0.2	0.6	1.0	1.1	1.2	1.3
Subcontracting[c]			0.3	0.6	0.7	0.8	0.9
Total resources		0.2	0.6	1.0	1.1	1.2	1.3
Direct personnel, FTE		2	3	4	4	4	4
Light-Water Reactor Safety and Technology							
Operating	5.1	12.8	13.6	12.3	12.5	11.3	7.4
Subcontracting and procurement	0.5	3.1	2.9	4.0	3.8	3.8	2.9
Capital equipment	0.4	1.3	1.5	2.1	2.4	3.5	3.5
Total resources	5.5	14.1	15.1	14.4	14.9	14.8	10.9
Direct personnel, FTE	39	80	94	81	81	72	43
Biotechnology Development							
Operating	3.2	4.2	4.8	5.5	6.3	7.3	8.4
Total resources	3.2	4.2	4.8	5.5	6.3	7.3	8.4
Direct personnel, FTE	30	36	40	46	52	60	69
Biogeochemical Cycles and Carbon Dioxide							
Operating	1.1	1.8	1.9	2.0	2.1	2.0	2.0
Capital eqiupment		0.1	0.1	0.2	0.2	0.1	0.1
Construction			0.2	0.4	0.3		
Total resources	1.1	1.9	2.2	2.6	2.6	2.1	2.1
Direct personnel, FTE	14	16	16	16	17	17	17
Eastern Shale[d]							
Operating		0.2	0.8	2.0	2.5	1.0	1.0
Total resources		0.2	0.8	2.0	2.5	1.0	1.0
Direct personnel, FTE		3	8	10	10	8	8

Table B.4[a] (continued)

	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986
Environmental Geoscience Research							
Operating	1.5	2.0	2.5	2.8	2.9	3.0	3.0
Capital equipment	0.2	0.2	0.3	0.3	0.1	0.1	0.2
Total resources	1.7	2.2	2.8	3.1	3.0	3.1	3.2
Direct personnel, FTE	20	25	29	32	33	34	35
Life Sciences Instrumentation Development							
Operating	1.4	1.9	2.1	2.6	3.2	3.9	4.8
Total resources	1.4	1.9	2.1	2.6	3.2	3.9	4.8
Direct personnel, FTE	17	22	23	28	35	42	50
Reservoir Research and Water Resource Management							
Operating	0.6	1.0	1.2	1.2	1.2	1.0	1.0
Total resources	0.6	1.0	1.2	1.2	1.2	1.0	1.0
Direct personnel, FTE	5	6	7	7	7	7	7
Risk Assessment							
Operating	0.2	1.0	2.0	2.5	3.0	3.6	4.1
Total resources	0.2	1.0	2.0	2.5	3.0	3.6	4.1
Direct personnel, FTE	3	11	20	25	30	35	40
Toxicology							
Operating	0.5	1.0	4.5	4.5	6.0	6.0	8.0
Total resources	0.5	1.0	4.5	4.5	6.0	6.0	8.0
Direct personnel, FTE	6	10	25	25	35	50	50
Technical Assistance to the Office of Alcohol Fuels							
Operating	0.1	0.3	0.4	0.6	0.8	1.0	1.1
Total resources	0.1	0.3	0.4	0.6	0.8	1.0	1.1
Direct personnel, FTE	1	3	4	6	8	10	11
Biomass Conversion							
Operating	0.4	0.7	0.8	0.9	1.0	1.0	1.0
Total resources	0.4	0.7	0.8	0.9	1.0	1.0	1.0
Direct personnel, FTE	4	7	8	9	10	10	10
Materials Development for Conservation and Solar Technologies							
Operating		1.3	1.5	2.0	2.5	2.5	2.5
Subcontracting and procurement		1.0	1.2	1.5	1.8	1.8	1.8
Capital equipment		0.1	0.1	0.1	0.1	0.1	0.1
Total resources		1.4	1.6	2.1	2.6	2.6	2.6
Direct personnel, FTE		3	3	5	7	7	7
National District Heating Program							
Operating	0	1.9	2.3	3.2	3.2	2.3	1.9
Subcontracting and procurement	0	0.9	0.2	0.3	0.3	0.3	0.3
Capital equipment	*	*	*	*	*	*	*
Total resources	0	1.9	2.3	3.2	3.2	2.3	1.9
Direct personnel, FTE	0	9	10	12	12	10	10
Coal Land Leasing Study							
Operating	0.1	0.5	0.7	1.0	1.2	1.5	1.5
Total resources	0.1	0.5	0.7	1.0	1.2	1.5	1.5
Direct personnel, FTE	1	3	4	4	4	4	4

[a]Funding for FY 1980 through FY 1982 is in millions of current dollars and reflects an 8% escalation factor; funding for FY 1983 through FY 1986 is in constant 1982 dollars. An asterisk indicates funding of less than $50,000. Personnel numbers are in full-time equivalent (FTE) person-years.

[b]FY 1980 dollars and personnel are funded in current OBES and applied technology programs with an 80 to 20% distribution respectively. By FY 1986, it is expected that 60% of the High Temperature Materials Laboratory will be supported by the Office of Basic Energy Sciences, and 40% will be supported by applied technologies.

[c]Subcontracting here refers to the funding of research by individual scholars on the basis of responses to requests for proposals.

[d]Resource projections reflect some subcontracting from FY 1983 to FY 1986.

Table B.5. Major construction projects, funded or budgeted[a]

	Budget authority (millions of dollars)				
	FY 1980	FY 1981	FY 1982	FY 1983	TEC[b]
Funded construction					
Programatic (Pre-FY 1980 projects with FY 1980 funding)					
Advanced Fuel Recycle Integrated Equipment Test Facility (AG)	6.4				15.4[c]
Programmatic Facilities Funded FY 1980					
Upgrading Laboratories to Handle Hazardous Materials	1.5				1.5
Radioactive Waste Facilities Improvements, plant engineering and design	1.3				1.3
Core Flow Test Loop	4.3	5.5			9.8
PDX Neutral Beams	1.2				1.2
EBT Proof-of-Principle Experiments	2.0	5.4			7.4[d]
Large Coil Test Facility	7.5	6.5			14.0
Total for funded construction	24.2	17.4			50.6[a]
Facilities in ORNL budget submissions					
Programmatic facilities					
1981					
Radioactive Waste Facilities Improvements ($1.3 million funded in 1980)		20.0			20.0
Accelerator Improvements and Modifications—EN tandem		0.2			0.2
Accelerator Improvements and Modifications—HHIRF		0.2			0.2
Modernization of Laboratories for Study of Environmental Pollutants		2.0			2.0
1982					
Improvements to Fusion Energy Facilities			7.6		7.6
Cytological Laboratory			1.0		1.0
Toxic Substances Laboratory and Animal Facility			18.0		18.0
Mutagenic Screening and Testing Facility for Synthetic Fuels			2.0		2.0
Low-Level Waste Pilot Facility			25.0		25.0
Accelerator Improvements and Modifications—HHIRF			0.6		0.6
Accelerator Improvements and Modifications—EN tandem			0.4		0.4
High Temperature Materials Laboratory (HTML)			17.0		17.0
1983					
Hazardous Waste Incinerator Facility, Biology Area				1.3	1.3
Chemical Toxicology Facilities				15.0	15.0
CFRP Hot Experimental Facilities (Partial Title I and II—Engineering Only)				60.0	60.0
Waste Collection Tanks Project				17.0	17.0
Accelerator Improvements and Modifications—HHIRF				0.7	0.7
Superconducting ORIC Conversion—HHIRF				7.0	7.0

Table B.5[a] (continued)

	Budget authority (millions of dollars)				
	FY 1980	FY 1981	FY 1982	FY 1983	TEC[b]
General-Purpose Facilities (Multiprogram)					
1981					
Energy Systems Research Laboratory (ESRL)		2.0	7.0	6.0	15.0
Energy Monitoring and Control System		4.0			4.0
1982					
Upgrade ORNL Primary Substation			0.7	3.3	4.0
Water Pollution Control, Phase I			2.0	3.7	3.7
Main Sewage Plant Upgrade					
Coal Pile Runoff Treatment System					
1983					
Cooling Water Facilities Restoration				6.8	6.8
Upgrade Electrical Service for Research Facilities				5.5	5.5
Laboratory Emergency Response Center				7.0	7.0
Water Pollution Control, Phase II				3.3	3.3
Environmental and Effluent Monitoring Systems Upgrade				9.0	9.0
Materials Warehousing Upgrade				3.0	3.0
Improve Space Utilization				1.5	1.5
Primary Electrical Distribution System Restoration				2.7	2.7
Relocation of Bethel Valley Road and New Entranceway to ORNL				3.0	3.0
Utilities Upgrade, Phase II				15.0	15.0
Central Chilled Water System Restoration				2.4	2.4
Total for facilities and budget submissions		45.8	81.3	173.2	331.5
Total funded and budget submissions	24.2	45.8	81.3	173.2	331.5

[a]Projects having conceptual designs complete include escalation as prescribed by "Management of Construction Projects," Appendix AEC-6101. Estimated costs for other projects are shown in FY 1980 dollars without escalation.

[b]Total estimated cost in millions of dollars.

[c]$9.0 million funded prior to FY 1980.

[d]TEC unknown.

Table B.6. General plant projects[a]

	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986
Total GPP requirements	3.0[b]	4.0	4.5	6.0	6.0	6.0	6.0

[a]For method of escalation, see footnote to Table B.5.
[b]Includes $0.7 million specifically for waste management projects.

Table B.7. Phases of research and development analysis

	Operating budget outlay (in millions)[a]		
	FY 1980	FY 1981	FY 1982
Director of Energy Research			
Basic research	29	31	36
Applied research	29	31	36
Technology or exploratory development	22	24	28
Advanced development	12	14	16
Engineering development	2	3	3
Assistant Secretary for Nuclear Energy			
Basic research	4	4	4
Applied research	20	17	19
Technology or exploratory development	33	29	31
Advanced development	20	17	19
Engineering development	4	4	4
Assistant Secretary for the Environment			
Basic research	9	10	12
Applied research	15	16	19
Technology or exploratory development	3	3	3
Advanced development	3	3	4
Engineering development	1	1	1
Assistant Secretary for Conservation and Solar Energy			
Basic research	1	1	1
Applied research	4	6	6
Technology or exploratory development	5	9	9
Advanced development	8	14	14
Engineering development	3	5	5
Totals for these programs			
Basic research	43	46	53
Applied research	68	70	80
Technology or exploratory development	63	65	71
Advanced development	43	48	53
Engineering development	10	13	13

[a]Totals may differ slightly from those in the detailed tables because of rounding.

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