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1978 · 1984 Institutional Plan

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Oak Ridge National Laboratory
OPERATED BY UNION CARBIDE CORPORATION FOR THE U.S. DEPARTMENT OF ENERGY

December 1978

The information in this Plan was obtained with the cooperation of the professional staff of the Oak Ridge National Laboratory. Additional copies of the *Institutional Plan 1978-1984* may be obtained from the Program Planning and Analysis Office, Building 4500N, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37830. Telephone (615) 574-4168 (FTS 624-574-4168).

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1978·1984
Institutional Plan
Oak Ridge National Laboratory

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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

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Director's Overview

Director's Overview

Oak Ridge National Laboratory (ORNL) is operated by Union Carbide Corporation, Nuclear Division (UCC-ND), the Department of Energy's (DOE's) largest contractor organization, and from this derive several unique features: an industrial management perspective and contacts; a production capability; a multisite location with a variety of unique physical resources; very large engineering and computing support; and, together with Oak Ridge Operations, a successful background in managing immense construction and demonstration projects. ORNL is located in the Southeast, a fast-growing region showing unusual receptiveness to change not shared by other parts of the country. In particular, the co-location of ORNL and the Tennessee Valley Authority (TVA), with its management actively seeking cooperation in new developments and demonstrations, presents the Laboratory and DOE with a unique opportunity.

ORNL stresses the selection of important technologies that require applied development and engineering to take them to practical application but that also need strong support from more basic areas of the engineering, physical, environmental, and biological sciences. The simultaneous application of the applied sciences (such as materials, chemical engineering, measurement sciences, impact analysis, biological testing, and environmental assessment) is a crucial constituent of the ORNL approach.

The last few years have seen significant changes at ORNL: from a laboratory that was almost wholly nuclear to one that now includes large nonnuclear technologies. At the same time, the basic sciences supporting those technologies have also shifted their emphasis from nuclear to nonnuclear through changes of people, approaches, and management directions within the constraint of very limited growth.

Thus the main growth that has taken place at the Laboratory is in the technologies, but it is accompanied by major new emphases in the sciences. ORNL has also made major shifts in modes of operations, with deliberate attempts to increase its outreach in the Southeast, to subcontract a much larger portion of its research and development (R&D), to undertake program management for DOE in several crucial areas, and to use industrial points of view and capabilities through subcontracting and advisory groups.

I shall next discuss those major areas in which ORNL is currently involved and how we expect those areas to evolve into new undertakings and new emphases in order to be in accord with DOE's overall strategy for energy R&D.

Fission

Still the largest single R&D area at the Laboratory, fission R&D currently emphasizes (1) the studies and evaluations of nonproliferating fuel cycles for the Nonproliferation Alternative Systems Assessment Program (NASAP) and the International Nuclear Fuel Cycle Evaluation (INFCE) program, (2) the research and development of advanced fuel reprocessing techniques, (3) the evolution of remote fabrication techniques in accord with nonproliferating cycles, (4) the thorium cycles, and (5) the high-temperature gas-cooled reactor (HTGR) advanced converter. We are also involved with the management of our local waste and with some of the fundamental measurements pertaining to geological disposal. We are heavily involved in liquid-metal fast breeder reactor (LMFBR) R&D in special areas in support of various parts of the national program.

We expect a decline in the fission program overall, and we expect the emphases of the program to change over the next few years, with more concentration on nonproliferating fuel cycles, particularly advanced fuel reprocessing and remote refabrication; an increase in attention to low-level waste manage-

ment; a slight decline in the breeder support program; and possibly major declines in the advanced converter program and space programs.

Fossil

ORNL began its fossil program at a very low level with the Office of Coal Research five years ago. The coal program has now become one of the fastest growing programs at the Laboratory, encompassing areas of process evaluation, assessment of critical components by UCC-ND engineering, support to the solvent refined coal (SRC) process, research in atmospheric fluidized-bed industrial-sized boilers, and supporting research in environmental and energy sciences. The program has been beset by uncertainties in budgets and by an emphasis on the present generation of processes. We expect to assume a major role in the coal program. This would involve work with the Pittsburgh Energy Technology Center (PETC), the Morgantown Energy Technology Center (METC), and TVA, in supporting and troubleshooting for demonstration projects as they come on-line. We expect this area to require some acquisition of new people and talents in addition to the use of project and program expertise from the declining nuclear programs at the Laboratory and from other programs that are changing emphasis or time scale, such as the Carbide Cascade Improvement Program-Cascade Uprating Program (CIP-CUP), weapons programs, and, possibly, the centrifuge plant program. We expect in the near term to provide strong technical support to existing technologies but will place growing emphasis on the next generation of processes and plants and on the supporting materials, chemistry, biological testing, and environmental sciences.

Fusion

The current program at ORNL has emphasized tokamaks and the technologies supporting them, in particular the development of neutral beam heating, its demonstration on the Oak Ridge Tokamak (ORMAK) and on the Princeton Large Torus (PLT), and a leadership role in large superconducting coil testing. We expect the fusion program to grow only slightly but with a different mix, which we hope will include the construction of ELMO Bumpy Torus II and a superconducting long pulse tokamak to test the nearly steady-state features of tokamaks, with emphasis on engineering and technology. This ORNL program is in accordance with the recent Foster report that outlines the strategy of fusion development.

Conservation

Our contributions in the conservation area date back to the National Science Foundation funding of this area in the early 1970s. Support has been provided by the Department of Housing and Urban Development (HUD), the Federal Energy Administration (FEA), and the Energy Research and Development Administration (ERDA); currently, it is provided by two secretarial offices within DOE. Most recently, emphasis has been placed on managing technology outreach programs, particularly in residential and commercial appliances, thermal envelopes, innovative structures, thermal energy storage, and utility load management.

We expect the conservation program to continue to grow in funding and program management but to require relatively few additional in-house people. We expect this growth to include some expansions in industrial energy conservation, thermal storage, low-temperature cycles, cogenerative systems, and biotechnology systems.

Solar and Geothermal

ORNL is involved in the geothermal and solar programs for which the Laboratory has special talents or capabilities. In the woody biomass program, for example, our location in the Southeast and our strong ecological group may enable us to render special service, and we will continue to use our talents wherever they seem applicable.

Overall Resources and Issues

We expect manpower at ORNL to remain essentially constant over the next few years. Declines in nuclear work [including work for the Nuclear Regulatory Commission (NRC) and some other agencies] will be accompanied by growth in coal programs, and continuing shifts in the sciences will be accomplished within

essentially constant levels. We expect to continue using the very strong capabilities of UCC-ND in engineering support, in procurement, in computing, and in contracting. However, large new undertakings will require the addition of some special capabilities and some relaxation of recently imposed manpower ceilings.

Two important questions need early resolution. The most important is the response of DOE/ORNL to the invitation of David Freeman, chairman of the Board of Directors of TVA, to become a full participant in TVA's research and demonstration activities. We have already identified a number of major areas that could benefit from such a joint effort, including fluidized-bed combustion, coal cleaning, environmental monitoring and modeling, ammonia production from coal, and uranium extraction from phosphates. The second major question is the degree to which ORNL will be involved with program management in lead areas. Subcontracting has grown from $4 million to nearly $30 million in the last four years, and further increases are envisioned in the future as ORNL supports DOE through more program management.

ORNL hopes to be more closely involved in the major emphases within DOE, employing the unique advantages of UCC-ND and the region. We need to reach understandings with DOE on those specific areas of emphasis and how the shifts should take place. In particular, the changes that have occurred in the past and those envisioned for the future require a general purpose facility and much-enhanced general plant projects support.

A great step in this dialogue was the onsite review of the Laboratory's *Draft Institutional Plan* in August 1978, which brought together senior representatives of DOE and UCC-ND. It is sincerely hoped that this initiative will be repeated in future years.

Herman Postma
Director

1. Institutional Overview

1. Institutional Overview

Historic Development

From modest beginnings during the World War II Manhattan Project, when its principal mission was the production and chemical separation of the first gram quantities of plutonium, ORNL has emerged as a diversified center of energy research and development (R&D).

Although historically ORNL's major mission was in nuclear energy development, nonnuclear programs had been growing steadily for several years prior to the creation of the Energy Research and Development Administration (ERDA) in January 1975 and the establishment of the Department of Energy (DOE) in October 1977. Today these activities cover many fields of science and technology, with the focus chiefly on energy production and conservation and its environmental and health effects. In addition, ORNL does work sponsored by other federal agencies in areas such as cancer research, environmental assessment, and reactor safety. Staff specialities—once limited to the physical and life sciences, mathematics, and engineering—now extend into the social sciences and economics.

Figure 1 is a summary of personnel numbers at the Laboratory in recent years and shows the marked decline that took place between 1969 and 1974. Recent years have seen some increases in employment, but little increase is expected in the future.

About 80% of the $242 million operating budget for FY 1978 was provided by DOE. Work for other federal agencies, including the Nuclear Regulatory Commission (NRC), National Institutes of Health (NIH), National Science Foundation (NSF), Environmental Protection Agency (EPA), and Department of Defense (DOD), accounts for most of the remainder.

ORNL's evolution into a diversified laboratory was the result of several factors. New interpretations of the Atomic Energy Act allowed increased flexibility in the laws and regulations regarding the use of national laboratories. At the same time, ORNL's management sought to maintain a capable staff whose technical expertise could be applied in nonnuclear as well as nuclear areas to meet national needs.

1948-1960—Early History

ORNL had its beginning early in 1943 as the site for the first nuclear reactor to be operated at power. Soon after the war the Graphite Reactor was converted to produce radioactive isotopes for applications in agriculture, industry, medicine, and research, and for many of the postwar

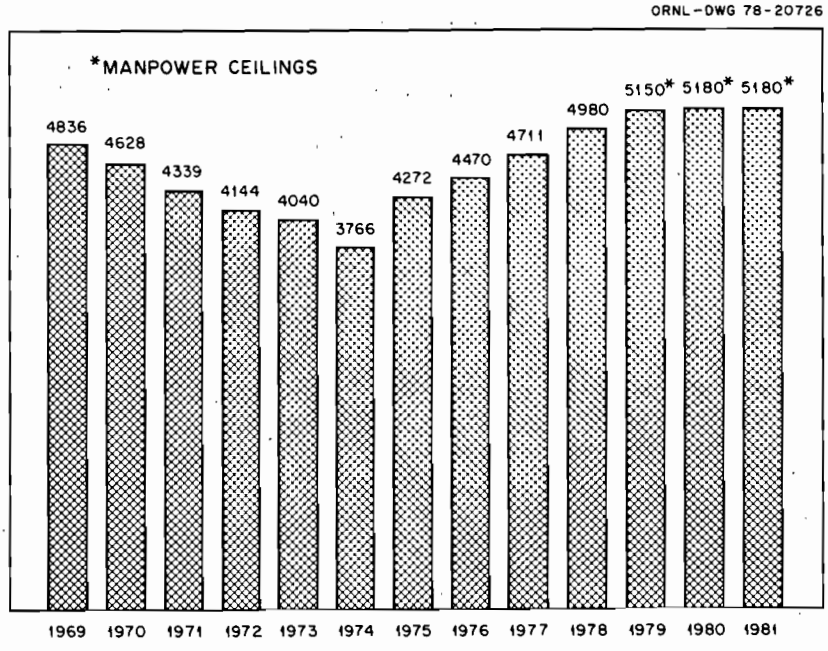


Fig. 1. Average ORNL employment, full-time equivalents. These figures include temporary and part-time staff but exclude UCC-ND engineering staff, computer sciences staff, and guests.

years isotope production was a key function of ORNL. More recently, as private industry has gained the capability for providing these services, the Laboratory's work with isotopes has largely been overshadowed by its broader involvement in energy R&D.

During the 1948–1960 period ORNL carried out various military and civilian reactor development projects for the Atomic Energy Commission (AEC). This included major work on the Aircraft Nuclear Propulsion Project, reactor types such as the Homogeneous Reactor Experiment, the development of the "swimming pool reactor," the Molten-Salt Reactor Experiment (the world's first to operate on ^{233}U fuel), and high-temperature gas-cooled concepts. In addition to the reactor development efforts, ORNL also did important biological radiation research, which has provided information of major significance in setting national radiation standards, and this work expanded into the environmental area.

During the mid-1950s the concept of nuclear fusion began to be investigated. Laboratory physicists who had experience in magnetic fields, ion sources, and accelerator physics from the calutron work at the Y-12 Plant began a technology development effort in magnetic mirror fusion. This effort grew slowly until 1970, when the Russian tokamak concept was adopted. Since then the fusion effort has grown rapidly at ORNL.

1960s—Broadening Research Areas

ORNL did little work for federal agencies other than the AEC during almost the first two decades of its existence. During the 1960s, however, there were three major areas in which the ORNL skill base began to be applied to nonnuclear research. These programs represented a modest departure from ORNL's strictly nuclear expertise to a more broad-based multidisciplinary approach to problems of important national interest. They were the desalting program, which included a basic water research program and a program aimed at developing nuclear-powered desalting plants; the expansion of ORNL's biology research, which involved a multimillion dollar effort between NIH and AEC in basic biological research; and the establishment of the Civil Defense Research Institute at ORNL in 1965 under agreement with the Office of Civil Defense.

In the late 1960s when environmental problems evolved as a national priority, ORNL's skill base included animal and plant ecology, chemical and radiation mutagenesis, and effluent control studies for nuclear power plants and other sources. ORNL was very interested in applying this expertise as a national resource for facing environmental problems. In 1967 the Atomic Energy Act was amended to authorize the AEC to assist other agencies in solving health and safety problems unconnected with nuclear missions, although no major impact of this new authority was reflected at the Laboratory until 1969 and 1970, when the first of several interagency agreements was entered into with the EPA and the NSF.

1970s—Recent Trends

In 1970 the NSF sponsored a study to investigate how ORNL could best contribute to the solution of environmental problems. General energy work began with energy conservation, energy demand analyses, and the economic and environmental aspects of the coal supply system. These early efforts included work on thermal insulation in residential construction and energy use in transportation. The environmental work explored two areas, the first of which was transport pathway modeling of mercury in several river systems in the southeastern United States. The second of these areas involved regional modeling, which initiated ORNL's social science program. The environmental information effort grew into an Environmental Information Systems Office, which later became part of the Information Center Complex. Today ORNL is a major national resource in technical information for such fields as basic physical sciences, engineering, biomedical and environmental sciences, energy, socioeconomic studies, and coal technology.

By the early 1970s nonnuclear energy was clearly emerging as a new national policy focus. In 1971 the AEC's authority was further extended to include research on "the preservation and enhancement of a viable environment by developing more efficient methods to meet the nation's energy needs." As a result of the National Environmental Policy Act of 1969 and the Calvert Cliffs decision, the AEC's environmental consciousness was abruptly raised, and the AEC was forced to undertake a large impact

assessment task. This movement paralleled ORNL's growing competence in environmental research. An Ecological Sciences Division had been formed in 1970, and because of ORNL's ability to mobilize groups to work on this multidisciplinary task, the Laboratory was assigned a significant share of the AEC's environmental impact work.

By 1971 ORNL had about $2 million in R&D concerned with nonnuclear energy in addition to its large biomedical and ecological research efforts. Examples of ORNL studies included impacts of central electrical plants, development of methods of absorbing sulfur dioxide (SO_2) from fossil fuels, and design of urban power systems. These were mainly sponsored by the NSF Research Applied to National Needs (RANN) Program and the AEC. At that time ORNL saw coal studies as an area of major interest. As part of an early long-range planning effort, coal hydrogenation had been explored in the early 1960s during a series of advanced energy seminars at ORNL. Interest in coal research was expressed at that time, but no funding had been available. However, in 1971 ORNL was asked by the AEC to look at SO_2 emissions from the Clifty Creek (Ohio) Power Plant to see if something could be done to meet Ohio's new SO_2 regulations.

The 1973 oil embargo provided additional impetus for funding coal research, and in 1974 ORNL became involved with the Office of Coal Research (a project then classified as work for others) in a joint effort with the AEC. Also in 1974, in order to be in a better position to administer nonnuclear energy programs, ORNL reorganized its internal structure and appointed an associate director for nonnuclear energy R&D.

In 1975, when ERDA was created, much of ORNL's energy work that had been work for other federal agencies became work for ERDA. During this period ORNL continued to build a broad technical expertise that could be used to support a variety of programs. The newly formed Department of Energy brings together many elements of the nation's energy policy that had been scattered among several agencies, and ORNL management expects to continue to work with these agencies in a coherent and effective manner to carry out energy R&D.

Location and Administration

The Laboratory occupies a wooded, 1200-ha (2900-acre) site approximately 16 km (10 miles) from downtown Oak Ridge, Tennessee (population 29,000). It is one of four major production and research facilities—three of which are located in Oak Ridge—that are operated for DOE by Union Carbide Corporation, Nuclear Division (UCC-ND). The others are the Oak Ridge and Paducah (Kentucky) gaseous diffusion plants and the Oak Ridge Y-12 Plant which, although primarily a national defense installation, also houses one-fifth of the ORNL facilities.

Knoxville (population 180,000) is about 50 km (30 miles) from Oak Ridge. It is the home of the University of Tennessee (UT), with about 27,000 students, and the central administrative office of the Tennessee Valley Authority (TVA). Also in the Oak Ridge area are the UT-DOE Comparative Animal Research Laboratory (CARL) and the Oak Ridge Associated Universities (ORAU). ORAU administers a number of cooperative programs with universities, through which faculty members and students participate in Laboratory programs for various periods of time.

The Oak Ridge Operations Office (ORO) of DOE has existed under various federal organizations since early in World War II when it was established for uranium isotope separation and for pilot plant plutonium production and separation. Currently, the office administers and manages DOE operating and construction programs funded at nearly $2 billion per year. These programs include field management of DOE uranium enrichment operations and capital programs, weapons production in support of national defense, and execution of various basic and applied energy research, development, and demonstration programs and projects. The contractor organizations responsible to ORO employ a staff of 27,000 and include the four facilities operated by UCC-ND, one of which is ORNL.

ORO performs all federal and DOE contract administration functions for ORNL operations, including funding authorizations, subcontract approval, management of large ORNL capital projects, and various reviews and audits. A multitude of DOE and other federal organizations fund programs at ORNL, and ORO also

provides the single point of comprehensive DOE programmatic interface, reviews the programs to be proposed, coordinates activities, and evaluates and supports the related multiprogram needs. Finally, ORO directly manages certain DOE R&D programs and projects, such as nuclear fuel reprocessing, waste studies, and SRC demonstrations: ORNL and other parts of UCC-ND support ORO in these efforts and also participate in the programs.

These various interfaces involve very close ORNL-ORO working relationships, joint efforts on program and budget planning, setting ORNL priorities, and resource availability.

Staff and Technical Capabilities

ORNL is one of the largest scientific and technological multiprogram laboratories in the world. One of ORNL's strengths is the diversity of the technical staff. Forty percent of the personnel are college graduates, including more than 900 with the Ph.D. degree. There are almost 1000 engineers, primarily chemical, electrical, and mechanical; about 140 mathematicians; 800 physical scientists, and more than 300 biomedical and environmental scientists. There is also a growing staff of behavioral and social scientists, which now numbers more than 80.

The Laboratory population also includes 400 to 500 guest scientists on assignment for periods ranging from a few months to a year or more: about 100 of them represent foreign laboratories or research centers. College and university visitors under a variety of research participation and advanced study programs number about 1200 annually; most of them spend between a few days and several months at the Laboratory. This number includes participants in ORNL's University Relations Programs as well as ORAU contractors and ORNL consultants from the university community. In addition to ORNL technical staff and guests, the UCC-ND central organizations that serve all three installations have a general engineering staff of 1275 and a computer sciences staff of 750 that are available to contribute to ORNL research efforts.

Major Facilities

In support of the Laboratory's programs there are facilities and equipment worth $480 million. Special facilities at ORNL include:

- Several nuclear reactors ranging from the High Flux Isotope Reactor (HFIR), which produces the world's highest neutron flux, to the Tower Shielding Facility, a reactor that can be suspended in the air for studies of radiation shielding.
- Six particle accelerators engaged in nuclear and atomic physics research, including an advanced electron linear accelerator (ORELA), designed to produce intense short pulses of neutrons for high-precision neutron cross-section measurements, and the isochronous cyclotron (ORIC), which has special capability for accelerating heavy ions.
- The world's largest electromagnetic stable isotope separation facility.
- A variety of chemical processing development facilities, including the Transuranium Processing Plant (TRU) for separating californium and other heavy elements and the nearly completed Thorium-Uranium Recycle Facility (TURF) for remotely processing reactor fuels.
- Two major toroidal fusion energy devices—the Impurity Study Experiment (ISX) and the ELMO Bumpy Torus (EBT)—as well as a variety of facilities for the development of neutral particle beams and superconducting magnets.
- The Large Coil Test Facility (LCTF), which will be used for testing U.S.- and foreign-built 2.5 × 3.5 m test coils for fusion devices.
- An extensive and varied biological laboratory complex, including a small animal facility that can house an experimental mouse population of about 400,000.
- The Oak Ridge Reservation, 15,000 ha (38,000 acres) of DOE-owned land of which 5,000 ha (12,000 acres) is currently assigned for long-term ecological experiments, including the Walker Branch Watershed Facility, a well-calibrated natural study area used to investigate the input, transport, fate, and effects of chemical pollutants in a forest ecosystem.
- The Aquatic Ecology Laboratory for studying the effects of pollutants on fish and other aquatic life.

- Extensive materials development facilities, including large laboratory-scale capabilities for purifying, casting, forming, and testing both metals and ceramics.
- A large diversified research fabrication and shop capability for the Nuclear Division complex.
- Comprehensive Nuclear Division computing hardware for general use, consisting of two large batch high-speed computers (IBM 360/91 and 360/195) and two major time-sharing units (IBM 360/75 and DEC PDP-10) as well as many smaller dedicated computing systems throughout the Laboratory. A new leased computer is expected in June 1979.
- Technical Information Processing facilities that include a major scientific library, computerized on-line access to the major bibliographic data bases in science and technology, and 23 specialized technical information centers that provide rapid state-of-the-art information in a wide variety of fields including physical, engineering, life, and social sciences.
- The Holifield Heavy Ion Research Facility, which, when completed in 1979, will house the world's highest energy tandem electrostatic accelerator and will also incorporate the Laboratory's present accelerator, the ORIC.
- The Environmental Sciences Laboratory, which is the first and only laboratory in the entire DOE complex designed specifically for environmental sciences research.

Institutional Relationships

Commercialization and Technology Utilization

A diverse research facility such as ORNL can interface with industry in several ways. For instance, the Laboratory can permit industry to refine and market equipment that was originally developed during research and that also has commercial value. The Laboratory can also encourage the involvement of private companies in the early stages of design and development of "big" technology. For some years ORNL has been involved successfully in these types of interactions and has attempted to establish working relationships with industry at the earliest possible development stage of new technology. An example of successful commercialization of ORNL research is the zonal gradient centrifuge that is in wide use in clinical laboratories around the world.

ORNL continues to be closely involved with industry in big technology development, such as development of large superconducting magnets. In the near future, ORNL will become involved with large development projects in the areas of nuclear fuel cycles, fossil fuel use, and magnetic fusion energy. Examples of commercialization activities with small-scale technology include ideas such as the Annual Cycle Energy System (ACES) concept, ANFLOW (an anaerobic, upflow, packed-bed bioreactor), and applications of end-use conservation.

In addition to the programmatic efforts that form the basis of technology transfer, the Laboratory also maintains an active program of public awareness of Laboratory developments through press releases and through the publication of technology utilization bulletins. Special workshops and conferences are held under the technology utilization and commercialization program to discuss Laboratory work and to identify the needs and concerns of industry or other user groups, as well as the barriers to their use of such technologies.

As a further measure of the industrial relevance of the Laboratory's work, ORNL has received 10 IR-100 awards during the last three years.

University Relations

ORNL has had a long history of cooperation with universities in education and research programs. The Laboratory's primary objective in its university cooperative research and training is to help assure an adequate supply of manpower for the accomplishment of energy R&D programs through activities that complement those of academic institutions. These programs, as well as providing unique opportunities for cooperative research with the university community, fit within the Laboratory's programmatic goals and simultaneously effect a transfer of scientific and technical information. In FY 1978 ORNL had programs (some of them carried out in cooperation with ORAU) involving 255 undergraduates, 157 graduate students, 48 postdoctoral fellows, and 64 visiting faculty. There are also user groups making use of the major research facilities at ORNL.

Cooperation with Energy Utilities

The Electric Power Research Institute (EPRI) is an organization of more than 500 public and private utilities interested in a national electric power research and development program. There is considerable overlap of interests between EPRI and DOE. In order that ORNL can most effectively work with EPRI on areas of mutual interest consistent with ORNL's mission, close contact is maintained. This effort emphasizes active information exchange as well as carrying out some direct R&D work for EPRI.

A much closer relationship with TVA is also developing. ORNL, ORO, and TVA have identified many areas for cooperation in the nuclear and nonnuclear energy fields.

Program Work

Basic Physical Sciences

The basic physical sciences program (which consists primarily of chemical, materials, and nuclear sciences) has been held at a roughly constant level during the last five years. During that period, however, the emphasis has shifted substantially away from nuclear-related work, multidirectional research, and the operation of facilities and toward a greater emphasis on nonnuclear programs (Fig. 2) that are related to problems in conservation, coal conversion technology, solar photovoltaic devices, and first-wall design in fusion devices, etc. This trend away from nuclear work is expected to continue, but at a slower pace. There will also be a greater involvement of outside users (especially from universities) with the research facilities, including the new Holifield Heavy Ion Laboratory, various neutron scattering facilities, and other unique equipment in the chemical, materials, and nuclear sciences.

Basic Life Sciences

In this field too, there has been a marked decline in nuclear-related work, accompanied by a marked increase in the effort devoted to research related to nonnuclear energy sources or not directly aimed at specific energy systems (Fig. 3). Important activities that will be under way during this planning period include the Gasifiers in Industry Program and a number of collaborative programs with TVA.

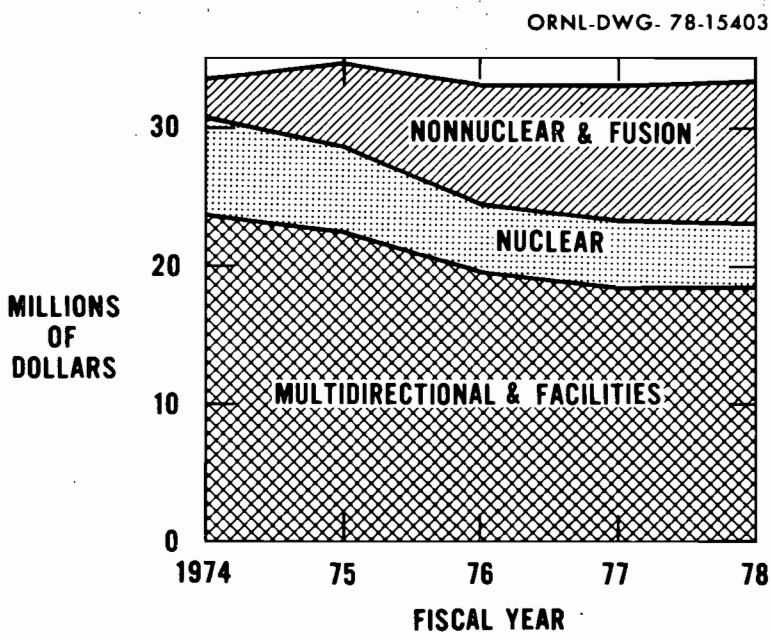


Fig. 2. Basic physical science funding (constant 1978 dollars). The emphasis has changed from nuclear- to nonnuclear-related activities.

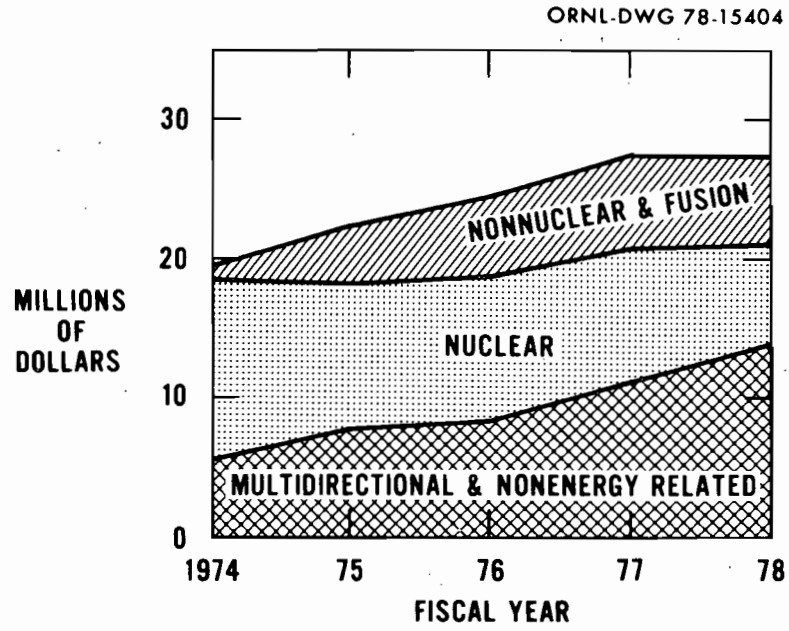


Fig. 3. Basic life science funding (constant 1978 dollars). The emphasis has changed from nuclear- toward nonnuclear-related activities.

Fossil Energy

Fossil energy activities at ORNL, primarily related to coal, will continue to grow in size and importance, and the Laboratory will work especially with the Energy Technology Centers [Pittsburgh Energy Technology Center (PETC) and Morgantown Energy Technology Center (METC)] and with TVA. Much more basic knowledge is needed about coal, coal conversion, and utilization processes and materials for use in coal facilities, and ORNL expects to be able to make major contributions in this area.

There is a need for an advanced look at the equipment requirements and testing of equipment for coal conversion plants, although this need not be done at one centralized facility. Atmospheric fluidized-bed combustion has significant potential in relatively small-scale industrial applications as well as in utilities, and the ORNL effort in this area is concentrating on cogeneration units for industry. ORNL is also providing increased R&D support to TVA for the development and demonstration of utility applications of atmospheric fluidized-bed combustion. The magnetic dry coal cleaning system being developed by ORNL shows great promise for removing inorganic sulfur.

The health and environmental testing of coal conversion and oil shale products and wastes is a most important area of research, and more funding is needed in this area. In general, it is anticipated that there will be greater international collaboration in coal research and that there will be more joint DOE/industry ventures arising during this planning period.

Solar and Geothermal

ORNL has a limited involvement in the solar and geothermal technologies although important work is being done in the basic sciences (including recent work on laser annealing of photovoltaic materials, which is a very important advance that is now being vigorously pursued by Bell Labs and IBM) and in the woody biomass program. ORNL's present outreach activities in solar technology will cease now that the regional centers have been established. Several transfers of responsibility to the Solar Energy Research Institute (SERI) are under way. In the geo-

thermal area, the Laboratory's involvement is limited to heat recovery and environmental aspects.

Fission

ORNL expects to continue to be involved in work on the breeder reactor program and to have a leading role in fuel cycle development, particularly in reprocessing. Generic breeder development work will be emphasized. The Laboratory proposes work on uranium resources (e.g., uranium from phosphates) to extend the resource available for light-water reactors (LWRs). The Laboratory will be involved in the development of nonproliferating fuels for research and test reactors.

Fusion

There have recently been substantial advances in magnetic fusion R&D due, in part, to the neutral beam technology developed by ORNL. At the same time, DOE intends to continue to explore a range of magnetic fusion devices, in addition to the tokamak configuration. The Laboratory proposes a substantial role in EBT work, in the preconceptual design of The Next Step/Engineering Test Facility (TNS/ETF), in tokamak R&D, in materials development, and in the continued technology development of superconducting coils and neutral beams.

Conservation

Continued growth is expected in the conservation area. ORNL manages a number of conservation programs for DOE and makes extensive use of subcontracting. This is an R&D field with great potential for energy savings in the short term and one that lends itself to rapid commercialization of research results.

Solid Waste Disposal

ORNL believes that R&D should address some problems relating to the Resource Conservation and Recovery Act now, before it is too late. The Laboratory is working on the recovery of resources (e.g., aluminum and iron) from fly ash: a process is being developed that may be an economically competitive source of these materials and that, at the same time, converts the fly ash to an inert waste.

Work for Others

Currently, about 15% of the Laboratory's research funding ($36 million in FY 1978) and much of the isotope sales receipts ($6 million) come from other federal agencies and from industry. The largest sponsor is the NRC which, in 1978, provided about $22 million or 10% of ORNL's operating budget. It is expected that the current NRC work will decline somewhat during this planning period but that there will be some increase in funding from other sponsoring agencies, especially the Department of Health, Education, and Welfare, that may provide for the continuation of some basic biological programs being dropped by DOE.

In addition, we expect much closer collaboration and more joint programs with TVA as they move further into their role as a demonstrator of new concepts and systems.

Subcontracting

ORNL only becomes involved in management of subcontracting when a strong technical input is required and when the Laboratory also carries out some (15–50%) of the work in-house. Subcontracting can be an effective means of technology transfer and is an important mechanism for the Laboratory to respond to DOE programmatic needs within manpower constraints. It has grown from $4 million in 1975 to $29 million in 1978.

Lead Mission Assignments

Table 1 lists the areas in which ORNL currently has lead mission assignments and the areas in which a lead role is proposed by ORNL. Some of the missions embody long-standing roles of this laboratory (for example, HTGR Fuel Recycle Development; Advanced Fuel Recycle Program; Superconducting Magnet Development for Toroidal Confinement Systems; Integrated Energy Assessments; and Health and

Environmental Effects of Synthetic Fuels). Others are fairly new, in whole or in part.

The allocation of lead mission assignments by DOE has not yet been finalized, and Table 1 also indicates those missions that were discussed by the Assistant Secretary for Energy Technology during his review of the ORNL *Draft Institutional Plan.* Appendix C describes the missions that this Laboratory has or is seeking. It is based on material recently prepared at the request of DOE Headquarters to aid in their discussions of these assignments.

Table 1. ORNL lead mission assignments

Current
Consolidated Fuel Recycle-Reprocessing Program[a,b] (Lead Mission with ORO)
Ecosystem Modeling for Regional Environmental Resource Analysis
Electric Utility Load Management and New Technology Integration[b]
Health and Environmental Effects of Synthetic Fossil Fuel Technologies
Low-Temperature Energy Storage Systems
Residential and Commercial Conservation in Buildings and Appliances
Proposed by ORNL
Effects of Atmospheric CO_2 on the Terrestrial Biosphere
ELMO Bumpy Torus Research and Development
Environmental Impact Assessment for Fossil, Solar, and Geothermal Energy[b]
Environmental Impact Assessment for Nuclear Fuel Cycle and Waste Management
Fossil Energy Materials Technology Center[b]
Instrumentation for Fission Energy Systems
Low-Level Radioactive Waste Management Program (Associate Lead Mission with EG&G at Idaho National Engineering Laboratory)
Materials and Structures Technology Center[b]
Neutral Beam Injection Systems for Fusion Devices
Nuclear Energy Assessments
Nuclear Standards Program[b]
Policy Analysis (Integrated Nuclear Assessment, Siting, and Water Availability)
Shallow Land Burial (Nonnuclear)
Superconducting Coils for Toroidal Confinement Systems
The Next Step/Engineering Test Facility (Planning and Preconceptual Design)
Waste Heat Utilization

[a] Includes the former Advanced Fuel Recycle and High-Temperature Gas-Cooled Reactor programs.

[b] These items were discussed, in whole or in part, by the Assistant Secretary for Energy Technology in his consideration of decentralization during the review of the national laboratories' draft institutional plans. Others that were discussed are shown on p. 67.

Summary of Laboratory resources[a]

	'78	'79	'80	'81	'82	'83	'84
			Funding				
Funding from DOE[b]	202.4	216.4	235.9	250.7	253.7	253.8	256.7
Non-DOE funding[c]	39.5	45.3	45.4	44.0	41.0	40.0	39.1
Total operating costs	241.9	261.7	281.3	294.7	294.7	293.8	295.8
(Including indirect expenditures[d])	(42.1)	(45.1)	(48.2)	(48.2)	(48.2)	(48.2)	(48.2)
Capital equipment	20.5	20.5	43.9	34.2	32.1	29.5	30.4
			Personnel				
Energy technology	855	804	819	869	890	889	901
Energy research	453	418	418	418	418	415	413
Environment	378	393	393	406	415	424	432
Conservation and solar	39	48	50	55	56	58	59
Other DOE[b]	280	137	125	109	95	93	92
NRC	194	222	210	191	173	157	140
Other non-DOE	217	230	229	227	228	233	238
Subtotal,							
Direct FTE	2416	2252	2244	2275	2275	2269	2275
Indirect FTE	2564	2898	2936	2905	2905	2911	2905
Total	4980	5150	5180	5180	5180	5180	5180

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] Including work for other DOE installations.

[c] Including sale of isotopes and isotope services.

[d] General and Administrative (G&A) and General Plant Services (GPS).

2. Program Activity

2. Program Activity

Assistant Secretary for Energy Technology

Approximately half of the Laboratory's operating funds are for programs carried out on behalf of the Assistant Secretary for Energy Technology (ASET). They include three of the largest programs at the Laboratory: Fission, Magnetic Fusion, and Fossil Energy. In addition, part of the conservation work is currently funded by ASET.

It is expected that the fossil energy program will continue to grow in size and importance and that there will be close collaboration with the Energy Technology Centers and with the Tennessee Valley Authority (TVA). The expansion of this program will require the Laboratory to take on new, experienced staff as well as to transfer people from some of the declining nuclear areas. In addition, a new general purpose facility (the Energy Systems Research Laboratory) is needed if this, and other, programs are to be pursued most effectively.

Magnetic fusion energy (MFE) research and development (R&D) is currently in a very exciting phase, partly because of the recent advances made in neutral beam heating. At the same time, the recent Foster study sponsored by the Department of Energy (DOE) recommends that the Department continue to explore a range of technical approaches to the problems of MFE. ORNL proposes to continue its leading role in the ELMO Bumpy Torus (EBT) work and to play a substantial role in the preconceptual design of The Next Step/Engineering Test Facility (TNS/ETF). We also expect to continue work in tokamak R&D and in the technology development and testing of neutral beams and superconducting coils. Substantially increased capital funding is badly needed for upgrading and renovating the very old facilities that house this program.

In fission energy, ORNL expects to be involved in the development of nonproliferating fuels for research and test reactors. We expect to continue work on the breeder reactor program and the nuclear fuel cycle, placing strong emphasis on generic breeder development. Work on uranium resources (such as uranium from phosphates) is proposed to extend the fuel resource available for light-water reactors (LWRs). The program on space applications is expected to decline.

The major resource projections are summarized in the following table.

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Summary of resources*—Assistant Secretary for Energy Technology

	'78	'79	'80	'81	'82	'83	'84
			Operating				
Liquefaction (AA 02)							
Direct FTE	13	20	14	19	23	26	28
B/O[a]	1.0	1.8	2.7	3.8	5.0	5.2	5.7
B/A[b]	2.2	1.3	3.0	4.2	5.0	5.4	5.9
Subcontracting and procurement	0.2	0.2	1.0	2.0	2.1	2.1	2.3
Gasification (AA 03)							
Direct FTE	33	34	32	31	31	30	32
B/O	3.9	4.2	5.3	5.6	5.6	5.6	5.9
B/A	5.3	3.9	5.4	5.6	5.6	5.6	5.6
Subcontracting and procurement	1.1	0.9	2.3	2.7	2.9	3.2	3.3
Advanced power systems (AA 04)							
Direct FTE	5	5	6	6	6	6	7
B/O	0.5	0.5	0.7	0.8	0.7	0.7	0.7
B/A	0.7	0.6	0.7	0.8	0.7	0.7	0.7
Subcontracting and procurement	0	0.1	0.1	0.1	0.1	0.1	0.1

Summary of resources —Assistant Secretary for Energy Technology (continued)

	'78	'79	'80	'81	'82	'83	'84
			Operating				
Direct combustion (AA 05)							
Direct FTE	9	21	26	30	32	33	35
B/O	0.7	3.3	6.3	7.7	8.2	8.5	9.0
B/A	3.6	2.3	6.7	7.9	8.2	8.6	9.5
Subcontracting and procurement	0.1	1.2	2.8	3.9	4.1	4.2	4.4
Advanced research and supporting technology (AA 06)							
Direct FTE	13	38	48	51	53	56	58
B/O	1.2	4.5	8.0	8.6	9.0	10.0	10.7
B/A	1.5	6.7	8.1	8.7	9.3	10.2	10.8
Subcontracting and procurement	0.2	0.2	3.2	3.6	4.2	4.7	5.2
Enhanced oil recovery (AB 01)							
Direct FTE	9	9	10	10	10	10	10
B/O	0.5	0.7	1.0	1.0	1.0	1.0	1.0
B/A	0.5	1.0	1.0	1.0	1.0	1.0	1.0
Subcontracting and procurement	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Solar technology support and utilization (AD 02)							
Direct FTE	2	8	10	10	10	10	10
B/O	0.4	1.0	1.0	1.0	1.0	1.0	1.0
B/A	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Subcontracting and procurement	0.2	0.6	0.5	0.5	0.5	0.5	0.5
Solar electric applications (AD 03)							
Direct FTE	15	14	14	16	16	16	16
B/O	0.9	2.0	2.3	2.6	2.6	2.6	2.6
B/A	1.3	2.6	2.4	2.6	2.6	2.6	2.6
Subcontracting and procurement	0.2	0.6	0.7	0.7	0.7	0.7	0.7
Fuels from woody biomass (AJ 01)							
Direct FTE	2	2	2	2	2	2	2
B/O	0.1	0.2	0.2	0.2	0.2	0.2	0.2
B/A	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Subcontracting and procurement	0	0	0	0	0	0	0
Geothermal engineering R&D (AE 01)							
Direct FTE	7	5	5	5	5	5	5
B/O	0.6	0.4	0.5	0.5	0.5	0.5	0.5
B/A	0.8	0.4	0.5	0.5	0.5	0.5	0.5
Subcontracting and procurement	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Environmental control and institutional studies (AE 06)							
Direct FTE	2	3	3	3	3	3	3
B/O	0.2	0.3	0.3	0.3	0.3	0.3	0.3
B/A	0.3	0.4	0.3	0.3	0.3	0.3	0.3
Subcontracting and procurement	0.1	0	0	0	0	0	0
Confinement systems (AF 01 01)							
Direct FTE	55	31	31	31	31	31	31[c]
B/O	14.1	11.7[d]	8.2	8.5	8.9	8.9	8.9
B/A	18.6	9.6	8.3	8.6	9.5	9.2	9.2
Subcontracting and procurement	3.0	2.1	0.7	0.8	1.2	1.2	1.2

Summary of resources —Assistant Secretary for Energy Technology (continued)

	'78	'79	'80	'81	'82	'83	'84
		Operating					
Development and technology (AF 01 02)							
Direct FTE	69	81	86	90	89	86	85
B/O	16.9	20.4[d]	23.8	25.4	19.6	16.0	15.0
B/A	27.7	21.7	24.3	23.5	18.7	15.9	15.0
Subcontracting and procurement	6.6	7.3	11.3	8.5	8.5	7.0	7.0
Applied plasma physics (AF 01 03)							
Direct FTE	55	55	57	57	57	57	57
B/O	5.8	5.6[d]	5.8	6.0	6.0	6.0	6.0
B/A	6.2	5.7	5.7	5.7	5.7	5.7	5.7
Subcontracting and procurement	0.2	0.3	0.4	0.6	0.6	0.6	0.6
Conservation and utilities (C1 01)							
Direct FTE	8	7	10	11	11	11	11
B/O	1.1	3.9	5.4	5.5	5.5	5.5	5.5
B/A	5.0	5.6	5.5	5.5	5.5	5.5	5.5
Subcontracting and procurement	0.5	3.1	4.4	4.4	4.4	4.4	4.4
Conservation, multisector (C8)							
Direct FTE	7	10	11	13	14	15	16
B/O	1.7	2.5	3.5	4.4	4.3	4.4	4.6
B/A	2.8	5.0	4.8	4.4	4.3	4.4	4.6
Subcontracting and procurement	1.0	1.4	2.5	3.2	3.0	3.0	3.1
Support for nuclear fuel cycles (AG 02 01)							
Direct FTE	200	148	148	151	157	164	174
B/O	23.6	19.2[e]	18.0[e]	20.0[e]	26.0[e]	30.0[e]	32.0[e]
B/A	34.9	17.7	17.6	20.7	28.0	31.4	32.7
Subcontracting and procurement	6.3	5.0	4.5	8.6	9.3	11.7	12.7
Commercial waste management (AG 02 02)							
Direct FTE	33	28	19	19	19	20	19
B/O	3.1	3.4	2.0	2.0	2.0	2.0	2.0
B/A	5.3	3.5	1.5	2.0	2.0	2.0	2.0
Subcontracting and procurement	0.7	1.0	0.2	0.2	0.2	0.1	0.2
Breeder reactor technology (AG 03 04)							
Direct FTE	124	109	109	115	115	115	115
B/O	12.0	10.8	11.5	13.0	13.0	13.0	13.0
B/A	16.4	10.4	11.7	13.5	13.0	13.0	13.0
Subcontracting and procurement	1.5	0.5	0.6	1.0	1.0	1.0	1.0
Gas-cooled thermal reactors (AG 04 02)							
Direct FTE	40	31	37	48	50	46	46
B/O	4.4	4.0	4.5	5.5	6.0	5.5	5.5
B/A	5.9	3.8	5.3	6.9	6.5	5.8	6.0
Subcontracting and procurement	0.5	0.2	0.3	0.5	0.3	0.2	0.2
Gas-cooled fast breeder reactors (AG 04 03)							
Direct FTE	20	23	22	30	38	32	32
B/O	3.1	4.0	6.0	7.0	6.0	5.0	5.0
B/A	6.4	5.8	6.3	7.3	7.0	5.7	6.0
Subcontracting and procurement	0.6	2.7	3.7	3.0	1.3	0.9	0.8

Summary of resources —Assistant Secretary for Energy Technology (continued)

	'78	'79	'80	'81	'82	'83	'84
Operating							
Technology development and special projects (AG 04 06)							
Direct FTE	17	2	2	2	2	2	
B/O	1.3	0.2	0.2	0.2	0.2	0.2	
B/A	1.8	0.2	0.2	0.2	0.2	0.2	
Subcontracting and procurement	0.1						
Space applications (AG 04 07)							
Direct FTE	15	16	11	11	11	11	11
B/O	1.3	1.7	1.2	1.2	1.2	1.2	1.2
B/A	2.2	1.8	1.6	1.5	1.3	1.3	1.3
Subcontracting and procurement	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Nuclear energy assessments (AG 04 09)							
Direct FTE	44	36	25	26	23	25	27
B/O	5.9	5.4	4.0	4.0	4.0	4.0	4.2
B/A	9.2	5.2	3.5	4.0	4.0	4.0	4.0
Subcontracting and procurement	2.7	2.3	1.4	1.3	1.5	1.5	1.5
Special materials (JM 03 01)							
Direct FTE	17	13	20	25	25	16	12
B/O	1.6	2.4	3.3	5.3	5.4	3.2	1.5
B/A	1.9	1.5	2.0	2.2	1.4	1.6	1.5
Subcontracting and procurement	0.2	1.2	1.3	2.8	2.6	1.5	0.2
Defense waste management (JM 03 03)							
Direct FTE	41	55	61	57	57	61	59
B/O	4.1	5.8	7.5	6.5	6.5	6.5	6.5
B/A	5.5	6.3	6.4	6.3	6.3	6.3	6.3
Subcontracting and procurement	0.7	0.9	2.5	1.2	1.2	1.2	0.7
Total operating							
Direct FTE	855	804	819	869	890	889	901
B/O	110.0	119.9	133.2	146.6	148.7	147.0	148.5
B/A	167.2	124.2	134.0	145.1	147.8	148.1	151.0
Subcontracting and procurement	27.0	32.2	44.8	50.0	50.1	50.3	50.6
Capital equipment B/A							
Liquefaction (AA 02)		0.2	0.7	0.9	1.0	0.9	0.9
Gasification (AA 03)	0.1	0.3	1.7	1.5	1.0	0.9	0.9
Advanced power systems (AA 04)	0.1			0.1	0.1	0.1	0.1
Direct combustion (AA 05)	0.1	0.3	0.5	0.6	0.6	0.5	0.5
Advanced research and supporting technology (AA 06)		0.4	0.8	1.0	1.0	0.9	0.9
Enhanced oil recovery (AB 01)		0.1	0.1	0.1	0.1	0.1	0.1
Solar electric applications (AD 03)		0.1	0.1	0.1	0.1	0.1	0.1
Confinement systems (AF 01 01)	1.5	1.2	1.5	2.5	3.0	2.0	2.2
Development and technology (AF 01 02)	3.9	4.9	3.9	3.0	3.5	4.0	4.3

Summary of resources —Assistant Secretary for Energy Technology (continued)

	'78	'79	'80	'81	'82	'83	'84
	Capital equipment B/A						
Applied plasma physics (AF 01 03)	0.2	0.4	15.8	4.0	2.5	1.5	1.3
Conservation, utilities (C1)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Conservation, multisector (C8)		0.2	0.2	0.2	0.2	0.2	0.2
Support of nuclear fuel cycle (AG 02 01)	4.9	2.4	5.8	6.0	5.0	4.0	4.0
Commercial waste management (AG 02 02)	0.5	0.3	0.2	0.3	0.4	0.2	0.4
Breeder reactor technology (AG 03)	1.1	1.1	1.3	1.3	1.3	1.5	1.5
Gas-cooled thermal reactor (AG 04 02)	0.3	1.0	0.7	0.5	0.8	0.7	0.7
Gas-cooled fast breeder (AG 04 03)	0.6	0.5	0.7	1.5	0.7	0.5	0.5
Technology development and special projects (AG 04 06)	0.2		0.1				
Space applications (AG 04 07)	0.2	0.2	0.1	0.2	0.1	0.1	0.1
Nuclear energy assessments (AG 04 09)		0.1	0.1	0.1	0.1	0.1	0.1
Special materials production (JM 03 01)	0	0.1	0.2	0.4	0.2	0.1	0
Defense waste management (JM 03 03)	0.3	0.4	0.5	0.5	0.7	0.7	0.6
Total capital equipment	14.1	14.3	35.1	24.9	22.5	19.2	19.5

[a] B/O = budget outlays.

[b] B/A = budget authority.

[c] The apparent reduction in this area reflects a transfer of EBT from the confinement systems program to the applied plasma physics program. In addition, a further effort would be invested in the LPTT work that is proposed later in this section.

[d] If funding for EBT II, Large Coil Program additions, and TNS consolidation becomes available, the total for 1979 will rise between $42 million and $44 million.

[e] Does not include funds to be placed in the ORNL financial plan for use by other DOE installations under the national lead laboratory management plan. These pass-through funds are estimated to be $10 million to $15 million in FY 1979 and subsequent years.

Fossil Energy (AA, AB)

Technical Thrust

We expect the Laboratory's fossil energy program to be broad and expanding over the next six years. In addition to work funded by the DOE Fossil Energy Program, there are closely related fossil energy efforts funded by the Assistant Secretary for Environment (ASEV) and the Office of Energy Research (OER). The total support related to fossil energy contributes about 10% of the overall Laboratory operating budget at present.

Components of the ORNL program that are funded by the DOE Fossil Energy Program include R&D on liquefaction processes, fluidized-bed combustors, coal beneficiation, advanced materials, component development, environmental control technology, solid waste disposal, and tertiary oil recovery. Engineering studies, program planning, and environmental assessment in support of fossil energy will continue to be important activities. ORNL support of

the programs managed by the Energy Technology Centers and of pilot and demonstration projects is expected to increase.

The main thrusts of experimental R&D for the DOE Fossil Energy Program are in coal liquefaction, fluidized-bed combustion, magnetic coal beneficiation, and materials and component development and testing. Supporting engineering evaluation and review studies continue to cover almost all aspects of coal conversion and use. New directions for the fossil program include expanded roles in materials and in component development and testing.

Direct support is being provided to TVA's fluidized-bed combustion activities. In addition to the work being performed for DOE's fossil programs, a strong program in coal chemistry is carried out as part of the program in basic energy sciences, and the Laboratory continues to have the leading role in the investigation of the health and environmental aspects of fossil energy use, particularly coal conversion.

Liquefaction (AA 02). Research and development activities supporting development of economically feasible, environmentally acceptable methods for converting coal to a clean liquid fuel include (1) the development of an improved understanding of the chemical and physical structure of coal, (2) exploratory investigations of advanced liquefaction techniques, (3) determination of the physical properties of coal liquids and coal-oil slurries under process conditions, (4) evaluation and review of liquefaction processes, (5) development and testing of portable monitors for low-level detection of polynuclear aromatic hydrocarbons in work areas and on equipment, and (6) assessments related to the environmental aspects of fossil energy use, especially coal conversion.

Gasification (AA 03). The technology required for coal gasification is being advanced by a number of efforts. The principal thrust is associated with coal gasification processes that are at an early stage of pilot plant operation or demonstration plant design and planning. Continuing efforts are expected in areas that include engineering evaluations of gasification processes and specific gasifiers, development of improved process modeling capabilities that are widely applicable to coal conversion systems, identification and testing of critical components required for gasification pilot and demonstration plants, and review of demonstration plant design.

We expect to continue our strong support of the Energy Technology Centers through component development and testing in areas related to coal preparation and handling as well as to critical equipment items.

Although the emphasis in the DOE demonstration plant programs will probably shift toward coal liquefaction during the next several years, leading to substantial growth of our support in that area, we shall continue a significant involvement with coal gasification.

Advanced Power Systems (AA 04). During the coming year, we shall evaluate closed-cycle gas turbine cycles in combination with fluidized-bed combustors for district heating applications.

Direct Combustion (AA 05). Our work on direct combustion is concerned principally with R&D on atmospheric fluidized-bed combustors (AFBCs) for the burning of coal in an environmentally acceptable manner. Our principal activities during this planning period will involve three areas: work on the AFB coal combustor for cogeneration, support for TVA's AFBC demonstration program, and support for the AFBC program carried out at the Morgantown Energy Technology Center (METC). Work on the coal combustor for cogeneration will include the design, construction, and operation of a 1.5-MW AFBC test system to facilitate the development of an industrial cogeneration system capable of supplying electrical power and process heat simultaneously. Support of the TVA program will include experimental work in materials and components as well as evaluations and technical assistance. Our participation in the METC program is likely to emphasize materials and coal feeding R&D.

Advanced Research and Supporting Technology (AA 06). Our work in this activity during the next six years will center on a substantial, and growing, materials development and testing program. This program will include (1) an increased emphasis on failure prevention and analysis in pilot and demonstration plants, (2) increased emphasis on corrosion and erosion-corrosion in coal conversion plants, (3) development of advanced materials for coal systems, (4) expanded studies on the physical and chemical structure of coal and on coal conversion

chemistry in support of advanced liquefaction processes, and (5) evaluation and development of methods for magnetic beneficiation of dry, pulverized coal. In addition, we expect our work on chemistry related to coal liquefaction to expand.

Enhanced Oil Recovery (AB 01). This activity includes R&D on enhanced oil recovery by fluid injection methods. Our activities include research on production of chemicals for micellar flooding from waste streams (such as pulp liquor wastes from fermentation), identification of elements and ions that can be used as tracers in enhanced oil recovery operations, and evaluation of the ion exchange characteristics of chemicals used in enhanced oil recovery with materials occurring in oil-bearing formations.

During the next several years we will continue to support enhanced oil recovery by means of micellar flooding. We will place increased emphasis on relating our work to information resulting from field tests.

Major Changes in the Program

The principal near-term changes in direction anticipated in the fossil work at ORNL are a major expansion of our materials-related work and an increased involvement in experimental chemical engineering efforts related to the development of environmental control technology and to the characterization of coal-derived liquids and oil-coal slurries under liquefaction process conditions. We also expect to play a broadened role in the analysis, evaluation, and systems engineering areas. In the long term, we expect significant growth in work on coal chemistry and solid waste disposal. Our assistance to DOE in the preparation of environmental impact assessments should expand as DOE's needs grow.

We anticipate a growing degree of interaction with TVA, the Electric Power Research Institute (EPRI), and other organizations for which the Laboratory could provide development support for demonstration projects.

The fossil energy program is expected to have one of the highest growth rates at the Laboratory during this planning period. The internal operating level will double, and the management responsibilities for major programs will involve us in larger amounts of subcontracting.

Major Difficulties or Issues

We expect to provide substantial assistance to the Energy Technology Centers as they take on increased management responsibilities, but these relationships have not yet been developed.

Major Results or Milestones Expected

Advances in coal liquefaction technology are expected in specific areas of research such as coal slurry preheating. New liquefaction technologies or new methods of liquefying coal will be investigated. The physical properties of coal liquids will be determined at temperatures and pressures representative of coal liquefaction processes.

Experimental laboratory and bench-scale programs in coal gasification are expected to result in new techniques for recovery of resource material and catalysts from gasifier ash. Coal-handling and feed systems for use in coal conversion will be tested with respect to their performance and endurance.

The 1.5-MW(t) technology test unit of the AFB coal combustor for cogeneration will be built and operated during this period. Detailed design of the experimental facility will be finished during FY 1979, and construction will be completed during FY 1980. A 6000-hr endurance test of the combustor will be followed by installation of the gas turbine for test in both open and closed cycle modes.

There will be a final report on the Alkali Vapor Topping Cycle in FY 1979, because the experiment is now terminated.

A predictive model describing the behavior and transport of constituents of coal conversion and utilization residues, including trace metals, under landfill disposal conditions, will be developed in close cooperation with demonstration plant projects.

Solar Energy (AD, AJ)

Technical Thrust

The solar energy program is still evolving; activities are being modified or added as DOE needs arise that match our capabilities. Many of

the solar energy activities fall into the areas of analysis, technical support, and evaluation.

Solar Technical Support and Utilization (AD 02). DOE's solar energy technology transfer activities are designed to provide ready access to the results of all solar research to potential users of the technology. ORNL plans and conducts workshops for transfer agents in major cities and helps the states in the region establish statewide information networks using existing library and university facilities. The regional Solar Energy Research Institute (SERI) will assume this role in FY 1979.

The ORNL engineering-economic computer models of residential and commercial energy use are being expanded to provide evaluation of solar total energy systems [types of modular integrated utility systems (MIUSs)] for DOE use in establishing the potential for such systems.

The decentralized solar energy technology assessment program examines the social, economic, political, institutional, and life-style impacts of decentralized solar energy on communities. The program involves communities in developing and assessing their own solar futures and assists DOE in evaluating solar energy policy alternatives.

Solar Electric Applications (AD 03). ORNL is reviewing those processes for the manufacture of fuels and heavy chemicals that require large quantities of energy at high temperatures to evaluate them as candidate processes for a DOE development program on concentrated solar energy.

In the small power systems mission analysis program, ORNL is providing support to DOE in program planning, coordination, and management of small (less than 10 MW) solar thermal power systems.

Staff members are assisting DOE by supplying technical advice and technical evaluations of equipment and services provided by other contractors for the DOE-funded photovoltaic demonstration project at Mississippi County Community College at Blytheville, Arkansas.

In support of the Ocean Thermal Energy Conversion (OTEC) Project, ORNL is performing experimental and analytical work on special heat exchangers, providing technical assistance for heat exchanger development by evaluation of proposals, monitoring contract work, and participating in special committees and conferences. We have a management role in the development of alternative OTEC power generating cycles that includes responsibility for managing existing subcontracted work and for conducting related R&D work at ORNL. This management role will be transferred to SERI in 1979.

Fuels from Woody Biomass (AJ 01). ORNL is assisting the Division of Distributed Solar Technology by managing 24 contracts in the Woody Biomass Program. These contracts are in the area of species screening, stand establishment, improved management strategies, and improved methods of collection and transportation. The Laboratory intends to establish a modest in-house R&D program dealing with the environmental constraints on fuels from woody biomass.

ORNL is also preparing the environmental assessment for the DOE Fuels from Woody Biomass Program. This work is funded through the San Francisco Operations Office and is, therefore, accounted for as "work for others."

Major Changes in the Program

In the area of solar heating and cooling, the most productive area for solar energy research is in the use of passive designs for heating and cooling. As funds become available, the program will be expanded to include comparative evaluations of passive solar energy use and conservation measures in farm, residential, and office structures. The results of the evaluations are expected to lead to projects demonstrating innovative passive solar and conservation technology in all three types of structures.

The 1982 International Energy Exposition will probably be located in Knoxville, Tennessee; it will place considerable emphasis on new energy technologies, particularly solar. Active technical support by ORNL in developing the exposition should stimulate active Laboratory participation in solar-related demonstrations.

Our staff is especially well qualified to provide a wide range of environmental assessments for all phases of solar energy applications. As the needs for such assessments develop, ORNL should assume a role comparable to those we already play in other energy technologies.

Major Difficulties or Issues

The expansion of solar research and the direction of it at ORNL depend on how DOE's programs expand and develop. In particular it depends on the way in which DOE establishes the relationships between the national laboratories and the central and regional solar energy research institutes.

Major Results or Milestones Expected

The technical assistance and project management projects require many ongoing reports of analyses and evaluations in order to provide timely information to the sponsors. In addition, the following specific milestones are identified.

The review and evaluation of solar total energy systems mission analysis activities of all DOE contractors will be completed and a detailed management plan prepared and initiated.

The major accomplishments for this area include (1) development of a plan and program for applying high-temperature solar energy to industrial processes and (2) doubling of the seawater heat transfer coefficient for the OTEC system.

Geothermal Energy (AE)

Technical Thrust

Our role in the development of geothermal energy is limited to specific areas in which we have particular skills and experience that are likely to contribute to significant progress.

Engineering R&D (AE 01). Our current participation in geothermal research is in the area of heat transfer and power conversion systems (the studies of scale formation in geothermal systems were phased out in FY 1978 at DOE's request). The low-temperature heat transfer work is expanding with continuation of heat exchanger development. The current thrust is toward scale-up and field demonstration of enhanced heat transfer technologies developed at the Laboratory. Experimental and analytical work is beginning in the area of heat rejection systems as related to geothermal power plants and the direct use of geothermal heat.

Environmental Control and Institutional Studies (AE 06). The environmental impact work is focused in the near term on generic environmental assessments and statements of the various categories within the DOE geothermal program. After the generic assessments are complete, the emphasis will be on impact evaluation for specific facilities, some of which may be associated with the federal Geothermal Loan Guarantee Program. The Environmental Assessments Project will involve some use of subcontracts to industry and consulting firms under ORNL supervision.

Major Changes in the Program

The heat exchanger development work described above is expected to include the management of subcontracted work in the area of waste heat rejection. Because the Gulf Coast geopressured resource and the Eastern Hydrothermal Region are likely to receive increased attention, and because major environmental questions are associated with it, we believe our work in this environmental area will expand.

In concert with the DOE objective of early commercialization of geothermal energy, we believe that the Laboratory's demonstrated capabilities in the social, economic, and technology transfer areas could be applied, especially in the eastern region. Also, because these resources will probably be developed for direct heat uses, the Laboratory hopes to apply its expertise in low-temperature waste heat use.

Major Difficulties or Issues

A continuing issue for ORNL's geothermal program is definition of a role in relation to DOE's objectives. Our primary talents lie in intermediate-term research efforts. This represents a small fraction of the DOE program, which places greater emphasis on early "on-line" power from commercial plants.

Major Results or Milestones Expected

The low-temperature exchanger development work is directed toward the major milestone of field-testing a condenser tube bundle at the East Mesa Test Facility. This is to be followed by the construction of a 500-kW(e) demonstration plant, for which the condenser will be the responsibility of ORNL.

The Environmental Assessments Project has a series of milestones for the completion of the generic and site-specific assessments.

Magnetic Fusion Energy (AF)

Technical Thrust

The fusion program at ORNL participates in nearly all phases of the national toroidal program and is unique in its breadth. This broad effort in plasma physics experiment, theory, and technology development is carried out in the context of advanced design activities and gives the ORNL program a major role in the effort to develop fusion as a viable energy option.

Confinement Systems (AF 01 01). The study of impurities and the plasma-wall interaction, which were initiated on Impurity Study Experiment-A (ISX-A), will be continued on Impurity Study Experiment-B (ISX-B), a modification of ORNL's second tokamak. The ISX-B device will seek to maximize the plasma pressure (beta) in a tokamak with an elongated cross section and neutral injection heating. An alternative heating technique—electron-cyclotron heating—will be added to the experiment beginning in FY 1979. The short pulse length of the ISX experiment (~0.1–0.25 sec), although sufficient for establishing plasma physics theory-experiment correlations, will not provide the long pulse demonstration required for proceeding to a fusion reactor. Thus the Long Pulse Technology Tokamak (LPTT) is proposed as a continuation of the ISX program in order to provide the required pulse lengths of 10–20 sec.

Development and Technology (AF 01 02). The major emphasis in development and technology will be the development and operation of a large superconducting coil array in the Large Coil Program (LCP) and the development of advanced neutral beam systems. In addition, significant work is in progress on the development of materials for fusion reactors, the development of accelerators for solid hydrogen pellets for fueling plasma devices, the characterization of the plasma-wall interaction, and the development of analytical tools for neutron transport in complex geometries and for checking the calculations with experiments. Design studies for tokamak and EBT demonstration power reactors and TNS/ETF (the next proposed large fusion facility after the Princeton Tokamak Fusion Test Reactor) serve as a focus for both the plasma physics experiments and the technology development.

Applied Plasma Physics (AF 01 03). The EBT concept, a leading alternative to that of the tokamak approach and one that was originated at ORNL, will be validated in a higher magnetic field and higher microwave power modification called EBT-S. Successful operation of this device should lead to the construction of EBT-II, a larger, higher field machine with superconducting coils. Paralleling the construction of EBT-II, a set of auxiliary coils [aspect ratio enhancement (ARE) coils] will be added to EBT-S to improve its confinement characteristics. The theoretical plasma physics effort continues to seek a basic understanding of EBT and tokamak behavior so that plasma equilibrium and stability, confinement, and heating may be understood. This work emphasizes detailed comparisons between theory and experiment and the timely application of relevant theory to the design of future experimental devices. The program also emphasizes the development of advanced diagnostics for high-temperature plasmas and the measurement of atomic cross sections that are required for plasma diagnostics and modeling.

Major Results or Milestones Expected

As the EBT concept matures, work on it will expand and become comparable with the tokamak effort. The growth will be associated with the construction and operation of EBT-II, a major confinement experiment. In addition to the current emphasis on neutral injection heating and impurities studies, ISX-B will have experiments involving electron-cyclotron heating, the use of bundle divertors for impurity control, and ripple injection. On a longer time scale, work is beginning on the conceptual design of a superconducting, long pulse tokamak—the LPTT—which will fill the programmatic needs of long pulse plasma physics and will integrate the constraints of tokamak design with those of superconducting coils.

The current neutral beam development effort is principally directed at filling the needs of present confinement experiments. Function is the primary objective whereas cost and efficiency are important but secondary objectives. The effort will be increasingly directed toward development of high energy beams ($E > 60$ keV/nucleon), and more emphasis will be placed

on cost reductions and increased efficiency. Both direct recovery and negative ion approaches will be investigated.

Conservation (C1 01, C8)

The overall conservation program at ORNL [energy technology (ET) and conservation and solar applications (CS) programs] is expected to grow in this planning period. National conservation needs are being assessed, and ORNL will work with DOE to meet these needs.

Technical Thrust

In one program, two-way communications are being field-tested with two utilities to enable them to control loads and distribution equipment and to read meters from a central control point. In another management program, the use of customer-side-of-the-meter thermal energy storage for load management is being demonstrated.

Conservation and Utilities (C1 01). The high-voltage research at the Laboratory is devoted to the application of basic knowledge to identify the best liquid and gaseous materials for use as high-voltage insulators. Strong emphasis is placed on gaseous insulators because of their distinct advantages and versatile properties.

Multisector (C8). ORNL manages DOE's low-temperature thermal energy storage programs and provides in-house R&D and technical assistance in all aspects of this work.

ORNL also supports work on high-temperature molten carbonate fuel cells, which efficiently convert natural or synthetic gas into electricity and reject heat at a temperature sufficiently high for effective use.

We are actively pursuing research on heat exchanger enhancement, especially those forms of heat exchangers that are applicable to open cycle systems.

ORNL's analyses of heat- and mass-transfer processes in beds of hydride-forming materials should provide guidance for improving the performance of hydrogen storage systems. Additionally, these analyses should supply a rational basis for designing systems for mobile and stationary units.

Studies have been initiated for nondestructive testing of composite materials. Composite materials have numerous applications in energy-moving systems, and the facilities and expertise of the Metals and Ceramics Division at the Laboratory are well matched to this work. Energy-saving machines and processes often require very high operating temperatures, and DOE is interested in funding the advanced materials work of ORNL.

Major Changes in the Program

Increasing emphasis has been given to management programs (of which ORNL now has seven in the conservation area, including ET and CS programs). A management role is accepted only if ORNL has technical expertise and is conducting, or prepared to conduct, significant in-house R&D in the area. These programs often are interdivisional, drawing expertise from throughout the Laboratory. Through careful selection, monitoring, and supervision of subcontractors, the Laboratory can substantially extend the activities in the conservation area.

ORNL expects a greater involvement in program management during this planning period, principally for the division of Building and Community Systems but also for Industrial Conservation and Fossil Energy Utilization.

Major Difficulties or Issues

Adequate laboratory and office space is a serious limitation in some programs and cannot always be economically provided by converting existing Laboratory space.

Major Results and Milestones Expected

The first results from the field tests of two-way communication links for distribution automation and load control will become available during FY 1979. Utilities will use the data from national demonstrations to evaluate the load-leveling impact on their system in terms of efficiency and reliability of service; shift of fuels from oil and gas to coal, nuclear, and renewable fuels; and capital requirements. A "whole city" demonstration of load management and distribution automation and control is scheduled to begin in FY 1980, as a joint venture among DOE, TVA, and a TVA distributor.

Gases with optimum dielectric characteristics will be identified for high-voltage transmission systems.

Fuel Cycle Research and Development (AG 02)

Technical Thrust

Fuel cycle development programs at ORNL include work on reprocessing technology of advanced reactor (breeder) fuel cycles, major support work for the LWR converter reactor and high-temperature gas-cooled reactor (HTGR) reprocessing programs, and work directed toward the fabrication of spherical particle fuel for fast breeder reactors (FBRs), LWRs, and HTGRs. The advanced reactor fuel cycles include thorium cycles and other alternative fuel systems being considered in nonproliferation assessment studies. The program on commercial waste management R&D emphasizes waste management analysis, removal of radioactive wastes, and methods for fixation of wastes.

Support for Nuclear Fuel Cycles (AG 02 01). The Advanced Fuel Recycle Program is developing reprocessing technology for advanced reactor fuel cycles, including thorium cycles and other alternative fuel systems as well as the uranium-plutonium cycle for FBRs. Laboratory flowsheet studies beginning in FY 1979 will provide input to a limited process demonstration, using kilogram quantities of irradiated fuel, in the Transuranium Processing Plant (TRU). Title II design of a nonradioactive equipment development facility, the Integrated Prototype Equipment Test (IPET), will be completed in FY 1980. Construction will begin in FY 1979 and will be completed in FY 1981. Engineering development of components to be incorporated into IPET will be the focus of the program. Design activities directed toward a pilot-scale hot facility (the Hot Experimental Facility) will be continued, possibly at a reduced level including only studies of several problems identified in the design.

The HTGR Fuel Recycle Development Program, the national program managed by ORNL, is developing the technology and engineering data base for recovery and recycle of ^{233}U from spent HTGR fuel. The focus of the program is the establishment of the HTGR Recycle Reference Facility (HRRF) as required by national policy and needs. The program emphasizes proliferation-resistant medium-enriched fuel for the uranium-thorium cycle, but it also includes work on low-enriched and highly enriched fuel. A strong cooperative program with the Federal Republic of Germany (F.R.G) has been initiated, the intent of which is to reduce the expenditures required in each country for HTGR fuel recycle R&D while meeting the objectives of each.

The Laboratory has also assumed a strong role in the Alternative Fuel Cycle Evaluations Program (AFCEP) to provide assistance to the Nonproliferation Alternative Systems Assessment Program (NASAP) and to U.S. participation in the International Nuclear Fuel Cycle Evaluation (INFCE) program. The Laboratory will aid these programs in evaluating the proliferation- and diversion-resistant features of various fuels and fuel cycles and in the economic assessment of associated fuel cycle facilities. This role involves the preparation and critical review of documents for submission to INFCE working groups.

Commercial Waste Management (AG 02 02). Waste management activities emphasize the analytical study of waste management problems, including experimental and analytical work on the partitioning and transmutation of actinides as well as projections of waste generation rates. Other important activities include the removal of radioactive nuclides from liquid wastes and the fixation of waste in various solid forms, primarily in concrete and cermets, both of which show substantial promise.

Major Changes in the Program

In the Advanced Fuel Recycle Program, the conceptual design directed toward the pilot-scale reprocessing plant known as the Hot Experimental Facility will be guided by evolving breeder policy matters. Latest guidance appears to recommend continuation of the conceptual design. Otherwise, a series of design studies on special problems associated with the facility will be carried out in FY 1979 at a reduced level of effort. Beginning in FY 1979 the HTGR Fuel Recycle Development Program will be absorbed into appropriate elements of the consolidated fuel cycle programs. Technology development for HTGR recycle will decrease whereas analytical studies on alternatives and strategies concerning the overall program, processes, and fuel designs will increase. Detailed plans for

design of the HRRF will be deferred until the fate of HTGRs with regard to the national energy policy is resolved. In this respect, the scope of all recycle programs will be strongly affected by the results of NASAP and INFCE studies.

Commercial waste program work on partitioning of actinides and high-level waste process tests will be completed and reported, but these activities will be replaced by new programs on transportation of wastes, studies of wastes from alternative fuel cycles, and handling and disposal of low-level and gaseous wastes. Total program effort on commercial wastes will be nearly constant over this planning period.

Major Difficulties or Issues

The scope and objectives of fuel cycle programs will be affected by major policy decisions on the HTGR's role with respect to national energy needs and the timing of breeder reactor introduction to the economy. Successful demonstration of fuel recycle technology on a pilot scale must be accomplished before commercial breeder reactors are introduced.

Fission Breeder Reactor (AG 03)

Technical Thrust

The Laboratory's breeder reactor program is designed to provide base technology and engineering support to the national program in areas in which ORNL has a demonstrated expertise. These include prominent roles in the following: High-Temperature Structural Design, Materials Behavior and Development, Nondestructive Inspection, Codes and Standards, Safety, Physics, Instrumentation, and Fuels. During the past year we have also chaired the important Information Transfer Working Group (ITWG) and have participated in the INFCE program.

The high-temperature structural design (HTSD) activity is aimed at the development and verification of design methods and criteria for components that operate at temperatures in the creep range. The task includes analysis methods, failure criteria, simplified design methods, and confirmatory structural tests. Materials behavior studies in support of HTSD involve the completion of national mechanical properties test matrices for DOE reactor programs and operation of a data storage and retrieval system (DSRS). Participants include the majority of national and industrial laboratories in DOE's breeder reactor program. Results are reported quarterly by ORNL.

Materials development studies include welding and brazing, advanced irradiation-resistant cladding alloys, alternative methods of fabrication of large diameter pipe and fittings, and commercialization of high-strength ferritic steels for FBR circuits.

In the area of nondestructive examination, ORNL is developing methods and is coordinating the national effort for manufacturing and in-service inspection of piping, transition joints, and steam generators.

A major effort in our breeder reactor safety program is the assessment of the transient fluid flow and heat transfer behavior of sodium-cooled breeder cores under accident conditions. Our Thermal-Hydraulic Out-of-Reactor Safety Facility (THORS) is a major DOE installation for experiments on sodium heat transfer in electrically simulated breeder reactor fuel assemblies under flow and power transients. In addition, safety sensitivity methods are developed, and computerized data bases are maintained for reliability and safety data. We are also addressing the environmental impact of advanced fuels and evaluating models for radioactivity releases.

In the important area of measurements and controls, ORNL continues to play a prominent role in thermometry, neutron sensor development, and surveillance and diagnostic systems. The Instrumentation and Controls Division at ORNL has a recognized unique capability in reactor control and protection system design, which could provide much-needed support for the breeder reactor program. A breeder-reactor needs analysis has been conducted, and a national program plan is being prepared for implementation.

ORNL has the largest overall effort in nuclear data generation for reactors. The Oak Ridge Electron Linear Accelerator (ORELA) is the major U.S. source of data on neutron capture in fissile, fertile, and core structural materials. Our physics program includes a prominent role in shielding analysis and methods development. The latter includes multidimensional diffusion and transport as well as cross-section processing and sensitivity codes. Our Radiation Shielding Information Center (RSIC) is ac-

knowledged worldwide as the leading collection, evaluation, and distribution center for shielding codes, processed cross-section libraries, and methodology.

Finally, a small but important activity involves the demonstration of sphere-pac fuels as an alternative to pellets for fuel systems. The sphere-pac concept offers the advantage of fuel fabrication in fully remote operation, which reduces personnel exposure in diversion-resistant fuel recycle concepts involving spiked or active fuels, including those based on Th-^{233}U.

The Nuclear Standards Office (NSO) provides technical management of nuclear standards programs for DOE-Nuclear Power Development, which leads all Energy Technology-Nuclear (ETN) standards activities. The NSO promotes the objectives of the programs by providing coordination of ETN standards activities to foster the development, acceptance, and application of nuclear standards and by providing leadership for the development and adoption of national consensus standards. This is accomplished through cooperation with standards coordinators at DOE laboratories and contractor organizations and liaison with national standards writing organizations.

Major Changes in the Program

The only anticipated change involves establishing a close liaison with the Conceptual Design Study (CDS) team comparable to our working arrangement with the Clinch River Breeder Reactor Project (CRBRP) staff. By maintaining a close working relationship, additional data requirements are identified. In responding to the CRBRP's needs, our base technology programs have contributed significantly.

Major Difficulties or Issues

The FY 1979 funding guidance reflected a reduced level relative to FY 1978. This will require reassignment of key technical staff, predominantly to nonnuclear programs. Though relatively small, ORNL's breeder reactor program is an exceedingly important part of the national effort. Our involvement in each technology area is unique, and our participation is prominent. Additional funds in response to several generic proposals could be accommodated.

Nuclear Research and Applications (AG 04)

Technical Thrust

The program develops engineering and materials technology for gas-cooled thermal and fast reactors and provides materials support for the isotopic power sources designed for space missions. Another important feature of the program is the engineering and economic assessment of nuclear energy options, which currently includes a leading role in NASAP.

Gas-Cooled Thermal Reactor (AG 04 02). This activity is designed to develop and assess HTGR technology. Specific development areas include HTGR design, operation, and safety and involve analysis of fission product behavior; testing, development, and evaluation of fuels; basic design and model testing of prestressed concrete reactor vessels (PCRVs); gathering of basic information on material behavior; study of the irradiation creep of graphite under reactor conditions; and evaluation of alternative reactor designs that may improve fuel use performance. HTGR program planning is carried out with General Atomic Company, Gas-Cooled Reactor Associates, and General Electric Company; cooperation with the Federal Republic of Germany takes place under the U.S./F.R.G. Umbrella Agreement covering gas-cooled reactor technology.

Gas-Cooled Fast Breeder Reactors (AG 04 03). This activity will develop the technology of PCRV closures, shielding designs, and thermal/hydraulic/structural behavior of fuel assemblies for gas-cooled fast reactors (GCFRs). Construction and commissioning of the Core Flow Test Loop (CFTL) and construction and operational testing of simulated fuel assemblies in the CFTL will be the focus of the activity during this planning period. The CFTL will provide test data on heat transfer, pressure drop, and thermal-hydraulic behavior, as well as structural behavior, of simulated GCFR fuel assemblies. Thus it will provide information on the operating characteristics and performance of fuel assemblies under design and abnormal conditions. These data are required to verify codes and models and to support licensing considerations. Program planning related to the GCFR is carried out with General Atomic Company and Helium Breeder Associates; cooperation with the Federal Re-

public of Germany takes place under the U.S./F.R.G. Umbrella Agreement covering gas-cooled reactor technology.

Technology Development and Special Projects (AG 04 06). Current activities in direct support of space application programs focus on materials for isotopic fuel cladding for use in 1981 through 1983 space missions. Other important tasks deal with the development of isotopic fuels and the technology of long-range ordered alloys for advanced energy systems. All of the above activities are being transferred to other programs in FY 1979. Development work on terrestrial application of radioisotopes will continue at a low level of effort.

Space Applications (AG 04 07). The activities on isotopic fuels and cladding materials development will be transferred to this program in FY 1979 and will be completed in FY 1980. Materials support of the Selenide Isotope Generator Program will continue in support of the 1981 Galileo and 1983 Solar-Polar missions. Support for the technology verification phase of the Kilowatt Isotope Power System will continue through FY 1980, and materials development supporting the Space Reactor Program at Los Alamos Scientific Laboratory will be initiated in FY 1979. Fabrication of iridium alloys required for the 1981 and 1983 flight systems will continue through FY 1981.

Nuclear Energy Assessments (AG 04 09). Nuclear energy assessment tasks include economic, technical, and environmental assessments of the ability of nuclear power plants and their alternatives to supply electricity and heat. A large commitment of resources in FY 1979 will provide technical support to NASAP, a high priority assignment. The purpose of NASAP is to evaluate alternate fuel cycles in the various reactor types for their proliferation resistance; economic and environmental performance; and research, development, and demonstration requirements. A significant number of studies and assessments are carried out through R&D subcontracts.

Major Changes in the Program

Significant increases in support for GCFR research are anticipated to carry out construction and commissioning of the CFTL and to prepare for testing of simulated fuel assemblies in the facility. The transfer of tasks from the Technology Development and Special Projects activity to the Space Applications activity is discussed in the previous section. Total support for activities under Space Applications will decline after FY 1979 because of the completion of some tasks. Completion of the NASAP study and related assessments in FY 1979 will reduce total support for assessments in FY 1979 and FY 1980, but this effort is expected to grow again as new tasks are initiated.

Major Difficulties or Issues

Future support for gas-cooled reactors, and for HTGRs in particular, is contingent on the results from alternative fuel cycle studies (NASAP and INFCE) and on the success of efforts by DOE and industry to promote commercialization of the HTGR. Some decisions based on these activities should be made during FY 1979. Current program plans assume positive, though modest, action on both contingencies.

In the isotopic fuels program, surveillance of the ^{244}Cu facility must be maintained until funding can be made available for decontamination and decommissioning of the facility. Because of the uncertain priority of the Space Applications activities in the FY 1980 budget, it may be difficult to fulfill our commitments to these DOE and National Aeronautics and Space Administration (NASA) end-use missions.

Special Materials and Waste Management

Technical Thrust

ORNL is working in the area of waste management and the storage and conversion of material containing ^{233}U.

The special materials program focuses on the operations and the R&D required to isolate, store, and dispose of radioactive wastes derived from current and past Laboratory operations. The program also provides support for the ^{233}U national repository and for the design, construction, and operation of a facility for conversion of uranium containing ^{233}U.

Production (JM 03 01). This activity provides for a national repository for ^{233}U and supports the design and construction of equipment for the conversion to an inert solid of 1050 kg of

uranium derived from Consolidated Edison (Con Ed) spent fuel. The conversion of the uranium has increased substantially in complexity and scope as the magnitude of the task has been evaluated. This is due in part to recently imposed restrictions. This task will require a sizable increase in resource commitment through FY 1982 for construction and operation of the system.

Defense Waste Management (JM 03 03). This category is concerned with the R&D tasks related to management of DOE radioactive wastes; it also includes operation of ORNL facilities for the storage and disposal of radioactive wastes. The proposed funding of the R&D programs has been increased from FY 1978 to FY 1980 to (1) develop the technology for the shallow land burial of radioactive wastes, (2) minimize the movement and potential release of radioactive materials, and (3) develop a process for the separation of tritium from natural or heavy water. The initiation in FY 1980 of a campaign to dispose of the sludge accumulated in the ORNL gunite waste storage tanks will add substantially to this program's funding requirements. Completion of two line-item capital projects (the modifications to the intermediate-level waste facility and the new hydrofracture facility) in FY 1979 and FY 1980, respectively, will markedly improve the handling and disposal of radioactive wastes from ORNL operations.

Major Changes in the Program

Conversion and storage of the Con Ed uranium will require a sizable commitment of resources through 1982 in order to comply with requirements for dry storage of material.

In addition to other increases in waste operations, conceptual design studies are under way for line-item capital projects proposed for authorization in FY 1980. These are the waste operations control center, the stream flow monitoring upgrading, and the cell ventilation and off-gas renovation. Another capital project, the solid waste handling and decontamination facility, is proposed for authorization in FY 1981. Completion and startup of the facilities is scheduled for FY 1982 to FY 1984.

Major Difficulties or Issues

Resources needed for the design and construction of a conversion facility for the Con Ed uranium require a substantial commitment of capital or expense funding for this planning period. A policy decision on funding for this project is urgently needed. A bench-scale pilot plant to demonstrate the tritium separation process was scheduled for construction in FY 1979, but it has been postponed because of funding limitations.

New Initiatives for ASET and Others

Nuclear Fuel Reprocessing Program

The Laboratory and the Oak Ridge Operations Office (ORO) of DOE have jointly proposed that they be assigned the lead role for management of a unified program on the development of fuel reprocessing technology. The objective of this consolidation is both the coordination and management of the reprocessing development work that is now carried out under four separate programs. Benefits to the unified program in both guidance and key staff will derive from the strong technical and management team that has been built up at ORNL and ORO to perform work on the Advanced Fuel Reprocessing Program. The extensive and historic background of ORNL in development of reprocessing technology will give strong support to the unified program. Important segments of the other three programs—the Alternate Fuel Cycle Technologies Program, the Thorium Fuel Cycle Technology Program, and the HTGR Fuel Recycle Program—are already being performed or managed at ORNL. Integration of the development efforts into one program will enable more effective use of resources. The Laboratory will provide technical management of the program in concert with DOE-ORO personnel and would identify the roles and assignments of other contractors in the program as well as continue its current major role in reprocessing R&D. Responsibility and authority for the program's administration and field management resides with DOE-ORO.

Materials and Structures Technology Center

The Laboratory is preparing to establish a technology center to encompass studies of both HTSD and materials behavior and development. Included in the technical activities of the center will be developing high-temperature design analysis methods and failure criteria and

conducting confirmatory structural and related materials behavior and properties tests. Work in the related nondestructive examination (NDE) area will also be included to ensure development of reliable components. Management activities will be to prepare a national plan for HTSD and related activities with the understanding and concurrence of DOE and managers of other participating organizations and to coordinate plans and key milestones with other DOE projects and technology centers. Through the center, specific design needs will be addressed by carefully planned and unified efforts. Duplication will be minimized and responsiveness to design needs improved. ORNL's prominent role in both conducting and coordinating current HTSD, NDE, and mechanical properties and materials development activities for the breeder reactor program provides the capacity for leadership in such a technology/management center.

Advanced Technologies Applicable to Light-Water Reactors

Inquiries from utilities and EPRI indicate that technologies under development for the breeder reactor program could also be applied in support of utility-initiated programs in three major areas of LWR improvements: (1) improved uranium use, (2) reduced levels of occupational radiation exposure, and (3) near-term solutions to technological problems that have potential for serious compromises to overall LWR plant on-line time. These developments include gel-sphere-pac fuel, which has been developed by ORNL primarily for refabrication of recycle fuel systems (see the discussion on gel-sphere fuels) and has the potential for reducing or eliminating problems of pellet-cladding interactions in the once-through fuel cycle. Such improvements could lead to substantial gains in fuel use through higher burn-up factors.

Other developments include (1) improved electronic diagnostic systems for the detection of abnormalities in nuclear performance and vibrations and of incipient failures in moving parts and (2) improved systems for the detection and interpretation of flaws in materials. The latter could be applied in both the manufacture of components for nuclear steam supply systems and the NDE of them during in-service inspection. ORNL also has strong capabilities in automated welding equipment and techniques, particularly for automated pipe and tube welding.

With respect to reductions in occupational radiation exposure, ORNL has very strong staff and facility capabilities for conducting high-temperature aqueous chemistry and corrosion investigations. These capabilities could be applied to produce effective component decontamination methods and primary-coolant-loop radiation control chemistry techniques. Facilities exist at ORNL for large-scale demonstration of this latter technology using contaminated reactor artifacts, including testing under irradiation conditions if required.

We are in communication with the nuclear industry regarding these contributions that ORNL's technological strengths could provide to support the utility programs on LWR improvement. It is expected that funding for this work would come from outside DOE (e.g., TVA, EPRI), but the technical description is included in this section because of its clear complementarity to the DOE-based reactor programs.

Nuclear Energy Assessments

The Laboratory has proposed to lead a program designed to provide studies and assessments of nuclear and alternative power systems in support of the various research, development, and demonstration efforts in DOE's energy programs. The scope of the program consists of general studies and evaluations of nuclear power systems and alternatives, analysis of alternative nuclear fuel cycles, studies of alternative siting concepts such as nuclear energy centers, large-scale cogeneration applications, and the technical overview of nonproliferation alternatives. These assessments would draw on the diversified staff and facilities of ORNL. The Laboratory would provide technical direction of program elements and technical support to DOE Headquarters staff.

Instrumentation for Nuclear Energy Systems

The Laboratory is proposing to lead a unified program intended to develop instrumentation and controls (I&C) technology that would improve the performance and safety of nuclear energy and related systems. The Laboratory's function would be to coordinate the many I&C

activities related to energy generation and conversion systems through a management center that would incorporate the three major I&C areas: Detection and Measurement, Signal Processing and Data Management, and Automatic Control. Such coordination would avoid duplication of development efforts on similar devices such as temperature sensors.

Generic Alternative Fuels

New and improved technologies are required to meet more stringent safeguards requirements and to reduce personnel exposures to radioactivity. Because one provision for potential diversion resistance is the use of highly radioactive fuels and fuel systems, these two requirements are sometimes in conflict. The proposed coprocessing of uranium-plutonium fuels and of denatured thorium/^{233}U/^{238}U fuels introduces additional requirements for new fuel refabrication techniques.

This program, which is part of the refabrication section of the consolidated fuel recycle program, managed by Batelle's Pacific Northwest Laboratory, centers on the development and testing of gel-sphere-pac fuels to be used in metal-clad pins in both advanced converters and breeder reactors. Gel-sphere-pac fuels were originally conceived for their advantages in remote refabrication. These advantages include handling of only liquids or free-flowing, dust-free solids, which are more amenable than powders to accurate accountability control and which reduce maintenance and personnel exposure. In addition, the mechanically simplified fuel fabrication and pin loading techniques afford the possibility of fully automated fabrication and transport systems in the refabrication of reprocessed fuel.

ORNL has extensive experience and laboratory-scale facilities that we propose to apply to the development of a technology base, process systems, and performance testing for remotely fabricated fuels. The Thorium-Uranium Recycle Facility (TURF), which was constructed (except for cell windows, manipulators, and other smaller items) in the late 1960s for remote fuel reprocessing and fabrication, is proposed as an important laboratory for conducting the portion of this program directly involving the highly active fuel process testing and fabrication.

EBT-II and Long Pulse Technology Tokamak

The imminent demonstration of scaling with magnetic field and microwave power on EBT-S will provide sufficient validation for the confinement concept to justify a larger, higher field device. A proposal will be submitted to DOE's Office of Fusion Energy (OFE) for EBT-II, which would have 2.4 MW of microwave power and superconducting coils.

ORNL is proposing to OFE that a major responsibility for the design and the necessary supporting R&D program for The Next Step (TNS) be assumed by the Laboratory's fusion program. The goal of the TNS program is to operate, by the late 1980s, a fusion reactor core—a long-lived, ignited deuterium-tritium plasma—and to develop simultaneously the necessary support technologies. The site would probably not be ORNL.

Recent successes on tokamak experiments both at ORNL and other institutions have reinforced the belief that the necessary tokamak physics base will be developed within the next several years. We must, therefore, place increasing emphasis on engineering and technology development in order to raise these areas to an acceptable level. In particular, as a result of the TNS activities, ORNL has identified the need for an LPTT as an interim device to provide integrated systems experience for the implementation of TNS. The LPTT would be a superconducting hydrogen device with a pulse-length capability of tens of seconds; it would be operational in the early 1980s and would be constructed at ORNL. The LPTT device would allow the logical continuation of the ISX program and would add the systems experience objectives required for TNS/ETF.

Discussions with OFE concerning the implementation of the LPTT are currently under way. Estimates of resource requirements are shown in the following table.

Summary of resources*—EBT-II and Long Pulse Technology Tokamak

	'79	'80	'81	'82	'83	'84
Direct FTE	13	17	22	21	24	22
Operating costs, B/O[a]	1.9	25.2	30.1	29.2	24.1	18.9
Subcontracting and procurement	0.4	4.1	4.4	4.8	4.8	4.1

[a]B/O = budget outlays.

Director for Energy Research

The basic physical sciences programs at ORNL are conducted on behalf of the Director for Energy Research (DER) and have been operated at a roughly constant level during the past five years. No substantial changes in staffing levels are expected during this planning period. However, there has been a shift in emphasis from nuclear-related work toward programs ultimately related to nonnuclear and fusion energy. This trend is expected to continue. There are continuing problems in relation to the support of large facilities used in pursuit of basic research, including the High-Flux Isotope Reactor and the existing EN Tandem Van de Graaff Accelerator.

The major resource projections are summarized in the following table.

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Summary of resources*—Director for Energy Research

	'78	'79	'80	'81	'82	'83	'84
Operating							
Nuclear science (AK 01 01)							
Direct FTE	110	112	112	112	111	110	110
B/O[a]	11.2	11.2	12.1	12.3	12.4	12.5	12.6
B/A[b]	14.8	11.9	12.4	12.6	12.7	12.8	12.9
Subcontracting and procurement	1.2	1.6	1.8	1.8	1.8	1.8	1.9
Materials science (AK 01 02)							
Direct FTE	168	150	150	150	150	150	149
B/O	13.5	14.4	15.6	15.7	15.9	16.1	16.3
B/A	18.3	15.1	16.1	16.2	16.4	16.6	16.8
Chemical science (AK 01 03)							
Direct FTE	88	85	85	85	85	84	84
B/O	6.3	6.6	7.1	7.2	7.3	7.4	7.4
B/A	8.5	7.0	7.5	7.6	7.7	7.8	7.8
Engineering, mathematics, and geoscience (AK 01 04), advanced energy projects (AK 01 05), advanced technology projects (AK 02)							
Direct FTE	10	10	10	10	11	11	10
B/O	0.7	0.8	0.8	1.1	1.3	1.3	1.3
B/A	1.1	0.7	0.7	0.9	1.1	1.1	1.1
Nuclear physics (HK 03), high energy physics (HK 02)							
Direct FTE	75	59	59	59	59	58	58
B/O	5.7	6.0	6.4	6.8	7.1	7.3	7.6
B/A	7.6	5.9	6.2	6.6	6.9	7.1	7.4

Summary of resources —Director for Energy Research (continued)

	'78	'79	'80	'81	'82	'83	'84
Operating							
University relations (KN 02)							
Direct FTE	2	2	2	2	2	2	2
B/O	0.2	0.2	0.2	0.2	0.2	0.2	0.2
B/A	0.2	0.2	0.2	0.2	0.2	0.2	0.2
All Office of Energy Research (OER) programs except AK 01 01							
Subcontracting and procurement	0.1	0.2	0.2	0.2	0.3	0.3	0.4
Total operating							
Direct FTE	453	418	418	418	418	415	413
B/O	37.6	39.2	42.2	43.3	44.2	44.8	45.4
B/A	50.5	40.8	43.1	44.1	45.0	45.6	46.2
Subcontracting and procurement	1.3	1.8	2.0	2.0	2.1	2.1	2.3
Capital equipment							
Nuclear science (AK 01 01)	0.3	0.3	0.4	0.4	0.4	0.5	0.5
Materials science (AK 01 02)	1.5	1.5	1.6	1.7	1.7	1.7	1.8
Chemical science (AK 01 03)	0.4	0.6	0.7	0.7	0.7	0.8	0.8
Nuclear physics (HK 03)	0.5	0.5	0.6	0.6	0.6	0.6	0.7
Other OER	0.1	0	0.1	0.1	0.2	0.2	0.2
Total capital equipment	2.8	2.9	3.4	3.5	3.6	3.8	4.0

[a] B/O = budget outlays.
[b] B/A = budget authority.

Basic Energy Sciences (AK 01)

Technical Thrust

The basic energy sciences program at ORNL includes materials research, chemical research, engineering science, mathematics and statistics research, and atomic and nuclear science. The programs comprise both experimental and theoretical work and include a substantial interaction with outside users of basic energy science facilities at ORNL.

Nuclear Science (AK 01 01). The experimental nuclear science program includes measurements of neutron cross sections that enhance basic understanding of the theory of nuclear interactions as well as measurements necessary for the economic exploitation of fusion and fission energy. The ORELA is the best facility in the world for such measurements; work is continuing to improve the machine characteristics still further. For example, an increase in the pulse repetition rate from 1000/sec to 1500/sec will be completed in 1979, and this improvement will reduce the amount of running time required to accumulate data.

Other research in this program includes light-ion nuclear physics; transuranium element production; stable isotopes separation; the chemistry of transuranium elements and compounds; and ORNL's recently demonstrated, and very exciting, technique of one-atom detection. A new goal is to be able to detect single ^{7}Li and ^{71}Ge atoms; both atoms are important in the measurement of the solar neutrino flux, which in turn may remove the current dilemma concerning the origin of solar energy.

In the field of light-ion nuclear physics, research has led to the discovery and understanding of giant nuclear resonances.

ORNL continues to provide the major portion of highly enriched, separated, stable and selected radioactive isotopes including actinides to the research and commercial communities.

Research and development are directed toward improved physical and chemical processing of separated isotopes to improve isotopic and chemical purity.

Research in the chemistry of transuranium elements and compounds is directed toward actinides in the environment as well as toward the overall understanding of the chemical properties of the actinide elements. Many experimental techniques are used, including, for example, microcalorimetry, x-ray diffraction, measurements of various absorption spectra, polarography, x-ray fluorescence, and electrochemistry. New research plans include x-ray diffraction studies at high pressures, growth of large crystals of compounds of americium and curium, and studies of plutonium speciation under environmental conditions.

Materials Sciences (AK 01 02). The materials sciences research program in metallurgy and ceramics, solid state physics, and materials chemistry deals with fundamental studies of mechanical, physical, optical, electrical, and magnetic properties of materials; the program is generally guided by the needs of the DOE missions. The experimental programs include investigations of crystal structure, superconductivity, transport properties, radiation effects, magnetic phenomena, surface properties, lattice dynamics, welding and joining, corrosion, and fracture. Strong theoretical programs are coupled closely to almost all fields of experimental research. Photovoltaic conversion in solar cells, stress-corrosion cracking in reactor containment vessels, contamination and radiation damage of the first wall in fusion devices, and ionic conductivity in solid electrolytes for batteries and fuel cells are specific examples of diverse materials problems for which vital information is being obtained.

Recent results of great promise were obtained by combining the techniques of ion implantation and laser annealing. Experiments on silicon indicate that the resulting material has excellent electrical properties for semiconductor devices and solar cells. The technique may well have widespread applications in other areas.

A number of large, unique facilities are available for research in the materials sciences. Included among them are a variety of neutron scattering facilities at the High Flux Isotope Reactor (HFIR), which furnishes the most intense beams of thermal neutrons now available for research; facilities at the Bulk Shielding Reactor (BSR) for closely controlled investigations of radiation effects at very low temperatures; several accelerators for research in the fields of ion radiation damage, ion implantation, ion scattering, and ion channeling; high-voltage and high-resolution electron microscopes; and a 10-m small-angle x-ray scattering camera. These facilities support many important types of materials research, which cannot be undertaken at other laboratories. For example, the small-angle x-ray scattering camera and small-angle neutron scattering facilities permit detailed investigations of microporosity and microinclusions in coal, void sizes and swelling in irradiated materials, and structural properties of polymers and biological materials. An extension of the current work that uses x-ray and ultraviolet sources will be initiated at the ORNL stations to be installed at the National Synchrotron Light Source now under construction at Brookhaven National Laboratory.

Chemical Science (AK 01 03). The chemical research program covers the range of chemistry disciplines from organic chemistry to chemical physics and atomic and molecular beams. There is a strong program in catalysis because of its fundamental role in coal conversion and processes and in resource recovery. Aqueous chemistry research provides basic chemical and thermodynamic data on solutions encountered in such diverse systems as geothermal brines and in high-temperature heat exchange systems in steam generation. Thermochemical, photochemical, and biochemical processes are studied; one area of particular interest is the production of synthetic fuels. Studies of tritium chemical equilibria and permeation are performed as background for the fusion energy program. Analytical chemistry research techniques are developed for identification of the constituents in a wide variety of materials, including potentially hazardous by-products of coal conversion processes.

Studies of molecular structure by electron spectroscopy and of atomic collisions with slow multicharged ions are important parts of the atomic physics program: charge exchange and ionization cross-section measurements are important to fusion energy programs. During FY 1979 electron-ionization cross sections will be

extended along isoelectronic sequences and to electron energies up to 3 keV. Preparations are being made to perform atomic physics measurements with the 25-MV tandem accelerator of the Holifield Heavy Ion Research Facility (HHIRF) when highly stripped ion beams become available during FY 1980.

Engineering, Mathematics, and Geoscience (AK 01 04). Research in a new subactivity—engineering science—emphasizes process control, advanced instrumentation, solid mechanics, and fluid flow. Mathematics research is directed toward moving-boundary problems, continuum mechanics, statistical methods, and numerical analysis. New programs in geochemistry involve modeling of igneous rocks and chemical migration in the earth's crust.

Major Changes in the Program

The major change in the direction of these programs will be a continuing shift from research relevant primarily to fission energy technologies to research applicable to fusion, fossil, solar, geothermal energy, and conservation technologies. More emphasis will be given in chemistry research to coal chemistry, especially to the structure of coal, to reactions of coal constituents, and to high-temperature materials chemistry. In materials research, the emphasis will be on properties of materials at very high temperatures in hostile environments. New work in engineering science, geochemistry, and resource recovery will be initiated. A diversified fundamental research program will be maintained to underlie the research directed toward energy technology.

Major Difficulties or Issues

A major issue in this program will be continuing support not only for the research reactors (the HFIR in particular) but also for the existing EN Tandem Van de Graaff Laboratory. The EN Tandem Van de Graaff Laboratory will no longer be supported by the nuclear physics program. Most of the experimental atomic physics research discussed here is carried out on the EN Tandem, and in the absence of additional support from the chemical sciences program, the accelerator will not be available on a continuing, full-time basis.

We propose a significant expansion of our effort in the area of materials research at elevated temperatures. This will require significant capital money for major pieces of new equipment.

Heavy-Ion Physics (HK 03, HK 02)

Technical Thrust

The nuclear physics and nuclear chemistry program at ORNL is dominated by the topics related to heavy-ion physics. The current experimental program, using the Oak Ridge Isochronous Cyclotron (ORIC), involves the study of nuclear interactions from coulomb excitation to complete fusion to deep inelastic processes. The theoretical physics program is strongly coupled to the experimental program. The current principal area of theoretical work is the investigation of gross properties of heavy-ion collisions in hydrodynamic, time-dependent Hartree-Fock, and classical theories.

A significant fraction of the nuclear physics and nuclear chemistry program is involved in the development of the HHIRF, the center of which is a new 25-MV Tandem Van de Graaff accelerator. The building to house the accelerator has been completed, and installation of the accelerator has begun. The installation is expected to be completed in FY 1979, and the first experiments are expected to begin in FY 1980.

More than 300 individual scientists representing over 100 universities and laboratories have been formally organized into the HHIRF User Group.

New Initiatives for DER

Important chemical changes occur when coal is heated in the range of 400°C for only a few minutes. These chemical changes make the coal much more reactive toward solvents used to obtain coal-derived liquids. We are initiating several investigations into the nature of such reactions. First, hydrogen is a key to coal liquefaction, and the rate of hydrogen exchange reactions versus the rate of carbon-carbon bond cleavage is needed to understand molecular weight reduction of the coal macromolecules. Isotopic tracing methods will be employed in studying these kinetics both in coal and model compounds. Also, ^{13}C nuclear magnetic resonance (NMR) will be used to follow reactions in the carbon skeleton of coal during rapid heating

as well as in more extensive pyrolysis reactions. The recombination and condensation reactions of heterocyclic oxygen and sulfur compounds that simultaneously increase the molecular weights of coal macromolecules are also being studied using isotopic tracer techniques and NMR. When solvents such as the Wilsonville recycle solvent are involved in the reactions, ^{14}C reagents are particularly helpful because they contain scores of compounds themselves.

It is expected that efforts on this new initiative will increase during this planning period and that the results will make valuable contributions to the nation's fossil energy programs.

A major problem with all energy technologies involving the generation of heat will be the availability of materials with appropriate properties at very high temperatures. The new High-Temperature Materials Laboratory (HTML) will be a unique laboratory for basic research on materials at elevated temperatures, including precise measurements and very long term experiments. New programs will be initiated under several general research groupings: mechanical behavior, environmental interaction, property measurements, structural characterization, materials synthesis and preparation, and materials development. Further discussion of the HTML is given in Chap. 3 of this report.

In the field of heavy-ion nuclear physics, the proposed Super Phase II Project will substantially expand the beam-producing ability of the HHIRF. A high-field isochronous cyclotron using superconducting main coils is the central item in Super Phase II. For the heaviest accelerated ions, the effective energy constant is approximately 1500, which implies a high energy beam of at least 50 MeV/amu for uranium ions. This facility is to be designed as a national facility with the capacity to support a large user organization. It is discussed further in Chap. 3 of this report.

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Summary of resources*—New initiatives in the physical sciences (primarily nuclear sciences, materials sciences, and advanced technology)

	'78	'79	'80	'81	'82	'83	'84
Operating costs	0.0	1.6	2.5	3.3	4.1	4.9	5.8
Subcontracting and procurement	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital equipment	0.0	0.3	0.4	0.4	0.5	0.5	0.6
Direct FTE	0	17	26	34	42	49	57

Assistant Secretary for the Environment

The Assistant Secretary for the Environment (ASEV) is responsible for programs in the GK and HK activities, as well as the decontamination and decommissioning of certain sites and facilities. There are substantial programs in these areas at ORNL.

The overall biomedical and environmental sciences program funded through the GK (Environment; Multi-Research) and HK (Life Sciences Research and Biomedical Applications) programs at ORNL is primarily concerned with the identification, understanding, and reduction of health and environmental impacts of energy production and use. Research activities in this program include physical, chemical, biological, ecological, health, and assessment studies on the transport and effects of products and by-products of both nuclear and non-nuclear energy technologies at the molecular, cellular, organism, population, and ecosystem levels.

In addition, a significant effort is under way in the Decontamination and Decommissioning subactivity (KN 03 60). These activities are directed toward the safe management and disposition of surplus or inactive radioactively contaminated facilities and sites of DOE (or predecessor agencies) and include the survey and surveillance of facilities and planning for the decontamination and decommissioning of these facilities.

Summary of resources*—Assistant Secretary for the Environment

	'78	'79	'80	'81	'82	'83	'84
Operating							
Overview and assessment (GK 01 01)							
Direct FTE	47	60	60	62	63	64	64
B/O[a]	4.5	4.4	4.5	4.6	4.7	4.8	4.8
B/A[b]	6.0	5.7	6.0	6.1	6.3	6.4	6.4
Subcontracting and procurement	0.9	0.2	0.2	0.2	0.2	0.3	0.3
Biomedical and environmental research (GK 01 02)							
Direct FTE	224	241	241	252	260	266	273
B/O	17.1	17.8	19.0	19.8	20.5	21.1	21.8
B/A	22.6	23.7	25.3	26.3	27.3	28.1	29.0
Subcontracting and procurement	0.9	0.8	0.9	0.9	1.0	1.2	1.4
General life sciences (HK 01 01)							
Direct FTE	75	68	68	68	68	70	71
B/O	5.8	6.0	6.2	6.2	6.2	6.3	6.4
B/A	7.7	8.0	8.2	8.2	8.2	8.4	8.5
Subcontracting and procurement	0.4	0.4	0.4	0.5	0.6	0.8	1.0
Biomedical applications (HK 01 02)							
Direct FTE	11	12	12	12	12	12	12
B/O	1.0	1.1	1.2	1.2	1.2	1.3	1.3
B/A	1.4	1.5	1.6	1.6	1.6	1.7	1.7
Subcontracting and procurement	0	0	0	0	0	0	0
Decontamination and decommissioning (KN 03 60)							
Direct FTE	21	12	12	12	12	12	12
B/O	1.5	2.2	2.2	2.2	2.2	2.2	2.2
B/A	1.8	1.9	2.9	2.9	2.9	2.9	2.9
Subcontracting and procurement	0.3	0.1	0.1	0.1	0.1	0.1	0.1
Total operating[c]							
Direct FTE	378	393	393	406	415	424	432
B/O	29.9	31.5	33.1	34.0	34.8	35.7	36.5
B/A	39.5	40.8	44.0	45.1	46.3	47.5	48.5
Subcontracting and procurement	2.5	1.5	1.6	1.7	1.9	2.4	2.8
Capital equipment							
Overview and assessment (GK 01 01)		0.4	0.4	0.4	0.5	0.6	0.6
Multiresource and other capital equipment—net environmental research (GK 90)	2.4	1.8	1.5	1.9	2.0	2.4	2.6
General life sciences (HK 01)	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Biomedical applications (HK 02)		0.1	0.1	0.1	0.1	0.1	0.1
Decommissioning and decontamination (KN 03 60)		0.1	0.1	0.1	0.1	0.1	0.1
Total capital equipment	2.5	2.5	2.3	2.7	2.9	3.4	3.6

[a] *B/O* = budget outlays.

[b] B/A = budget authority.

[c] Estimates for FY 1979 include $2.2 million in programs that may be transferred to the Environmental Protection Agency (EPA). However, these programs are to be continued at ORNL for two years.

Biomedical and Environmental Sciences

Technical Thrust

Overview and Assessment (GK 01 01). This subactivity is primarily directed at ensuring that environmental, health, and safety considerations are incorporated in formulating and implementing energy technology decisions, plans, and programs. Toward this end, ORNL has established the Office of Environmental Policy Analysis to examine current and future policies related to the development and use of energy technologies and provide input for decision making by DOE management. This office has been assigned responsibility for performing critical analyses of criteria, land use, and institutional arrangements for control of solid wastes from energy technologies. Particular emphasis will be placed on the Resource Conservation and Recovery Act; decontamination and decommissioning criteria for inactive uranium mill tailings sites and excess DOE sites; and water and energy development policy issues in the eastern United States.

In support of these policy and assessment activities, ORNL has established a broad base of information systems and data bases concerning the environmental, safety, and other aspects of various energy technologies.

Another important aspect of this subactivity at ORNL is related to environmental engineering for coal and nuclear technologies. These efforts are directed at ensuring the timely development of adequate environmental control capability for these energy technologies. In addition, significant efforts will be aimed at identifying appropriate bioprocesses that can be used as control technologies for the various energy sources and for resource recovery.

Biomedical and Environmental Research (GK 01 02). This subactivity is directed at securing the information that is required for an understanding of the possible short- and long-term consequences to humans and to the environment of the various processes leading to the production and use of energy, particularly those processes involved in coal conversion. This activity encompasses a broad effort to gain an understanding of the interaction of radiation and other energy-related pollutants 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 individuals and human populations can be identified, evaluated, and anticipated; and that the overall environmental costs of the various energy options can be meaningfully assessed. Major research programs are involved with the development of genetic and somatic testing systems designed to screen a variety of potentially hazardous substances in animal populations. In addition, many of the techniques developed during the past 30 years to study the risks to human well-being from exposure to radiation are also being applied to estimating the risk to humans from exposure to energy-related chemicals. In support of this effort, new techniques are being developed for identifying specific chemicals and mixtures of chemicals, determining the methods of exposure to them, determining the dose received, and correlating the effects with risk to human health.

Information concerning the environmental transport, fate, and effects of energy-related pollutants is necessary to understand better the potential impacts of developing energy technologies. Major research efforts are involved with developing ecological test systems that will enable environmental hazard analyses to be made. Investigations designed to elucidate transport and transformation processes provide data concerning the fate of effluent components in the environment. Such data are useful in determining critical pathways to man.

Another part of this subactivity aims at providing the information necessary for decision makers who must ensure that processes for converting coal to synthetic fuels will not result in unacceptable risks to human health and the environment when implemented on a commercial scale.

General Life Sciences and Biomedical Applications (HK 01 01, HK 01 02). These subactivities are directed at the more basic life science research activities that support the specific technology-oriented activities in the GK programs. The development, validation, and improvement of systems for testing new biological hazards are supported by research efforts in carcinogenesis and mutagenesis. The problems relating to toxicological effects are making

imperative the acquisition of new knowledge on which to base identification, dosage, and source of the materials involved. The biomedical applications program involves efforts to capitalize on the unique probing abilities of stable and radioactive isotopes, using them to detect subtle pathological changes that may be harbingers of serious diseases in human populations.

Decontamination and Decommissioning (KN 03 60). This program supports DOE's efforts to provide for the safe management and disposition of surplus radioactively contaminated facilities and sites of DOE (and predecessor agencies). These activities include the planning and scheduling of disposition and stabilization and the monitoring of selected sites to determine baseline conditions as well as conditions after decontamination and decommissioning activities.

Major Changes in the Program

There have been four major changes in ORNL efforts in the biomedical and environmental areas. First, the Health and Safety Research Division was created through the reorganization of some aspects of the overall biomedical and environmental sciences program. This division conducts efforts concerned with basic and applied research on pollutants of energy technologies. Second, in response to DOE's interest in environmental policy analysis, ORNL has established the Office of Environmental Policy Analysis as part of the DOE program. Third, in the area of toxicological research, the Laboratory is developing a strong major program to support the shift in emphasis from investigation of the biological aspects of radiation damage to investigation of the biological aspects associated with chemical pollutants. Finally, ORNL has shifted the program to stress the early detection of environmental and health effects from new technologies. This has resulted in an increased emphasis on the development of instrumentation for area and personnel monitoring for the effluents from coal conversion technologies.

Major Difficulties or Issues

Although we do not anticipate any major problems in our technology-related research funding, as indicated by our projections in the accompanying budget summaries, we are concerned about the plateau of funding in the basic life sciences (both environmental and health) research area. This leveling off is coming at a time when more emphasis is being placed on the basic life sciences research associated with nonnuclear technologies. We have reprogrammed some of the nuclear-related work into the non-nuclear-related areas, but it will be difficult and unwise to increase this reprogramming further. Because both nuclear and nonnuclear technologies will be relied on to meet the future U.S. energy demands, basic life sciences research in both areas must be carried out in a balanced manner.

New Initiatives in the Life Sciences (Involving ASEV, ASET, DER, ASRA,* ASC&SA†)

Site-Specific Gasification and Liquefaction Studies

As part of its charter to develop new energy sources, DOE has stressed the conversion of coal to gaseous and liquid fuels. However, various opportunities for occupational exposure and effluent release to the environment will arise from the production and use of these fuels. These effluents must be characterized to permit evaluation of their potential environmental and health impacts. In addition, environmental control systems must be provided to minimize effluent releases, and engineering control systems must be provided to minimize fugitive emissions. Information on their efficiency in reducing these releases as well as on operating costs and maintenance requirements is also required. Sample collection, on-line monitoring, and subsequent analysis and testing are needed to provide data from which assessments can be made of the environmental acceptability of the various proposed gasification and liquefaction technologies.

At the request of DOE, ORNL is preparing program plans for the investigation of selected gasification and liquefaction processes by onsite monitoring of coal conversion facilities as

*Assistant Secretary for Resource Applications.

†Assistant Secretary for Conservation and Solar Applications.

they are built. The objective of this program is to provide the additional data, information, and assessments on coal conversion that will permit DOE and other federal agencies to judge the potential environmental and health impacts and the consequent environmental acceptability of proposed conversion processes. The information will be site specific but will lend guidance on program modifications or additions at other installations. It will be developed through onsite measurements, coupled with the evaluation of this site data by the multidisciplinary expertise available in the ORNL Life Sciences Synthetic Fuels Program.

Although the Laboratory anticipates that this new program will be applicable to all potential conversion processes, it will initially be directed (through the Gasifier in Industry programs) at the evaluation of the three low-Btu gasifiers to be built at the University of Minnesota-Duluth (UMD); Pike County, Kentucky; and Land O'Lakes, Minnesota. The program developed for evaluating the UMD gasifier is characteristic of the approach that would be applied to the evaluation of any coal conversion facility. It involves (1) examining the industrial hygiene aspects of the facility, (2) evaluating the efficiency of the environmental control technology used, (3) investigating the environmental fate and effects of the process effluents, (4) evaluating the potential impacts of product use, and (5) preparing an overall assessment of the health, safety, and environmental impacts of the facility.

In addition to the low-Btu gasifiers, DOE has requested that similar investigations be performed for the H-coal pilot plant now under consideration. No full-scale environmental field program is planned at any of the Gasifiers in Industry sites or at the H-coal plant. It is proposed, however, that such studies be undertaken at the solvent refined coal (SRC) demonstration site. Initial efforts must be undertaken as early as possible (perhaps two years before construction begins) and must continue throughout the operation of the demonstration facility. Costs for these efforts are reflected in the budgets for FY 1980 and beyond. Also, a cooperative program is envisioned with TVA at their demonstration project that uses a Texaco coal gasifier to produce the feed materials for the synthesis of ammonia to be used in fertilizer production (Ammonia from Coal Project).

These studies will require support for the investigation associated with each specific site, as well as increased levels of support for the core effect of the Life Sciences Synthetic Fuels Program. The estimated resources required from ASEV are identified in the following table.

Summary of resources*—Site-Specific Gasification and Liquefaction Studies

	'78	'79	'80	'81	'82	'83	'84
Site-specific studies	1.1	2.5	2.5	2.9	2.4	1.7	0.9
Life Sciences Synthetic Fuels Program	0.3	0.5	0.7	0.8	0.6	0.5	0.3
Subcontracting and procurement	0.3	0.9	2.5	2.6	2.7	1.3	0.8
Total operating cost [a]	1.7	3.9	5.7	6.3	5.7	3.5	2.0
Direct FTE	13	30	41	49	40	29	16

[a]Approximately $0.5 million of the money identified for this new initiative is considered to be part of the ORNL ongoing program and is also included in the ASEV summary table.

Biotechnology Development

Biological processes offer great promise for both the near- and long-term production of fuels, as well as for the abatement of pollution and the recovery of valuable resources. However, if such biotechniques are to be practically and economically viable, the engineering and biological processes involved must be optimized. ORNL possesses the expertise in chemical processing and engineering, biological, and environmental sciences areas to make a major contribution toward the goal of developing efficient bioprocesses for the production of fuel, treatment of wastes, and recovery of valuable resources.

Three major areas of concentration are envisioned in this initiative. The first of these—bioengineering research—is directed toward the design of practical engineering units for using the biological processes developed in other areas of the program; it will involve investiga-

tions in several areas. First, high-resolution separation techniques will be designed and developed for various compounds. Second, the immobilization of whole cell, enzyme, or organelle materials on suitable solid supports, or in compatible fibers or semipermeable membranes, will be investigated. Third, reaction kinetics of these biological materials, when immobilized or suspended, will be investigated. These investigations then support the design and optimization of bioreactors.

The second major area of concentration will be in advanced instrumentation; it will be directed at the development of advanced instrumentation to measure and monitor important parameters in bioprocesses or to help define environmental and human exposure to energy pollutants. This effort will concentrate on examining biological or biochemical indicators in bioprocesses or environmental and human systems that are produced as a result of exposure to energy-related pollutants. Of particular interest will be efforts to identify biochemical indicators of mutagenesis in humans.

The third major area of concentration will be in bioprocess development. Various bioprocesses will be investigated for their potential in environmental control technology, biomass use, and resource recovery. This will involve determining which organisms or plant species are most efficient for a given process, which conditions are optimal for a given organism or biological process, and which conditions are optimal for mass culture of the most efficient organism.

In addition, ORNL is sponsoring a series of symposia with the DOE on bioprocesses in energy production and conservation. These symposia will bring together the various disciplines and institutions involved in the development of viable new bioprocesses for energy production and conservation.

The following table identifies the resources that would be required to support this new initiative, and it gives some indications of the DOE organizations that might be involved.

Summary of resources*—Biotechnology Development

	'78	'79	'80	'81	'82	'83	'84
Bioengineering research							
ASEV	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE	3	3	3	3	3	3	3
OER	0	0.1	0.2	0.3	0.4	0.5	0.5
Direct FTE	0	1	2	3	4	5	6
Advanced instrumentation							
ASEV	0.6	0.6	0.6	0.7	0.7	0.7	0.7
Direct FTE	7	7	7	8	9	9	9
ASET	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Direct FTE	1	1	2	3	3	3	3
Bioprocess development							
ASEV	0.2	0.2	0.3	0.5	0.5	0.5	0.5
Direct FTE	2	3	4	5	5	5	5
ASET	0.7	0.8	0.9	1.0	1.0	1.2	1.2
Direct FTE	7	8	9	10	10	12	12
ASC&SA	0.4	0.4	0.5	0.5	0.6	0.6	0.6
Direct FTE	4	4	5	5	6	6	6
ASRA	0	0.1	0.1	0.2	0.2	0.3	0.3
Direct FTE	0	1	1	2	2	4	4
Total operating cost[a]	2.2	2.5	2.9	3.6	3.8	4.2	4.2
Total FTE	24	28	33	39	42	47	48

[a]Approximately $2 million of the money identified for this new initiative is considered to be part of the ongoing ORNL program (ASEV, ASET, and ASC&SA programs) and is included in the appropriate operating budget tables.

National Environmental Research Parks

Establishment of certain federal lands as National Environmental Research Parks (NERPs) is an outgrowth of the National Environmental Policy Act of 1969, which has demonstrated the need and value of long-term studies related to the environmental impacts of technology. The objectives of these programs are (1) to develop methods for the continuous and quantitative assessment of the environmental effects of man's activities; (2) to develop models to predict the response of environmental components to proposed technological activities; and (3) to provide landscapes, representative of the ecological systems found in particular regions of the United States, that can be used as regional reference and research sites. Thus the NERP can serve science and technology as a

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

protected, controlled outdoor laboratory for investigations by scientists having environmental interests or responsibilities. Four such parks already have been designated at DOE facilities (Savannah River, Los Alamos, Idaho Falls, and Hanford).

In 1977 the Environmental Sciences Division prepared a proposal to designate certain lands within the Oak Ridge Reservation as an NERP. This proposal was approved and forwarded to DOE by ORO, and we are awaiting a decision. The benefits to ORNL environmental research outlined originally remain—namely, to ensure the continuity of selected land and water resources areas within the reservation and the continued preservation of areas of undisturbed, natural lands that are protected from external influences and to protect unique biological areas, as well as rare and endangered species. The most important benefit to ORNL environmental research programs is that the existence of an NERP and the activities associated with it provide a long-term frame of reference in which to interpret the many results of short-term research on specific issues.

Current DOE support for the park project is used to document the natural resources of the proposed NERP, to develop plans for long-term monitoring networks, and to coordinate in-house environmental research with outside operations activities (e.g., timber management and facility construction). With only modest increases in support, designation of reservation land as an NERP would facilitate the setting up of monitoring networks to identify effects of technological activities and to document long-term biological trends; the development of a data storage and retrieval system for all environmental data, which would provide review capability; and the monitoring of research by offsite participants.

Summary of resources*—National Environmental Research Parks

	'79	'80	'81	'82	'83
Operating cost	0.1	0.2	0.2	0.2	0.2
Direct FTE	2	3	3	3	3

The Carbon Dioxide (CO_2) Problem

The increased use of fossil fuels and changes in land use practices (especially deforestation) are contributing to an increase in the atmospheric concentration of CO_2, which has given rise to national and international concern. At some presently unknown level of CO_2 concentration, the "greenhouse" effect would lead to significant changes in the earth's climate. These changes would, in turn, affect land use in several important, even vital, ways. Because it is proposed to increase the use of fossil fuels notably in the coming decades, it is imperative that we develop a good understanding of the global carbon cycle. Three general questions have been identified as critical: (1) How is carbon distributed in the biosphere? (2) What climatic changes could result from CO_2 build-up? (3) What would be the environmental impacts of these changes?

We have proposed to DOE's Division of Biomedical and Environmental Research that ORNL contribute to a broad-based program of research and assessment of the CO_2 problem. A comprehensive R&D program has been funded by the National Science Foundation (NSF) as part of an ongoing program in ecosystems science.

We would conduct research in four areas of the CO_2 problem:

1. Modeling the carbon cycle in the biosphere. We already have extensive experience in terrestrial ecosystem analyses and are almost a sole source of much of the needed data. We will continue these terrestrial studies and will initiate additional research to obtain missing parameters such as rates of CO_2 efflux from soil following a disturbance.

2. Climatological modeling. Our major development effort here will be in the area of coupling biological responses to climatic change.

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

3. Impact research and assessment. There is very little effort in this area now, and we propose to play an increasingly major role. Our experience in this field gives us a unique capability for impact studies. Particular emphasis will be given to risk analysis of CO_2 buildup and to sensitivity analysis of those parameters in the model whose values may be uncertain.

4. Critical data management.

The following resources from the ASEV are required to support the DOE portion of this proposed initiative:

Summary of resources*—The Carbon Dioxide Problem

	'78	'79	'80	'81	'82	'83	'84
			Approved				
Cost	0.1	0.2	0.2	0.2	0.3	0.3	0.3
Direct FTE	1	3	3	3	3	3	3
			Proposed				
Cost	0	1.0	1.1	1.2	1.0	0.9	0.7
Direct FTE	0	10	11	11	10	9	7
Total cost	0.1	1.2	1.3	1.4	1.3	1.2	1.0
Total FTE	1	13	14	14	13	12	10

Biological Utilization of Waste Resources for Energy Conservation

The objective of this new initiative is to develop an energy-conserving advanced waste treatment system for temperate climates that produces usable biomass. This concept uses the natural efficiency of biological systems in removing nutrient and trace metal contaminants and provides for use, for various applications, of the biomass produced in the process.

The basic concept involves a closed cycle energy-conserving system that uses harvestable aquatic plants as nutrient scavengers for effecting tertiary wastewater treatment. The biomass produced would be combined with sludge obtained after primary wastewater treatment and subjected to anaerobic digestion to produce methane gas. The methane would be used (1) to provide supplemental heat to optimize the growth of the plants, (2) to maintain favorable temperatures for the digestion process, and (3) to provide power for other facility functions.

Discussions have been held with TVA about the possibility of a joint project in this area. ORNL would perform the basic research on species and process condition optimization to provide the information necessary to design the proposed system. TVA would then consider constructing a pilot plant using this design as part of their Innovative Waste Treatment Development Program.

Summary of resources*—Biological Utilization of Waste Resources for Energy Conservation

	'79	'80	'81	'82	'83	'84
ORNL	0.08	0.32	0.51	0.75	0.47	0.27
Subcontracting and procurement	0.01	0.08	0.15	0.15	0.06	0.06
Direct FTE	1	4	5	9	6	3

Coal Conversion Solid Waste Management

In line with ORNL's increasing role in the DOE coal program, we propose to develop a new initiative in the area of solid waste management for coal conversion facilities. This initiative is currently at a preliminary stage, so details are not yet available on its precise scope or on the supporting resources required. This information will be developed over the next several months and will be discussed further in the next *Institutional Plan*. However, some discussion of ORNL capabilities in this area and of the broad objectives of this initiative will be presented here.

Through its radioactive waste management activities, ORNL has developed a broad expertise in the management of solid wastes, which has resulted in the development of strong geoscience, hydrologic modeling, monitoring, and general engineering capabilities. A limited program for examination of landfill disposal of coal conversion residues was initiated by ORNL under fossil energy program funding during FY 1978, and tests are in progress for determining the extent of soil interactions with coal conversion waste constituents including the trace metals. Furthermore, as part of the life sciences

synthetic fuels program, capabilities have been developed for evaluating the characteristics of various coal wastes for candidate demonstration plant projects. In addition, lysimeter tests are under way to determine the extent to which interaction with soils is important in limiting the transport of waste constituents, including the trace metals, and to provide information needed to develop environmentally sound solid waste disposal techniques.

Significant expertise has also been developed at ORNL in the area of ecological and biological testing of solid waste leachates through a program sponsored by the Environmental Protection Agency (EPA) to develop protocols for use in conjunction with the implementation of the Resource Conservation and Recovery Act (RCRA). These efforts involved the development of protocols for obtaining leachate material and the development of ecological and biological tests to determine the hazards from the leachates associated with solid wastes.

In addition, the Office of Environmental Policy Analysis at ORNL has been given the task of monitoring the development of RCRA for ASEV and developing an analysis of the policy implications for DOE. Current Laboratory efforts are aimed at developing mechanical, chemical, and biological processes that can be applied to solid wastes to recover useful resources before disposal or to reduce the volume of the waste that must be disposed.

As can be seen, ORNL possesses broad expertise in all areas related to the disposal of the solid wastes from coal conversion facilities. This enables the Laboratory to apply a holistic approach to the problem of developing environmentally sound techniques for the disposal of these wastes.

As currently envisioned, this new initiative would focus on developing waste management techniques for specific coal conversion pilot or demonstration plants now being considered by DOE. These onsite activities would then serve as the basis for deriving waste management techniques that could be used for commercial scale plants. Three components would be involved in this program. The first would be aimed at developing waste management techniques for use at specific demonstration locations. This would involve a program of physical and chemical site characterization, coupled with small-scale testing (lysimeter tests) to evolve a waste management scheme for each site that is being considered.

Second, experiments will be performed to obtain leachate samples from these solid wastes for use in ecological and biological assay tests to determine the hazard of the leachates. These studies will provide information for input into the waste management scheme for each facility to ensure protection of the environment and human health, as well as compliance with RCRA.

Finally, the site-specific information will be used as a basis for conducting more generic efforts to develop additional waste management techniques. These efforts will involve consideration of the potential for resource recovery in conjunction with solid waste management, the possibility of establishing a regional approach to solid waste management, and an investigation of the environmental health and safety aspects of the transportation of solid wastes.

Assistant Secretary for Conservation and Solar Applications

Conservation work in DOE is currently divided between ASC&SA and ASET. Work carried out or managed by ORNL for ASC&SA is discussed in this section.

The conservation program at ORNL (both ET and CS) is expected to grow in this planning period. National needs in conservation are being assessed, and ORNL will work with DOE in contributing to meet these needs.

Conservation and Solar Applications

Technical Thrust

Residential and Commercial Conservation (C3). Demonstration of the Annual Cycle Energy System (ACES) concept will wind down during this planning period. Studies continue on reduction of initial costs and improved reliability. The load-leveling characteristics of the ACES are important, and this spin-off will

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Summary of resources*—Assistant Secretary for Conservation and Solar Applications

	'78	'79	'80	'81	'82	'83	'84
Operating							
Residential and commercial conservation (C3)							
Direct FTE	30	33	33	33	33	33	33
B/O[a]	4.0	6.1	6.5	6.7	7.1	7.2	7.2
B/A[b]	6.4	6.6	6.6	6.7	7.0	7.1	7.2
Subcontracting and procurement	1.7	3.4	4.1	4.5	4.7	4.8	4.8
Industrial conservation (C4)							
Direct FTE	3	4	5	9	9	10	10
B/O	0.4	0.9	1.3	2.0	2.1	2.2	2.3
B/A	0.6	1.2	1.2	1.3	2.2	2.2	2.3
Subcontracting and procurement	0.2	0.2	0.4	0.5	0.7	0.7	0.7
Transportation conservation (C5)							
Direct FTE	4	8	9	10	11	12	13
B/O	0.5	0.6	0.7	0.8	0.9	1.0	1.2
B/A	0.5	0.7	0.7	0.9	0.9	1.0	1.2
Subcontracting and procurement	0.2	0.2	0.2	0.2	0.3	0.4	0.5
Solar thermal applications (AD 01)							
Direct FTE	2	3	3	3	3	3	3
B/O	0.2	0.2	0.2	0.2	0.2	0.2	0.2
B/A	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Subcontracting and procurement							
Heating and cooling (BD 01)							
Direct FTE							
B/O		0.2					
B/A	0.2	0.2					
Subcontracting and procurement							
Total operating							
Direct FTE	39	48	50	55	56	58	59
B/O	5.1	8.0	8.7	9.7	10.3	10.6	10.9
B/A	7.9	9.0	8.7	9.1	10.3	10.5	10.9
Subcontracting and procurement	2.1	3.8	4.7	5.2	5.7	5.9	6.0
Capital equipment							
Residential and commerical conservation (C3)		0.3	0.2	0.2	0.2	0.2	0.2
Industrial conservation (C4)		0.3	0.3	0.3	0.3	0.3	0.3
Transport conservation (C5)			0.1	0.1	0.1	0.1	0.1
Total capital equipment		0.6	0.6	0.6	0.6	0.6	0.6

[a]B/O = budget outlays.
[b]B/A = budget authority.

be fully explored. A modified ACES using air as a heat source when outside temperatures exceed 32°F will be studied.

Improving engineering systems to minimize the energy requirements of residential and commercial heating and cooling appliances is a major objective of the buildings and appliances programs. The heat pump management program focuses on gas-fired heat pumps and new components and systems to improve efficiency and reliability: ORNL is planning this program for DOE.

The current thrust in the ANFLOW (an anaerobic, upflow, packed-bed bioreactor) program is to produce a data base for engineering design of larger systems, and markets for the ANFLOW process are being assessed. Large-scale research and demonstration projects are proposed to be conducted in cooperation with industry to optimize energy conservation in treating industrial wastes.

Assistance is given in planning the national program, measuring the properties of insulation, developing materials standards, and developing instrumentation to measure the heat loss or gain in a prototype building structure.

ORNL is collecting and validating data on energy use in the building and industrial sectors.

Industrial Conservation (C4). Economical materials that can be used in high-temperature recuperators to recover energy from discharge streams are vital to industrial conservation. The ORNL thrust is on materials technology.

ORNL's program for the identification and analysis of detrimental reactions in commercial refractories will provide information and guidance that will be needed if heavy oils and coal are to be used in industrial furnaces.

Current treatment of industrial waste has generally required energy-intensive onsite processes followed by offsite transportation of sludge. An alternative is the anaerobic digestion of carbonaceous waste materials; the optimization of this process is a continuing effort at ORNL.

Concepts, evaluations, and experiments to recover valuable resource material from wastes have far-reaching conservation potential; the initial ORNL program is aimed at recovering metallic componds from fly ash.

Transportation Conservation (C5). Reliable data on the use of energy in transportation are needed to make decisions for energy conservation in this sector. ORNL will continue the development, modeling, and analysis of a comprehensive data resource of ongoing use of the transportation sector.

ORNL has been selected by the director of DOE's Division of Transportation Conservation as the primary laboratory for transportation data analysis. A comprehensive sector-wide model will be developed as the objective of an R&D effort.

Solar Thermal Applications (AD 01). Technical assistance is being provided to the DOE Agricultural and Industrial Process Heat Branch of the Office of Conservation and Solar Applications and to the Department of Agriculture (DA), which manages the agricultural portions of the program. We independently evaluate each proposed project submitted to DA as well as monitor and report to DA and DOE the progress of each project funded.

Major Changes in the Program

Increasing emphasis has been given to management programs (of which ORNL now has seven, including ET and CS programs). A management role is accepted only if ORNL has technical expertise and is conducting, or prepared to conduct, significant in-house R&D in this area. These programs are often interdivisional and draw on expertise from throughout the Laboratory. Through careful selection, monitoring, and supervision of subcontractors, the Laboratory can extend substantially its conservation activities.

ORNL expects a greater involvement during this planning period in management-type work, not only for the divisions of Building and Community Systems and Electric Energy Systems but also for those of Industrial Conservation, Fossil Energy Utilization, and Energy Storage Systems.

Major Difficulties or Issues

Although the Laboratory has a good deal of basic equipment that can be, and is, used in the conservation programs, there is a continuing

need for funding to acquire additional equipment for this work.

Adequate laboratory and office space is a serious limitation in some programs and cannot always be economically provided by converting existing Laboratory space.

Major Results and Milestones Expected

An independent evaluation of pilot plant performance, market projections, and a conceptual design study for large-scale ANFLOW systems is being made by an engineering consulting firm. If the results are positive, a large-scale demonstration of ANFLOW will be made in cooperation with TVA beginning late in FY 1980.

Standards for building insulation will be established. Models forecasting energy use will enable energy-saving decisions to be made. Innovative housing designs will be achieved, and advanced heat pump cycles will be evaluated. A cascade system will be designed to reduce the energy wastage from industrial processes.

New Initiatives for ASC&SA

Waste Heat Utilization

ORNL has proposed to the Division of Industrial Conservation a comprehensive 189 entitled "Industrial Energy Conservation Management and Technical Support." The proposal encompasses all in-house R&D interest in cogeneration, cascaded use of industrial process heat, integrated industrial parks, and use of heat rejected from generation of electricity. More than 20 of the 74 quads of energy consumed in the United States in 1978 were wasted, and this problem should be addressed comprehensively. In this initiative ORNL has the expertise to be the lead laboratory.

Recovery of Basic Resources and Generation of Energy from Waste Products

Two separate, but related, proposals have been submitted to the Division of Industrial Conservation for investigations of onsite anaerobic fermentation systems for handling industrial wastes and for recovering resource material from coal wastes. Subsequently, the Division of Community Systems has asked ORNL to consider a greater involvement in treatment and resource recovery from domestic and commercial wastes.

Treatment of wastes to produce energy or to recover basic chemical or mineral resources often has simultaneous environmental improvement qualities. The combination of all characteristics offers significant economic incentives, and commercialization is a realistic objective for these systems.

Assistant Secretary for Resource Applications

Ongoing Program

The ORNL program on behalf of the Assistant Secretary for Resource Applications (ASRA) supports and interacts with other DOE efforts aimed at developing emergency preparedness procedures and capabilities. The ORNL effort is

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Summary of resources*—Assistant Secretary for Resource Applications

	'78	'79	'80	'81	'82	'83	'84
	Operating						
Emergency preparedness (EK 02)							
Direct FTE	2	6	6	6	6	6	6
B/O[a]	0.1	0.5	0.6	0.6	0.6	0.6	0.6
B/A[b]	0.2	0.7	0.6	0.6	0.6	0.6	0.6

[a]B/O = budget outlays.
[b]B/A = budget authority.

directed primarily at developing easily implemented techniques for general population protection and emergency situations.

New Initiative for ASRA

The ASRA has initiated the Low-Head Hydroelectric Power Development Program to encourage and accelerate the redevelopment of existing dams that are amenable to the construction or retrofitting of hydropower facilities. The purpose of this new initiative is to establish ORNL as the technical support group responsible for the development and implementation of an environmental subprogram for low-head hydroelectric technology development.

This new initiative will be directed at four areas as follows:

1. to provide environmental expertise for the development and implementation of an environmental subprogram plan that will ensure an environmentally sound development of this emerging technology;
2. to provide, on the basis of extant information, in-depth environmental analyses on identified potential issues;
3. to conduct specific environmental research in identified areas; and
4. based on the methodologies, predictive capabilities, and research insights developed in the above effort, to prepare guidance documents and to identify continuing research needs to ensure the protection and potential enhancement of the environment coincident with the development of low-head hydroelectric resources.

Summary of resources*—Low-Head Hydroelectric Power Developmental Program

	'79	'80	'81	'82	'83	'84
Direct FTE	0.3	0.3	0.5	0.7	0.7	0.7
Subcontracting	5	5	5	5	5	5
and procurement	0	0	0.2	0.3	0.3	0.3

Administrator, Energy Information Administration

The data validation program, which ORNL carries out for the Energy Information Administration, derives from the needs of energy policy makers and other data users for reliable and credible information. Central to this program is the study of data validation methods including statistical methods, economic cost-benefit analysis, numerical data editing, and validation techniques not yet identified. ORNL research, under this program, will be directed toward verifying the accuracy of energy data (and eventually models), evaluating the adequacy of energy data systems, developing and validating suitable methodologies, and ensuring the coordination and comparability of energy information provided by DOE.

Other tasks carried out on behalf of EIA are the preparation of industrial, residential, and commercial energy use models; a highway gasoline demand model; extension of and access to MULTIREGION, a simulation-forecasting model of Bureau of Economic Analysis economic area population and employment; and the preparation of an end use energy consumption data base.

Administrator, Economic Regulatory Administration

ORNL is undertaking a number of tasks for the Economic Regulatory Administration (ERA). The Laboratory is providing assistance in the forecasting and analysis of electric power supply (including data collection), in energy emergency planning to identify potential regional shortages of natural gas and to develop and evaluate strategies for avoiding them, and in studying the regulatory aspects of cogeneration/district heating systems in a joint program between the Office of Utility Systems (ERA) and the Advanced Systems and Materials Production Division (Nuclear Energy Programs). ORNL will also prepare

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Summary of resources*—Administrator, EIA

	'78	'79	'80	'81	'82	'83	'84
Data validation and end use energy consumption data base (FK 01 01)							
Direct FTE	0	5	4	5	6	7	8
B/O[a]	0	0.4	0.4	0.5	0.8	1.0	0.8
B/A[b]	0.2	0.5	0.4	0.8	1.2	1.2	1.2
Subcontracting and procurement	0	0.1	0.1	0.1	0.1	0.1	0.1
Industrial, residential, and energy use models; highway gasoline demand model; and extension and access to MULTIREGION (FK 02 01)							
Direct FTE	4	10	10	10	10	10	10
B/O	1.0	2.8	4.0	4.5	4.6	4.8	5.0
B/A	1.4	5.7	5.0	5.0	5.0	5.0	5.0
Subcontracting and procurement	0.7	1.8	2.6	2.8	3.6	3.8	4.0
Total operating							
Direct FTE	4	15	14	15	16	17	18
B/O	1.0	3.2	4.4	5.0	5.4	5.8	5.8
B/A	1.6	6.2	5.4	5.8	6.2	6.2	6.2
Subcontracting and procurement	0.7	1.9	2.7	2.9	3.7	3.9	4.1

[a]B/O = budget outlays.
[b]B/A = budget authority.

Summary of resources* — Administrator, ERA

	'78	'79	'80	'81	'82	'83	'84
Forecasting and analysis of electric power supply, and regulatory aspects of cogeneration/district heating (C1 05)							
Direct FTE	1	1					
B/O[a]	0.1	0.1					
B/A[b]	0.2						
Subcontracting and procurement							
Energy emergency planning (EK 02)							
Direct FTE	1	2	2	2	2	2	2
B/O	0.1	0.5	0.5	0.5	0.5	0.5	0.5
B/A	0.2	0.6	0.5	0.5	0.5	0.5	0.5
Subcontracting and procurement		0.1	0.3	0.3	0.3	0.3	0.3
Total operating							
Direct FTE	2	3	2	2	2	2	2
B/O	0.2	0.6	0.5	0.5	0.5	0.5	0.5
B/A	0.4	0.6	0.5	0.5	0.5	0.5	0.5
Subcontracting and procurement		0.1	0.3	0.3	0.3	0.3	0.3

[a]B/O = budget outlays.
[b]B/A = budget authority.

a supplement to the environmental impact statement on the El Paso II (Matagordo Project) LNG terminal facility.

Assistant Secretary for Policy and Evaluation

The ORNL program for the Assistant Secretary for Policy and Evaluation supports DOE efforts in evaluating the environmental considerations involved in conducting the National Energy Strategy Study (NESS). This effort will culminate in the preparation of an environmental impact statement that will accompany the legislation implementing the National Energy Plan II.

Summary of resources*—Assistant Secretary for Policy and Evaluation

	'78	'79
Policy and evaluation (KK 02 01)		
Direct FTE	7	5
B/O[a]	0.3	0.5
B/A[b]	0.5	0.3
Subcontracting and procurement	0.2	0.2

[a] B/O = budget outlays.
[b] B/A = budget authority.

Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) programs at ORNL provide the Commission with research and technical support in areas where ORNL has demonstrated technical expertise. The major emphasis is on research, including hydraulics, heat transfer, solid mechanics, fuel and cladding behavior, instrumentation, fission product technology, aquatic and terrestrial ecology, and health science. Technical support is provided to NRC offices as required in the areas of environmental impact statements, standards and codes, instrumentation, materials, social science, and information management.

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Ongoing Programs

Technical Thrust

Reactor Safety Research (RSR). Systems engineering research is focused on the Blowdown Heat Transfer Program using the Thermal Hydraulic Test Facility, for which the major objective is the separate effects testing of transient thermal hydraulics analysis in the blowdown phase of a pressurized-water reactor (PWR) loss-of-coolant accident (LOCA). Fuel behavior experimental research includes investigation of (1) cladding failure of pressurized PWR fuel rods in a prototype bundle subjected to LOCA conditions; (2) cladding creepdown during in-pile fuel exposure; (3) nuclear decay heat released following a nuclear "scram;" and (4) fission product release and transport under conditions of core meltdown, LOCA, or shipping accidents. Metallurgy and materials work includes the Heavy Section Steel Technology Program in which the basic properties ensuring integrity of reactor vessels are studied under operating and accident conditions, the Pressure Vessel Irradiation Program for studies of materials properties when irradiated in a prototype neutron spectrum, and an effort examining design criteria for piping and nozzles. Research applications programs include development, fabrication, and testing of in-vessel flow instrumentation for the international 3-D reflood experiment program, research on diagnostics instrumentation, human-factors studies on operator response and action, development of advanced two-phase flow instrumentation, and safety information center activities.

The Aerosol Release and Transport Program includes investigation of the release and transport of radionuclides from liquid-metal fast breeder reactor (LMFBR) fuels under a range of accident conditions. Using a capacitor discharge fuel vaporization system in air, water, or sodium in a scale containment, this program also provides data for testing complex accident analysis codes. The HTGR Safety Analysis Program is performing dynamic modeling and code testing of HTGR behavior in transients, including analysis of transients occurring in operation of the Fort St. Vrain reactor.

Safeguards, Fuel Cycle, and Environmental Research (SAFER). Aquatic ecology research is performed to examine the impact of reactor cooling systems concentrating on impingement

Summary of resources*—Nuclear Regulatory Commission

	'78	'79	'80	'81	'82	'83	'84
Reactor safety research							
Direct FTE	126	137	130	121	112	104	95
Operating costs	15.0	17.3	17.7	17.0	15.0	14.0	13.0
Subcontracting and procurement	3.0	2.4	3.5	3.5	2.0	2.0	2.0
Safeguards, fuel cycle, and environmental research							
Direct FTE	10	17	13	7	6	4	3
Operating costs	1.3	1.5	1.2	1.0	0.9	0.6	0.5
Subcontracting and procurement	0.1	0.06	0.05	0.05	0.05	0.05	0.05
Office of Standards Development							
Direct FTE	10	7	6	6	6	6	6
Operating costs	0.7	0.6	0.5	0.5	0.5	0.5	0.5
Subcontracting and procurement	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Office of Nuclear Materials Safety and Safeguards							
Direct FTE	16	16	22	22	18	16	13
Operating costs	1.9	1.8	1.9	2.0	1.6	1.5	1.2
Subcontracting and procurement	0.2	0.04	0.04	0.04	0.04	0.04	0.04
Office of Nuclear Reactor Regulation							
Direct FTE	30	35	34	30	26	22	18
Operating costs	2.7	2.9	2.8	2.8	2.5	2.5	2.5
Subcontracting and procurement	0.15	0.15	0.15	0.45	0.50	0.80	1.10
Other							
Direct FTE	2	5	5	5	5	5	5
Operating costs	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Subcontracting and procurement	0	0	0	0	0	0	0
Total							
Direct FTE	194	222	210	191	173	157	140
Operating costs	21.9	24.5	24.5	23.7	20.9	19.5	18.1
Subcontracting and procurement	3.4	2.7	3.8	4.1	2.6	2.9	3.2

and entrainment. Other activities include the development of standardized analysis of fuel shipping containers and development of dosimetry and biotransport models to implement "as low as reasonably achievable" (ALARA) guides for the release of radioactive materials.

Standards Development (OSD). Technical support on standards includes development of reactor materials, codes and standards, nondestructive examination, reactor surveillance and diagnostics, radiation exposure from products, and internal dosimetry.

Nuclear Materials Safety and Safeguards (ONMSS). Technical support work includes evaluation of terminated licenses, assistance in shipping cask analysis, safety review and environmental assessments of fuel cycle facilities, and investigation of radon release from uranium mines and mills.

Nuclear Reactor Regulation (ONRR). The major technical support activity for this office is the preparation of environmental impact statements. ORNL provides teams of engineers, social scientists, and environmental scientists to prepare impact statements for each assigned plant and to follow through with hearing testimony and review until final statement acceptance. Other technical support activities include direct assistance in regulation involving electrical and control systems, surveillance and diagnostic instrumentation, power systems, nondestructive examination, and welding.

Administration. Technical support for administration includes the efforts of the Radiation

Shielding Information Center and a computerized radiation exposure information and reporting system.

Major Changes in the Program

Technical support activities will change in concert with NRC activities. Emphasis is now shifting to operating reactors and is expected to return to design and construction as demand for nuclear power increases again. In the research areas most of the initiatives concerned with LOCA will be completed within the next two to five years. New research tasks will be undertaken as needed to support licensing and regulation; priority will be determined by value/impact analyses based on risk analysis.

There will be more subcontracting of work for ONRR, and a shift of emphasis, especially in the in-house programs, away from assessments relating to reactors and toward work on fuel cycles and waste repositories.

Major Difficulties or Issues

Significant technical challenges remain in the research areas, particularly in two-phase flow instrumentation and in the overall analytical/experimental logic for reducing uncertainty in accident analysis (risk) and for providing means of improving regulatory criteria. In environmental research a more methodical and structured program is needed to ensure that the proper emphases are placed.

New Initiatives for NRC

As ongoing programs complete the stated objectives, new efforts will be undertaken in materials technology, thermal hydraulics, instrumentation, chemical technology, and environmental science. These programs will address problems identified in review of operating reactors, in new designs for improved safety, or value/ impact analysis. In general, we expect that ORNL will be selected to undertake medium-scale experimental programs in the areas of traditional expertise: solid mechanics, thermal hydraulics, advanced instrumentation, chemical technology, and aquatic and terrestrial ecology.

*1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Summary of resources*— New initiatives for NRC

	'81	'82	'83	'84
Direct FTE				
RSR	9	15	34	47
SAFER	8	10	15	18
ONMSS		5	5	7
Operating costs				
RSR	1.0	1.5	3.0	4.0
SAFER	0.5	0.6	0.8	1.0
ONMSS		0.4	0.4	0.5

Work for Others (Excluding NRC)

Approximately 15% of ORNL's R&D funding comes from sources other than DOE, the majority of it from the NRC, as discussed in the preceding section.

ORNL is actively pursuing Work for Others which supports DOE's efforts in the areas of biomedical and environmental sciences research and application. Programs are under way with the National Cancer Institute, the National Institute for Environmental Health Sciences, and other agencies of the Department of Health, Education, and Welfare (HEW); they include study in the areas of carcinogenesis, mutagenesis, toxicology, and teratogenesis. In addition, increased efforts with NRC, NSF, EPA, and EPRI are being pursued in the areas of cooling system impacts, CO_2 atmospheric buildup, radiation dosimetry, and toxic substances. These programs often provide information that is of direct use to major program thrusts that are of interest to DOE.

A major effort has been initiated that is aimed at establishing joint cooperative programs with TVA in various environmental areas. Discussions to date have indicated mutual interest in the environmental areas of solid waste (nonnuclear) management; coal gasification; instrument development; chlorination procedures; fly ash ponds; energy-conserving wastewater treatment processes; pollutant transport, transformation, and fate; and regional assessments. Future efforts will be aimed at coordinating ongoing ORNL and TVA programs in these areas as well as identifying support to initiate new programs where ORNL's research capabilities can be coupled with TVA's energy facility experience and demonstration capabilities.

It is also hoped that support will be gained, perhaps from TVA or EPRI, to apply the ex-

pertise gained by the Laboratory through the breeder reactor program toward work aimed at improving the operation of LWRs. This area is discussed in greater detail in the sections devoted to Energy Technology.

Some DOE programs are also accounted for in the Work for Others category. These include work for other operations offices and for other plants operated by Union Carbide Corporation, Nuclear Division (UCC-ND).

It is expected that the total work for others will decline noticeably during this planning period as more DOE work is undertaken within the limitations imposed by manpower ceilings.

Summary of resources*—(excluding NRC)

	'78	'79	'80	'81	'82	'83	'84
Department of Health, Education, and Welfare							
Direct FTE	95	95	95	97	100	105	110
Costs	5.1	6.3	6.3	6.5	6.8	7.2	7.7
Environmental Protection Agency							
Direct FTE	34	30	30	32	36	40	43
Costs	2.1	2.6	2.6	2.8	3.2	3.6	4.0
National Science Foundation							
Direct FTE	13	20	22	23	23	23	23
Costs	1.3	2.2	2.3	2.3	2.4	2.5	2.5
Department of Defense							
Direct FTE	12	13	12	12	12	12	12
Costs	1.3	1.2	1.0	1.0	1.0	1.0	1.0
Other federal agencies							
Direct FTE	8	10	10	10	10	10	10
Costs	0.8	0.9	0.9	0.9	0.9	0.9	0.9
Nonfederal agencies							
Direct FTE	55	62[a]	60	53	47	43	40
Costs	7.0[b]	7.6	7.8	6.8	5.8	5.3	4.9
Other DOE agencies							
Direct FTE	112	46	46	38	29	26	24
Costs	12.4[c]	5.7	5.8	4.8	3.8	3.4	3.1
Other DOE contractors							
Direct FTE	51	59	54	45	39	39	39
Costs	5.7[d]	7.1	7.1	5.9	5.1	5.1	5.1
Total							
Direct FTE	380	335	329	310	296	298	301
Costs	35.7	33.6	33.8	310	29.0	29.0	29.2

[a] These projections include proposed LWR work.

[b] All but approximately $1 million of this figure is for the sale of isotopes and isotope services.

[c] Approximately $1 million of this figure is for isotopes transfers to DOE.

[d] Approximately $0.7 million of this figure is for programmatic work; approximately $1.5 million is for miscellaneous activities on behalf of other UCC-ND plants. Projections assume that funding for the Alternate Fuel Cycle Technology Program (funded through Savannah River Office in 1978) will be funded directly in the future.

3. Resource Discussion and Construction Projects

3. Resource Discussion and Construction Projects

Computer Equipment

The projection of computing capability needed at ORNL and at the other plants comprising the Oak Ridge site is shown in Fig. 4. The existing batch computing facilities were saturated at the end of 1976, and it is expected that a major new system will be installed late in FY 1979.

The interactive capability was greatly oversaturated, but with the addition of a PDP-10 KL-10 central processor in FY 1977, adequate interactive computing became available. It is now saturated again and will be seriously overloaded by mid-FY 1979: relief will be needed.

The main users of the batch computing facilities at ORNL will still have the heaviest requirements in FY 1982, but the greatest uncertainties in the projections arise from the impact of relatively young programs in fields such as environmental and health sciences and information processing, which have a large potential for growth in computer usage.

Projected needs and the computer acquisition schedule indicate that there will obviously be a significant computer shortage in the immediate future. A temporary solution has been to shift some of the load to a large computer at Idaho Falls that is not yet saturated but will be by the end of FY 1979.

The proposed new computers in FY 1979 will cost approximately $10 million but will initially be leased. Included in the new system will be the devices needed to meet on-line storage requirements, particularly for interactive information retrieval from energy-related data bases.

Energy Systems Research Laboratory

ORNL has grown in staff and programs in recent years, especially in nonnuclear areas. Our laboratories often do not meet our current programs' requirements for height, floor loading, safety, isolation, temperature control, and cleanliness. Our office space is insufficient for the current staff—over 800 office users are overcrowded (have less than 75 ft^2 each), and an additional 1100 are in offices of substandard quality (old and deteriorated; in attics, basements or trailers; noisy, etc.). The Energy Systems Research Laboratory, submitted as an $18 million line item for the FY 1980 budget, will alleviate some of these problems. The new 100,000-ft^2 building will provide space for research laboratories, offices, and service areas. The largest fraction of the building will be used to house much of the fossil energy program. It will also house most of the geothermal, solar energy, and conservation programs and essentially all of the biotechnology program.

High-Temperature Materials Laboratory

Almost all energy technologies involve the generation of heat. A major problem of all these

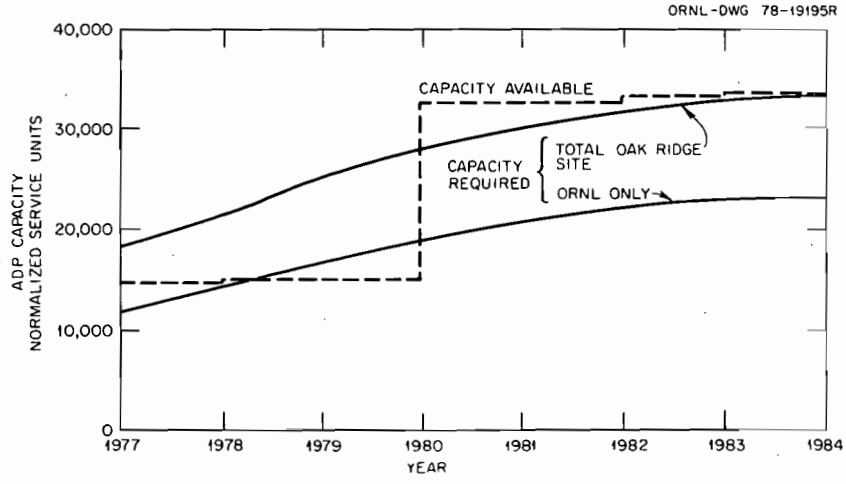


Fig. 4. Requirements and capacity for automated data processing. Computing facilities are greatly overloaded currently, but the situation will be relieved by the installation of the new computer in 1979.

technologies will be the availability of materials with appropriate properties at elevated temperatures. Materials may be the decisive factor in a technology for reasons of economy as well as efficiency and reliability. The new High-Temperature Materials Laboratory (HTML) would be a unique laboratory for basic research on materials at elevated temperatures, including dedicated precise measurements and very long term (100,000-hr) experiments. It would be organized for a variety of interdisciplinary studies. A large inventory of materials-testing equipment already exists at ORNL that would be incorporated in the new laboratory with extensive new equipment. The estimated expenses (given in millions of dollars) for building and equipping HTML are as follows:

Building (80,000 ft^2)	18.3
Equipment and moving expenses	6.5
	24.8

The $6.5 million for equipment and moving expenses is not included in the summary of operating cost forecasts. It is estimated that the HTML staff would include about 65 professionals, requiring total operating funding of approximately $10 million per year (FY 1979 dollars). The operating funding would be roughly 60% from the materials sciences program and 40% from applied funding sources. Although we proposed HTML as a line item in FY 1979, it was not included in the budget; we are submitting it for the FY 1981 budget. Discussions on this proposal have been held with the materials science program in the Office of Energy Research. A conceptual design report has been prepared.

Holifield Heavy Ion Research Facility, Phase II

The Phase II project would expand the Holifield Heavy Ion Research Facility (HHIRF) to provide the higher energy beams (at least 50 MeV/nucleon for the heaviest elements and at least 250 MeV/nucleon for lighter elements) to support a broad spectrum of national research programs in nuclear physics, nuclear chemistry, atomic physics, and materials science. A high-field, superconducting cyclotron with an ion energy capability of approximately 1500 q^2/A MeV will be the central item in Phase II. This K = 1500 cyclotron will be arranged to provide a second stage of acceleration for ion beams from the 25-MV tandem.

The facility will be designed as a national facility with the capacity to support a large user organization. The total project cost for Phase II is estimated to be $25.0 million. A conceptual design report is in preparation, and construction is proposed to begin in 1982.

Support of Special Facilities

We have already alluded to the problem of obtaining continuing support for facilities that have interprogrammatic and, in some cases, interagency applications. The research reactors (especially the High-Flux Isotope Reactor) are one type of such facilities, and the existing EN Tandem Van de Graaff Laboratory is another: about 40% of the operating costs of the EN Tandem will be provided by the DOE Office of Basic Energy Sciences, primarily for atomic physics research. However, additional support is needed if there is to be reasonable continuity of operation.

The Tower Shielding Facility (TSF) is the only facility in the United States that is available to support shield analysis programs for any fission reactor to be developed in the future. In the past, it has been supported entirely (at a cost of approximately $1 million per year) by a single reactor program. However, the basic operation of the TSF may be transferred to the Reactor Support Branch of the Division of Nuclear Power Development, with specific additional support being provided from time to time as needs arise within individual projects. Whatever mechanism finally evolves, it is very important that this facility continue to be available as a national resource.

General Purpose

The funding for general purpose equipment (GPE) and general purpose projects (GPP) has been inadequate for many years, giving little opportunity to update and renovate old buildings, facilities, and equipment. The problem has worsened over the past decade because GPP funding has fallen very rapidly compared with the other operating costs of the Laboratory

(Fig. 5). ORNL has fared especially badly compared with the other multiprogram laboratories (Fig. 6), particularly when it is remembered that the weapons facilities have other sources of funding for these items. This is a problem in need of urgent attention.

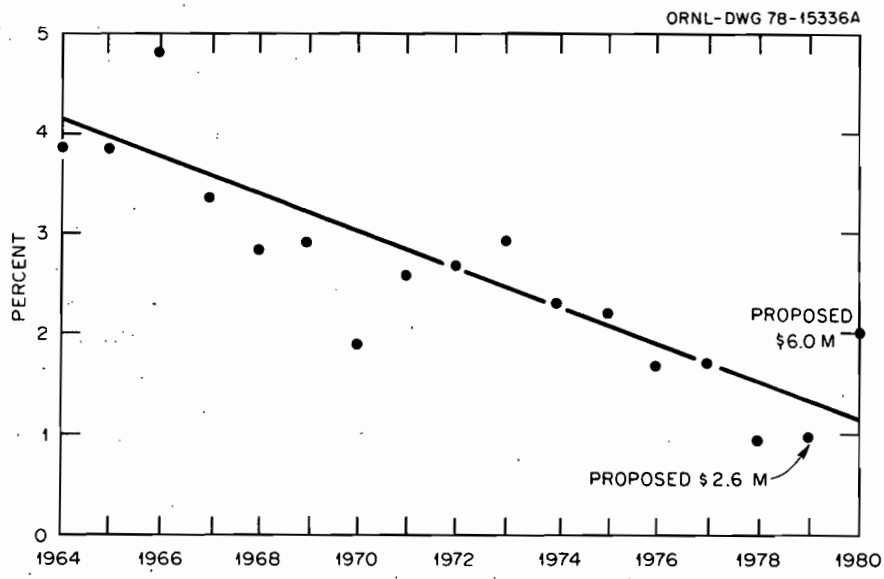


Fig. 5. ORNL GPP funding as a percentage of the operating budget. This funding has decreased dramatically in recent years. The figure reflects the actual dollars used (with no normalization to the cost of construction).

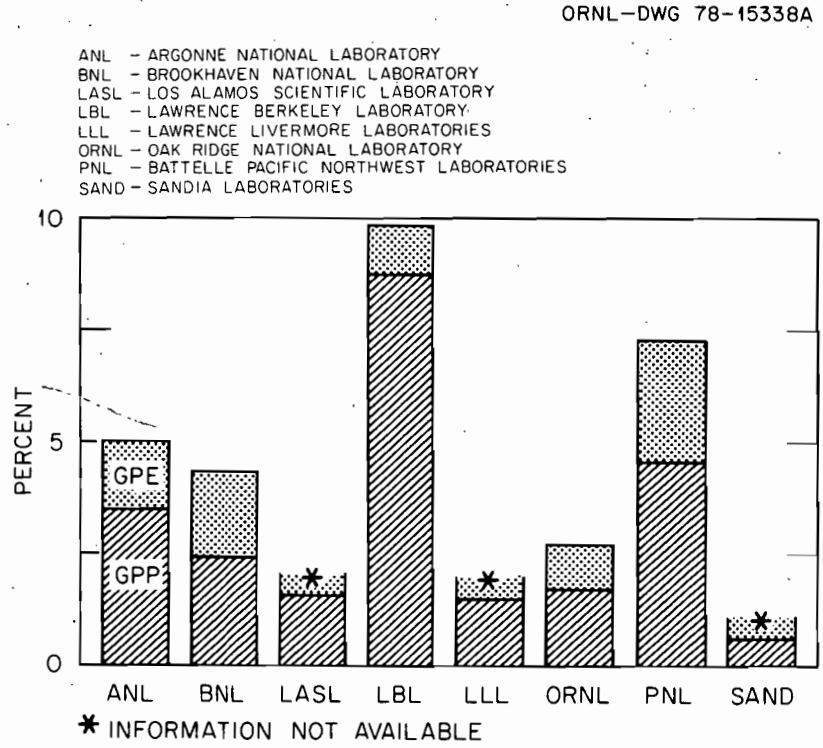


Fig. 6. GPP and GPE funding for 1977 as a percentage of ERDA operating funds. There are very wide variations in GPP and GPE funding relative to operating costs at the different multiprogram laboratories.

Cost of construction projects, millions of dollars

Description	1978		1979		1980		1981		1982		1983	1984	After 1984
	TEC[a]	BO[b]	TEC	BO	TEC	BO	TEC	BO	TEC	BO	BO	BO	BO
Funded for FY 1978													
Advanced Fuel Recycle Integrated Equipment Test Facility	16.0	2.6		7.0		5.9		0.5					
Energy pollutant control system	1.8	0.4		0.8		0.6							
Toxicology laboratories	1.4	0.3		0.8		0.3							
New hydrofracture facility	5.4	0.9		2.5		2.0							
Solid waste handling and decontamination facility (construction plan and design only)	0.3			0.3									
Proposed for FY 1979													
Addition to Aquatic Ecology Laboratory			1.6	0.2		1.1		0.3					
Proposed for FY 1980													
Improvements in fusion energy facilities					12.6	3.0		4.3		5.3			
Modifications aimed at compliance with OSHA[c]					3.8	0.8		2.6		0.4			
Energy Management System					3.4	0.7		2.6		0.1			
Improvements to radioactive waste facilities[c]					12.0	1.7		5.4		4.2	0.7		
Energy Systems Research Laboratory (ESRL)[c]					18.0	2.0		6.5		8.0	1.5		
Upgrade ORNL primary substation[c]					3.5	0.6		2.2		0.7			
Improvements to fire protection[c]					2.8	0.5		1.4		0.9			
Accelerator and Reactor Improvement Project					0.6	0.4		0.2					
Toxic substances laboratory and animal facility					14.5	2.0		2.5		8.0	2.0		
Addition to the Oak Ridge Isochronous Cyclotron Building					1.8	0.3		0.8		0.7			
Environmental and effluent monitoring systems upgrading[c]					8.1	1.1		1.8		5.2			
Upgrading laboratories to handle hazardous materials					1.9	0.4		0.9		0.6			

Cost of construction projects (continued)

Description	1978		1979		1980		1981		1982		1983	1984	After 1984
	TEC[a]	BO[b]	TEC	BO	TEC	BO	TEC	BO	TEC	BO	BO	BO	BO
Proposed for FY 1981													
High-Temperature Materials Laboratory (HTML)							27.5	2.2		6.6	14.6	4.1	
Solid Waste Handling and Decontamination Facility[c]			0.4	0.4			34.5	5.1		5.4	7.7	9.6	6.7
Environmental waste management complex							2.0	0.5		1.4	0.1		
Hot Fuels Engineering Laboratory (Title I, II, and long lead procurement only)							6.5	2.1		4.4			
Water pollution control—ORNL[c]							3.5	1.1		1.7	0.7		
Long Pulse Technology Tokamak (LPTT) partial architect engineering and advance procurement only							20.0	5.0		15.0			
Warehousing upgrade[c]							3.3	0.3		1.6	1.4		
Information Resource Center for Energy and the Environment							11.0	1.0		5.0	4.8	0.2	
Laboratory control center[c]							2.6	0.7		1.1	0.8		
Safeguards and physical security developments							5.8	1.0		3.0	1.8		
Proposed for FY 1982													
Holifield Heavy Ion Research Facility — Phase II									21.8	1.8	8.5	8.5	3.0

[a]TEC = total estimated cost.
[b]BO = budget outlays.
[c]General purpose facility (GPF) projects.

General purpose equipment and facilities

Laboratory forecast of operating cost (budget authority), millions of dollars

	1978		1979		1980		1981		1982		1983		1984		1985	
General purpose equipment (GPE)																
General purpose capital equipment	1.1		1.2		3.2		3.5		3.5		3.5		3.5			
General purpose ADP equipment	0.9		0.4		0.8		1.0		1.0		1.0		1.0			
Subtotal	2.0		1.6		4.0		4.5		4.5		4.5		4.5			
General purpose projects (GPP)																
	2.3		2.6		6.0		6.0		6.0		6.0		6.0			
	TEC[a]	**BO[b]**	**TEC**	**BO**	**TEC**	**BO**	**TEC**	**BO**	**TEC**	**BO**	**TEC**	**BO**	**TEC**	**BO**	**TEC**	**BO**
General purpose facilities (GPF)																
Energy Systems Research Laboratory					18.0	2.0		6.5		8.0		1.5				
Upgrade ORNL primary substation					3.5	0.6		2.2		0.7						
Environmental effluent monitoring system upgrade					8.1	1.1		1.8		5.2						
Improvements to fire protection					2.8	0.5		1.4		0.9						
Energy Management System					3.4	0.7		2.6		0.1						
Modifications aimed at compliance with OSHA					3.8	0.8		2.6		0.4						
Solid waste handling and decontamination facility	0.3		0.4	0.7			34.5	5.1		5.4		7.7		9.6		6.7
Water pollution control — ORNL							3.5	1.1		1.7		0.7				
Materials warehousing upgrade							3.3	0.3		1.6		1.4				
Laboratory control center							2.6	0.7		1.1		0.8				
GPF beyond FY 1981																
Primary electrical distribution system restoration							2.0									
Central chilled water system restoration							1.8									
Renovate HVAC systems in four heavy engineering laboratories							20.0									
Primary water mains restoration							4.0									
Alternate water supply							2.5									
Maintenance facilities							4.5									

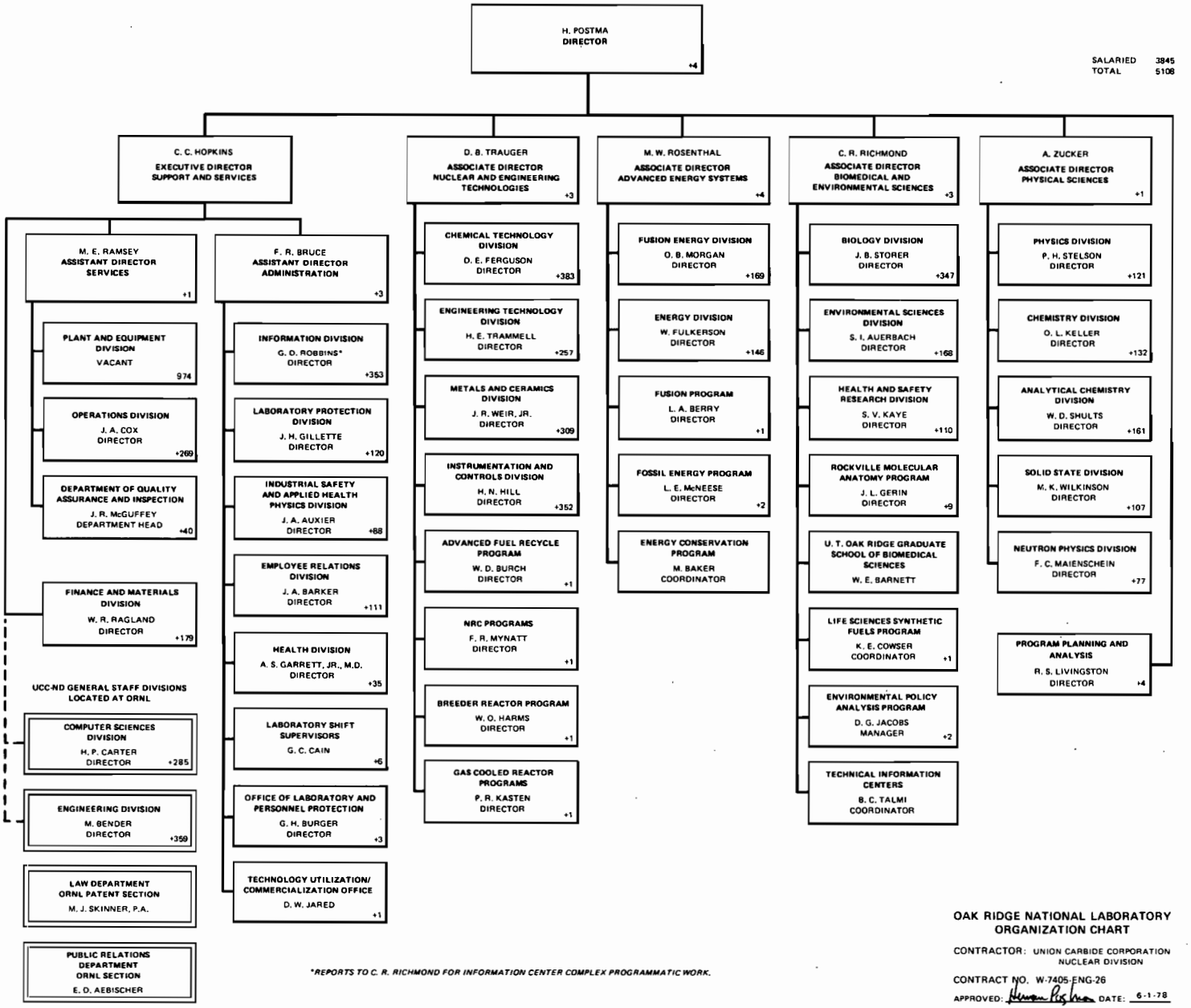
General purpose equipment and facilities (continued)

	1978	1979	1980	1981	1982	1983	1984	1985
Machine shop facilities				4.0				
General analytical laboratory renovation				1.3				
General engineering facility				5.0				
General laboratories replacement				7.0				
Multiprogram support shop facilities				1.3				
Personnel service facilities				1.3				
Main laboratory access and parking				1.3				
Total GPF beyond FY 1981				56.0				

[a]TEC = total estimated cost.
[b]BO = budget outlays.

Appendixes

Appendix A—ORNL Organization Chart



Appendix B

Summary of Functional Phase of Research and Development in Major Program Areas

Table B-1. Summary of functional phase of research and development in major program areas – operating costs[a]

	1978	1979	1980	1981	1982	1983	1984
Assistant Secretary for Energy Technology							
Basic research	0.5	0.5	0.6	0.7	0.6	0.5	0.5
Applied research	14.6	15.7	18.0	14.4	15.4	14.1	13.1
Exploratory development	31.3	31.4	33.3	29.4	30.3	30.8	30.9
Technology development	51.3	50.5	54.1	58.4	57.5	56.3	54.6
Engineering development	10.3	10.3	13.6	19.4	20.1	19.9	18.9
Other	2.0	2.2	3.3	10.2	3.7	2.7	1.8
Subtotal	110.0	110.6	122.9	132.5	127.6	124.3	119.8
Director for Energy Research							
Basic Research	22.6	24.0	26.4	27.0	27.5	27.9	28.2
Applied research	14.2	14.0	15.0	15.3	15.6	15.8	16.1
Exploratory development	1.0	1.0	1.0	1.0	1.1	1.1	1.1
Subtotal	37.8	39.0	42.4	43.3	44.2	44.8	45.4
Assistant Secretary for the Environment							
Basic research	9.0	9.6	9.6	10.2	10.4	10.6	10.9
Applied research	16.2	16.3	16.1	17.0	17.5	17.9	18.2
Exploratory development	2.1	2.2	2.2	2.4	2.4	2.5	2.6
Technology development	2.7	3.2	3.2	3.4	3.5	3.6	3.7
Engineering development	0	0.3	1.0	1.0	1.0	1.1	1.1
Subtotal	30.0	31.6	32.1	34.0	34.8	35.7	36.5
Assistant Secretary for Conservation and Solar Applications							
Basic research	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Applied research	1.3	1.8	1.9	1.5	1.9	1.9	2.0
Exploratory development	1.5	2.2	2.3	2.5	2.0	2.1	2.4
Technology development	2.5	3.3	3.5	3.9	4.2	4.2	4.1
Engineering development	0.4	0.6	0.9	1.6	2.0	2.2	2.3
Subtotal	5.8	8.0	8.7	9.6	10.2	10.5	10.9
Total	183.6	189.2	206.1	219.4	216.8	215.3	212.6

[a]1978, 1979, and 1980 figures are in millions of current dollars and reflect a 7% escalation factor. Others are in constant 1980 dollars.

Appendix C

Lead Mission (Lead Laboratory) Assignments

Fission [Energy Technology (ET)]

1. Consolidated Fuel Recycle-Reprocessing Program[a,b] (Current lead mission with ORO)
2. Instrumentation for Fission Energy Systems (Proposed)
3. Nuclear Energy Assessments (Proposed)
4. Nuclear Standards Program (Proposed)[b]
5. Low-Level Radioactive Waste Management Program (Proposed associate lead mission)

Fusion (ET)

6. ELMO Bumpy Torus (EBT) Research and Development (Proposed)
7. Superconducting Coils for Toroidal Confinement Systems (Proposed)
8. The Next Step/Engineering Test Facility (Planning and Preconceptual Design) (Proposed)
9. Neutral Beam Injection Systems for Fusion Devices (Proposed)

Fossil (ET)

10. Fossil Energy Materials Technology Center (Proposed)

Conservation (ET)

11. Electric Utility Load Management and New Technology Integration (Current)[b]
12. Low-Temperature Energy Storage Systems (Current)

Other ET

13. Environmental Impact Assessment for Fossil, Solar, and Geothermal Energy (Proposed)[b]

Conservation [Conservation and Solar Applications (CS)]

14. Residential and Commercial Conservation in Buildings and Appliances (Current)
15. Waste Heat Utilization (Proposed)

Environment [Environment and Safety (EV)]

16. Shallow Land Burial (Nonnuclear) (Proposed)
17. Environmental Impact Assessment for Nuclear Fuel Cycle and Waste Management (Proposed)
18. Health and Environmental Effects of Synthetic Fossil Fuel Technologies (Current)
19. Ecosystem Modeling for Regional Environmental Resource Analysis (Current)
20. Policy Analysis (Integrated Nuclear Assessment, Siting, and Water Availability) (Proposed)
21. Effects of Atmospheric CO_2 on the Terrestrial Biosphere (Proposed)

Generic

22. Materials and Structures Technology Center (Proposed)[b]

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[a] Includes the former Advanced Fuel Recycle and High-Temperature Gas-Cooled Reactor programs.

[b] These items were discussed, in whole or in part, by ASET during his review of the Laboratory's October draft of the *Institutional Plan*. In addition, five other lead roles, which the Laboratory had not proposed, were discussed: Defense Intermediate-Level Waste Management, Experimental Program Management for the Holifield Heavy Ion Accelerator, Experimental Program Management for the High Flux Isotope Reactor, Analysis of Basic Research Underlying Fossil Energy Technologies, and Validation of Energy Information Relating to Distribution and Consumption. Details of the scope and content of these roles are not yet known.

Consolidated Fuel Recycle-Reprocessing Program (Current Lead Mission with ORO)

Assigned to ORO and Oak Ridge National Laboratory (assigned to ASET)

DOE program Energy Technology; Division of Nuclear Power Development (NPD), Assistant Director, Fuel Cycle Development

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program Currently, four separate programs within DOE address the development of technology for reprocessing specific reactor fuels. The objective of this proposed unified program is to bring their management under one organization.

During a visit to Oak Ridge in January 1978 by Robert Morgan (DOE Headquarters) to discuss decentralization and lead laboratory roles, ORO proposed that ORNL assume the lead laboratory role in fuel reprocessing research and development (R&D). It was envisioned that efficiencies in management of the several fuel reprocessing programs could occur if they were placed under a single field office and laboratory direction.

No action was taken then on this recommendation, but on August 6, 1978, Robert Thorne (Energy Technology) wrote Herman Postma, director of ORNL (copy to Robert Hart, manager, ORO), indicating that "he anticipated ORNL taking the lead on developing creative reprocessing techniques for uranium and thorium fuels." A program plan for such an assignment is now being discussed with the Assistant Director for Fuel Cycle Development, NPD, Headquarters.

Laboratory role ORNL would be delegated the responsibility for technical management of the R&D program. ORNL would manage this program in a similar way to that used for the Advanced Fuel Recycle Program, one of the existing major reprocessing programs.

Operations Office Support ORO would be delegated the responsibility and authority for field management of the program, including specific guidance to program participants. ORO would review and make recommendations to NPD on the program plan; develop, recommend, and justify budgets to be considered by DOE Headquarters; and manage the program to achieve objectives on schedule and within allocated budget ceilings. ORO would coordinate administrative and technical matters with other field offices.

Authority Field and Laboratory Coordination Council (FLCC) meeting, 16 November 1978.

Budget and manpower To be determined. DOE reprocessing programs in 1978 total approximately $66 million.

Milestones To be determined.

Subcontracts To be determined.

Related programs This program encompasses all reprocessing programs.

Technology transfer There will be close cooperation and involvement with reprocessing industry, but little contact with state and local governments or universities at this time is envisioned.

References See the description of the technical program above.

Instrumentation for Fission Energy Systems

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Energy Technology

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to develop instrumentation and controls (I&C) technology aimed at improving the performance and safety for fission energy and related systems. Although measurement and control are integral parts of virtually every technological discipline, there is a need for coordination of the many I&C activities related to energy generation and conversion, safety, component and materials testing, and fuel reprocessing. Such coordination would replace duplicate development effort where similar devices such as temperature sensors are being applied on almost all energy production and conversion systems as well as on their supporting and peripheral systems. Technically this management center will incorporate the three major I&C areas: Detection and Measurement, Signal Processing and Data Management, and Automatic Control. The broad range of experiences that has been acquired at the Laboratory in these areas has established a strong foundation for assuming a lead role in I&C.

Laboratory role The Laboratory will be responsible for technical direction of the program, including coordination of activities by other contractors and program requirement definition.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; provides a field focal point and management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority Proposed role

Budget and manpower

Summary of resources[a]—Instrumentation for Fission Energy Systems

	'78	'79	'80	'81	'82	'83	'84
Operating costs	1.7	1.5	1.75	2.5	3.4	4.0	5.0
Capital equipment	0.2	0.2	0.2	0.3	0.5	0.7	1.0
Subcontracting and procurement	0.1	0.1	0.3	1.0	1.8	2.5	3.5
Direct FTE	16	13	15	17	17	18	18
Indirect FTE	22	18	21	23	23	24	24

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Major milestones include (1) high-temperature neutron detector development and test, FY 1982; (2) simulation of a direct digital control system, FY 1983; (3) complete development of 36-in. flow meters, FY 1981; (4) complete development of on-line calibration of process instruments, FY 1982; (5) development and testing of the signal multiplexing system, FY 1984; (7) initial and final testing of automated pattern recognition system, FY 1984; (8) initial and final testing of failed element detection and location system, FY 1981 and FY 1984; (9) development and testing of the high-temperature strain gage, FY 1980; and (10) development and testing of the high-temperature accelerometer, FY 1981.

Subcontracts Subcontracts include those with the University of Tennessee and North Carolina State University.

Related programs Related DOE programs requiring technical coordination with this one are Fuel Reprocessing, Advanced Fuel Recycle Program, High-Temperature Gas-Cooled Reactor, and Long-Term Waste Repository Monitoring and Surveillance.

Technology transfer The program has technology transfer and commercialization responsibilities to (1) universities—the University of Tennessee, North Carolina State University, Penn State University, the University of Florida, Georgia Institute of Technology, and the University of Washington; (2) Utilities—the Electric Power Research Institute (EPRI) and the Tennessee Valley Authority (TVA); (3) industries—Technology for Energy Corporation, Analysis and Measurement Services Corporation, Kaman Science Inc., SEMCO, ARi Industries, Claude S. Gordon Company; and (4) nuclear equipment manufacturers and other manufacturers.

References This program is covered by the following 189s: CA060, CA061, FF087, FF033, OH016, OH017, OH030, OH049, and SL008.

Nuclear Energy Assessments

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Energy Technology-Nuclear

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to provide studies and assessments of nuclear and alternative power systems in support of DOE research, development, and demonstration programs. These assessments draw on the diversified staff and facilities of the Laboratory. The scope of the program consists of general studies and evaluations of nuclear power systems and alternatives, analysis of alternative nuclear fuel cycles, studies of alternative siting concepts such as nuclear energy centers, large-scale cogeneration applications (e.g., for process heat and district heating), and technical overview of nonproliferation alternatives.

Laboratory role The Laboratory is responsible for technical direction of portions of the program and provides technical support to DOE Headquarters staff, including coordination with other contractors and definition of program requirements.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This is a proposed assignment that was discussed during the recent field review of the Laboratory's *Draft Institutional Plan.*

Budget and manpower BRC number—AG 04 09

Summary of resources[a]—Nuclear Energy Assessments

	'78	'79	'80	'81	'82	'83	'84
Operating costs	5.5	5.1	4.0	4.0	4.0	4.0	4.0
Capital equipment	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Subcontracting and procurement	2.2	2.5	1.5	2.0	2.0	2.0	2.0
Direct FTE	44[b]	35	29	27	27	27	27
Indirect FTE	31	25	20	19	19	19	19

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] Current manpower levels include staffing for the Nonproliferation Alternative Systems Assessment Program (NASAP), which will be declining in future years.

Milestones Major milestones include completion of the Nonproliferation Alternative Systems Assessment Program final report (1979), the Gulf States Utilities cogeneration study (1979), the Minnesota district heating studies (1979–1980), the South Carolina Nuclear Energy Center study (1980), and the Utah Nuclear Energy Center study (1980).

Subcontracts Subcontracts include those with Babcock and Wilcox, General Electric, and Westinghouse for studies of advanced light-water reactor systems; with Booz-Allen-Hamilton for management support to NASAP; with International Energy Associates, Ltd., for an assessment of the international aspects of nonproliferation; with Babcock and Wilcox and General Atomic for nuclear process heat source studies; with Gulf States Utilities and others for large-scale cogeneration system studies; with the Minnesota Energy Agency, AB Atomenergi (Sweden), and others for study of a large-scale district heating system; and with Utah and Southern States Energy Board for nuclear energy center studies. Work conducted by Argonne National Laboratory (NASAP support) and Battelle Pacific Northwest National Laboratories (meteorological effects) receives technical coordination. Subcontracts comprise 40 to 50% of the total budget; both management-type contracts (directed by DOE) and supporting subcontracts (initiated by ORNL) are included.

Related programs Programs requiring coordination are (1) NASAP-supported assessments at the National Accelerator Laboratory; Hanford Engineering Development Laboratory; Stoller, Burns, and Roe, and elsewhere; (2) capital-cost evaluations by United Engineers and Constructors; and (3) closely related studies of power systems, cogeneration, and district heating sponsored by the Economic Regulatory Administration (ERA) and Energy Technology.

Technology transfer Subcontracts are used as a means of technology transfer.

References This program is covered by the following 189s: 1303, 1307, 1308, 1310, 1333, 1312, 1313, 1446, 1447, 1449, 1477, 1478, and 1480.

Nuclear Standards Program [Nuclear Standards Office (NSO)]

Assigned to Oak Ridge National Laboratory

DOE program Energy Technology-Nuclear (ETN), Division of Nuclear Power Development (NPD)

Supporting operations office Oak Ridge Operations Office

Technical program The objective of this program is to provide technical management on standards development and standards application within nuclear energy programs (ETN).

Laboratory role DOE provides policy, guidance, and overall direction for program planning and implementation. DOE approves program plan including scope, tasks, priorities, major deliverables, significant milestones, schedules, and costs. DOE as sponsor retains final accountability.

The NSO manages ETN's multidivisional Nuclear Standards Program in accordance with an approved management plan and DOE guidance and funding. The NSO provides assistance on standards development and application to ETN Headquarters managers, field offices, project offices, and contractors. It maintains cognizance of ETN activities and standards needs to identify and define issues, problems, or proposals for consideration by ETN division directors, field office managers, project directors, and program managers. The NSO encourages the development of, and maintains liaison with, national consensus standards activities related to ETN programs.

Operations Office support ORO provides contract management/administration, assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment is performed under 189a No. OH022, Nuclear Standards Program, in accordance with the management agreement between DOE/NPD, ORO, and the ORNL Nuclear Standards Office (September 27, 1978).

Budget and manpower

Summary of resources[a]—Nuclear Standards Program

	'78	'79	'80	'81	'82	'83	'84
Operating costs	0.70	0.73	0.92	0.97	0.97	1.00	1.00
Capital equipment	0	0.02	0.04	0	0	0	0
Subcontracting and procurement	0.05	0	0	0	0	0	0
Direct FTE	9	11	12	12	12	12	12
Indirect FTE	12	15	16	16	16	16	16

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones ORNL will continue to manage the program as directed by NPD, conduct necessary meetings; assess application of standards; provide guidance to program participants; and prepare standards, reports, indexes, and catalogs. New standards will be prepared where needed, existing standards will be evaluated for conversion to national standards where appropriate, and other standards will be updated as technology, experience, and related standards require. Technical and editorial reviews of standards will be made, and assistance will be provided to ongoing projects. Assistance to the national standards effort will continue through participation in ANSI-NSMB functions and standards committees and preparation of the personnel directory.

Related programs Coordination will be developed and maintained with breeder reactor and other ETN programs and projects, as well as with other technology centers in components (Argonne National Laboratory), fuels and core materials (Hanford Engineering Development Laboratory), fuel cycle (ORNL), and fusion, fossil, and conservation (laboratories as identified by DOE).

Technology transfer DOE, ORO, all nuclear standards participants, and other related technology centers will be kept informed through consolidated monthly technical summary reports, quarterly management cost and milestones reports, and annual status reports. All participants and the U.S. industrial community will be further informed by independently generated reports distributed in a consistent manner in collaboration with DOE's Technical Information Center.

References For the breeder reactor program, there are approximately 12 applicable 189a's nationwide and two at ORNL (OH022 and OH048). For other related programs, the information will be requested from DOE.

Low-Level Radioactive Waste Management Program (Associate Lead Mission)

Assigned to Energy Technology

DOE program Waste Management

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to develop environmentally sound techniques for managing all types of low-level solid wastes produced by such activities as energy production, manufacturing, and the use of radioisotopes in medical and other fields. Another purpose is to improve the technology for managing solid and liquid radioactive wastes that are not classified as

high-level, airborne, or transuranium wastes. Activities included in the program are development of waste treatment and packaging technology; definition of the utility of shallow land burial; establishment of remedial measures for stabilizing and improving performance of existing burial grounds; evaluation of methods for storage and disposal that are alternatives to land burial; and development of guidelines or standards for waste characterization, disposal, and monitoring. In addition, the program includes assistance in developing a strategic national plan for handling such wastes and the development of methods to reduce waste volumes.

Laboratory role In this associate lead role the Laboratory has responsibility to manage a delegated part of the national effort and is accountable to EG&G at Idaho National Engineering Laboratory (INEL), which has the program lead responsibility. The Laboratory is responsible for directing the technical effort of other contractors and executes a part of the research and development (R&D) program using ORNL facilities. Although the Laboratory will generally assist EG&G in the total program, emphasis at the Laboratory is on systems analysis for R&D and for development of concepts for advanced systems of processing and disposal.

Operations Office support ORO provides contract management and administration; assists the Idaho Operations Office (IOO) in development of program management plans; monitors and evaluates performance; provides liaison with IOO; expedites business management interfaces and follow-up actions; and makes recommendations to IOO on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment as associate lead laboratory was proposed by INEL and the DOE Headquarters staff. At a meeting in Idaho Falls on October 31 through November 2, 1978, details of the ORNL role were agreed on by EG&G, IOO, ORO, and ORNL.

Budget and manpower BRC numbers—AG 30, AG 40, JM 05

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

	'78	'79	'80	'81	'82	'83	'84
Operating costs	4.2	6.5	9.0	12.0	16.0	18.0	18.0
Capital equipment	0	0.5	1.0	2.0	2.2	1.5	1.9
Subcontracting and procurement	0.1	1.7	3.7	6.5	10.4	11.6	11.6
Direct FTE (ORNL)	50	55	58	60	62	70	70
Indirect FTE (ORNL)	65	72	75	78	81	91	91

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones The first major milestone will be the completion of a detailed overall program plan in the second quarter of FY 1979. This plan in turn will define milestones for the development and demonstration of low-level waste management technologies. It is expected that there will also be milestones to assess current practices for the management of solid wastes.

Subcontracts In this EG&G/INEL program associate lead role, the Laboratory will conduct low-level waste management R&D activities at DOE multiprogram laboratories, including work at LASL,

Mound Laboratories, Battelle-Northwest Laboratories (BNWL), Rockwell-Hanford, and Scientific Research Laboratory (SRL). Contracts with universities, commercial firms, and consultants are anticipated.

Related programs Related DOE programs include several in nuclear waste management on transuranium and high-level wastes and several under the Director of Energy Research in the coal program (resource recovery from fly-ash and coal conversion residues, ash disposal, etc.). Several programs under the Assistant Secretary for Environment are also pertinent to this program (environmental control R&D, environmental monitoring, environmental data bases, etc.).

Technology transfer A primary goal of the program will be to transfer technology of low-level waste management to industry and to federal, state, and local governments. During the course of the program, it is expected that both universities and industry will become involved through the use of subcontracts.

References The following 189s either fully or partially cover low-level waste management: PM 01 09 A, ON 03 09 A, ON 08 09 A, ON 26 09 A, ON 29 09 A, ON 38 09 A, ON 43 09 A, ON 48 09 A, ON 57 09 A, ON 59 09 A, ON 66 09 A, ON 67 09 A, ON 69 09 A, OR 01, AL 38 (Mound Laboratory), AL 50 [U.S. Geological Survey (USGS)], LS 1510A (LASL), LS 2010A (LASL), BNW 033 (BNWL), BNW 034 (BNWL), BNW 044 (BNWL), SR 11 (SRL), ID 0109A (USGS), and ARH 20 (North American Rockwell-Hanford). Other 189s are being prepared to cover the requirements of the program fully.

ELMO Bumpy Torus (EBT) Research and Development

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Assistant Secretary for Energy Technology, Office of Fusion Energy (OFE), Division of Applied Plasma Physics

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program A number of magnetic fusion concepts show promise of being able to produce reactor-level parameters. Two of these (tokamaks and mirrors) are being advanced with large, broad experimental programs. There are, however, many other approaches. Of these, the EBT concept, developed at ORNL, shows the greatest promise in terms of demonstrated performance and reactor potential.

Laboratory role The Laboratory role would be that of conducting the research necessary to advance this concept to a level at which its potential could be evaluated and compared with that of tokamaks and mirrors. This would involve experiment, theory, reactor studies, and coordination with other construction projects that might become involved. Criteria for selection should involve demonstrated competence in EBT experiment and theory and a magnetic fusion program of sufficient breadth to provide the skills required for integrated development and evaluation.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This is a proposed assignment in an area in which ORNL has a clear technical lead.

Budget and manpower

Summary of resources[a]—EBT Research and Development

	'78	'79	'80	'81	'82	'83	'84
Operating costs	2.6	9.5	20.4	17.4	17.4	6.0	6.0
Capital equipment	0.2	0.3	13.0	3.2	1.4	0.7	0.7
Subcontracting and procurement[b]	0	1.0	12.0	10.0	6.0	0	0
Direct FTE	12	20	23	23	23	23	23
Indirect FTE	16	26	27	27	27	27	27

[a] Costs include construction of EBT-II and its associated development costs. Costs are in millions of dollars and are escalated to the appropriate year. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] These procurements and subcontracts are associated with EBT-II.

Milestones The major milestone will be operation of the EBT-II facility in FY 1982.

Subcontracts Major subcontracts will be used to support the design and construction of EBT-II. The high-power tube development, conducted by OFE, Division of Development and Technology, and managed by ORNL, currently has a subcontract with Varian Associates in Palo Alto, California, and new contracts are now being bid.

Related programs An EBT theory effort is maintained at SIA, La Jolla, Calif.

Technology transfer No technology transfer goals have been set for this program.

References This program is covered by the following 189s: No. 00008, "Confinement—Magnetic Mirror Systems—EBT-I/A," AF 01 01 02 0; No. 00037, "Confinement—Magnetic Mirror Systems—EBT-II (MDF)"; and No. 00115, "Applied Plasma Physics—EBT Theory—Accelerated Program—'B' Budget."

Superconducting Coils for Toroidal Confinement Systems

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Assistant Secretary for Energy Technology, Office of Fusion Energy (OFE), Division of Development and Technology

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objectives of this program are the design, fabrication, testing, and evaluation of large-bore, high-field superconducting magnets for toroidal fusion machines. The magnets developed will be directly applicable to toroidal machines for the near future and can be extrapolated to reactors. Research and development activities will be carried out at ORNL as well as at other laboratories in direct support of the Large Coil Program (LCP). The program is oriented in response to OFE's policy of providing an industrial magnet technology base to support fusion by magnetic confinement. The LCP also involves international cooperation through the International Energy Agency, and we expect to test and compare the performance of U.S. products with those of Germany, Switzerland, and Japan.

Laboratory role The Laboratory manages the procurement of LCP coils from industry, the Large Coil Test Facility (LCTF), the procurement of 12-T coils from industry, supporting ORNL R&D activities, and the combustor development in industry. The Laboratory provides guidance to the foreign participants and coordinates the interface tasks of their coils with the LCTF.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment has been discussed with ORO and OFE.

Budget and manpower BRC number—AF 01 02

Summary of resources[a]—Superconducting Coils for Toroidal Confinement Systems

	'78	'79	'80	'81	'82	'83	'84
Operating costs	7.3	12.2	15.6	8.1	4.6	3.7	3.9
Capital equipment	2.3	3.1	2.3	1.1	0.3	0.2	0.2
Subcontracting and procurement	5.9	8.4	9.3	3.0	0.6	0.6	0.5
Direct FTE	19	22	28	37	36	16	16
Indirect FTE[b]	25	29	37	49	48	21	21

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] In the May draft of the *Institutional Plan*, a ratio of 1.33 indirect FTE per direct FTE was used for this program.

Milestones In 1979 the Phase II design activities will be completed by all the LCP subcontractors. In 1980 General Dynamics and General Electric will deliver their coils. In 1981 Westinghouse will deliver their coil, and the three domestic coil tests will be completed. Also in 1981 the test of the two 12-T coils in the High Flux Test Facility will be completed. In 1982 all three foreign coils will be delivered, and the complete compact torus test will be conducted.

Subcontracts Subcontracts for LCP coils are held by General Dynamics (California), General Electric (New York), and Westinghouse (Pennsylvania). Their work is to design and fabricate an LCP coil. Some research and development activities (RDAC) are being performed at Francis Bitter National Magnet Laboratory (Massachusetts Institute of Technology) (FBNML/MIT) and the National Bureau of Standards, Boulder. About 8% is done in the Laboratory, and 92% is subcontracted.

Work on the LCTF is done by Pittsburgh-Des Moines Steel (Pennsylvania); they design and site-fabricate a vacuum chamber. TRW (Tennessee) is a subcontractor to perform cryogenic analysis. About 93% is done in the Laboratory (but this includes procurement), and 7% of the cost is appropriated for those two contracts.

With respect to the advanced conductor, Airco (New Jersey), IGC (New York), and Supercon (Massachusetts) will develop and manufacture conductors both to meet specifications and on a best-efforts basis. About 33% is done in the Laboratory, and 67% is subcontracted to industry.

General Dynamics (California) and General Electric (New York) will each design and fabricate a 12-T coil to fit in the high flux test facility at Lawrence Livermore Laboratories. About 10% is done in the Laboratory, and 90% will be contracted to industry.

Related programs Related DOE programs requiring technical coordination with this one are the advanced systems studies, the long pulse experiments, the poloidal coil development, and the 12-T programs being managed at FBNML/MIT and at General Atomic.

Technology transfer This program is designed to provide a technology base in industry, and all of RDAC are fed divertly into the companies who are building the coils we are testing.

References This program is covered by the following 189s for FY 1979: 00010, 00011, 00012, and two supplements prepared for 00010. A revised program plan, ORNL/TM-5401, issued in April 1976 and updated by a set of RDAC statements prepared in August 1978, is contained in No. 00010. The 189s Nos. 00011 and 00012 are covered in ORNL/TM-5824, issued in February 1977.

The Next Step/Engineering Test Facility Planning and Preconceptual Design

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Assistant Secretary for Energy Technology, Office of Fusion Energy, Division of Development and Technology

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The purpose of The Next Step/Engineering Test Facility (TNS/ETF) is to provide a test bed for fusion components, materials, and operation. This facility represents the next phase of the fusion program following the phases of the Toroidal Fusion Test Reactor and the Mirror Fusion Test Facility. Design studies of the TNS/ETF have been carried out at several different laboratories over the past few years. The purpose of this consolidation is to establish a central design site for a preconceptual design effort. This preconceptual design effort would eventually lead to a request for commitment to the TNS/ETF. Selection of the group to implement and construct the TNS/ETF would represent a next phase of the program.

Laboratory role The lead laboratory for the TNS/ETF consolidation would provide a project manager, one of three associate managers, and approximately one-third of the supporting staff for the project. Major responsibilities include coordination with institutions doing supporting R&D and with other laboratories having TNS/ETF interests, as well as responsibility for the preconceptual effort itself. Criteria for selection of the lead role laboratory would include strong laboratory support, quality of proposed management, diversity and depth of the ongoing fusion program, and quality of previous efforts in integrated advanced system design studies.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Budget and manpower BRC number—AF 02

Summary of resources[a]—TNS/ETF Planning and Preconceptual Design

	'79	'80	'81	'82	'83	'84
Operating costs	2.0	3.0	4.0	Task completed		
Capital equipment	0	0	0			
Subcontracting and procurement	1.0	1.5	2.0			
Direct FTE	10	10	10			
Indirect FTE	13	13	13			

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones The major milestone at the end of FY 1981 would be a set of documents including the preconceptual design, schedule, and cost, and an R&D document that establishes interfaces between the development technology and plasma physics programs in the context of implementing the TNS/ETF.

Subcontracts It is anticipated that three major subcontracts with industry will be bid. The work will involve engineering, and the majority of the work will be carried out at the lead laboratory site. It is anticipated that somewhere from one-half to two-thirds of the work will be subcontracted to industry.

Related programs This effort will require technical coordination within the divisions of OFE.

Technology transfer Industry would provide engineering support for the preconceptual design.

References There are none at this point.

Neutral Beam Injection Systems for Fusion Devices

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Assistant Secretary for Energy Technology, Office of Fusion Energy, Division of Development and Technology

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to (1) conduct the research necessary to develop concepts and design information for neutral beam systems; (2) design, fabricate, and test state-of-the-art systems for specific users [Oak Ridge Tokamak (ORMAK), Princeton Large Torus (PLT), Impurity Study Experiment (ISX), Long Pulse Technology Tokamak (LPTT), ELMO Bumpy Torus (EBT), and The Next Step (TNS)]; and (3) provide expertise to integrate and operate these systems in the field. The auxiliary heating that neutral beam injection provides is critical for the success of the fusion energy effort.

Laboratory role The Laboratory would (1) conduct R&D to support neutral systems design, (2) design and proof systems for specific applications, (3) provide operations interface for these systems, and (4) provide information that would allow appropriate development on the part of other laboratories. This information would be derived from beam development, tokamak and EBT theoretical and experimental programs, and reactor studies. The interaction with Lawrence Livermore Laboratories–Lawrence Berkeley Laboratory, the other major developer, would be one of coordination rather than program management.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority Proposed role.

Budget and manpower BRC number—AF 01 02

Summary of resources[a]—Neutral Beam Injection Systems for Fusion Devices

	'78	'79	'80	'81	'82	'83	'84
Operating costs	5.5[b]	8.0[c]	1.0[d]	11.5[d]	12.0[e]	12.0[e]	12.0[e]
Capital equipment	0.7	0.7	1.0	1.0	1.0	1.0	1.0
Direct FTE	20	23	26	26	26	26	26
Indirect FTE	26	27	28	28	28	28	28

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] Includes PLT, ISX, and PDS support.

[c] Includes Poloidal Divertor Experiment (PDX), LPTT, and EBT support.

[d] Includes LPTT and EBT support.

[e] Includes TNS support.

Milestones Major milestones include (1) continued support for the PLT injection program in FY 1979; (2) prototype testing and implementation on the Impurity Study Experiment (ISX) in FY 1979; (3) prototype testing on the PDX system in FY 1979; (4) system implementation on the PDX in FY 1980; (5) LPTT and EBT R&D in FY 1979 through FT 1981; (6) LPTT and EBT system implementation in FY 1980, FY 1982, and FY 1983; (7) TNS R&D in FY 1979 through FY 1981; and (8) TNS system design in FY 1981 through FY 1984.

Subcontracts These have not yet been defined.

Related programs Related DOE programs requiring technical coordination with this one are (1) LBL-LLL development; (2) BNL development; (3) TRW development; (4) PLT, PDX, and TFTR—PPPL applications; (5) General Atomic's Doublet-III; and (6) MFTF applications.

Technology transfer There are no defined responsibilities for technology transfer.

References This program is covered by the following 189s: 00103 (AF 01 01 12 J); 00106, 00017, 00107, and 00108 (AF 01 02 21 1); 00054 (AF 01 02 21 2); 00110 (AF 01 02 23 0); 00022 (AF 01 02 24 0); and 00113 (AF 01 02 41 0).

Fossil Energy Materials Technology Center

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Energy Technology, Fossil Energy

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of the Fossil Energy Materials Technology Center is to manage the national program of research and development on materials of construction for fossil energy application, including mining and extraction technology, fossil fuel processing (gasification, liquefaction, refining), fossil fuel (heat engines and recovery, combustion, fuel cells, turbines, coal cleaning and preparation, environmental control), magnetohydrodynamics, and supportive systems engineering.

Laboratory role The Laboratory is responsible for assessing programmatic needs for materials for fossil energy programs, developing plans in support of the program to meet those needs, and coordinating plans with other lead laboratories. The Laboratory establishes program goals, required facilities, program milestones, decision points, and cost schedules for meeting

programmatic needs. The laboratory reviews prospective participants in the program, selects participants, and reviews their proposals including detailed milestones. The Laboratory participates in contract awards, reviews program progress, reviews costs, and controls remedial measures for nonperformance. The Laboratory is responsible for maintaining records of the program and for disseminating relevant information to other lead laboratories and parties with a need to know.

All activities are performed with approval of responsible offices in DOE Headquarters. DOE provides policy and guidance for program planning. DOE provides resources and retains overall accountability for the program.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance, provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment was proposed by ASET and the Director of Fossil Energy Programs; details are currently under negotiation with DOE Headquarters.

Budget and manpower

Summary of resources[a]—Fossil Energy Materials Technology Center

	'78	'79	'80	'81	'82	'83	'84
Operating costs[b]	8	8	12	16	20	20	20
Capital equipment	0	1	1	1	2	2	2
Subcontracting and procurement	7	7	9	12	15	15	15
Direct FTE	12	17	33	42	50	50	50
Indirect FTE	12	18	34	43	51	51	51

[a] 1978, 1979, and 1980 figures are in millions of current dollars. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.
[b] Cost estimates will be revised following further discussions with DOE Headquarters.

Milestones Major milestones will be defined following completion of current discussions with DOE Headquarters.

Subcontracts Approximately 15 to 25% of the proposed work will be done in-house at ORNL; 15% will be subcontracted to Argonne National Laboratory; and approximately 65% will be subcontracted to other organizations, including other national facilities, industrial laboratories, and universities.

Related programs Proposed work is related to all phases of the DOE fossil energy program.

Technology transfer The lead laboratory role includes responsibility for overseeing publications, seminars, technical meetings, and interaction with professional societies and codes and standards organizations to ensure full use of the data and information generated.

References The Fossil Energy Materials Technology Center was proposed only recently and the associated 189a's and program plans will be developed through discussions with DOE Headquarters on the responsibilities of the center.

Electric Utility Load Management and New Technology Integration

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Energy Technology; Division of Electric Energy Systems; Program Office—Solar, Geothermal, Electric, and Storage

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program Conservation of oil and natural gas is very important to DOE and to the nation. One method of conserving is to limit the use of inefficient oil and gas turbines for peak generation of electric power by shifting load from peak to off-peak periods. This shift can be accomplished through load management using utility-controlled loads with energy storage at the customer load. Additional conservation can be realized through using controlled loads without storage to reduce peaks but with only marginal shifting of the load. An objective of this work is to establish the feasibility of load management and to determine the costs and benefits to the utility and its customers. A further objective is to investigate the feasibility of using load control for emergency shedding of selective blocks of load to avoid system breakup. The work also includes the development of the methodology needed to assess the impacts and cost benefits for both peak shifting, peak shaving, and emergency control. The methodology for assessing the impacts of locally dispersed generation and energy storage will be developed. In addition to load management, the program will be concerned with the development and assessment of distribution automation and load control, including the control of dispersed storage and generation.

The integration of these new technologies into the utility system and the assessment of their energy conservation, economic, and operating impact are principal concerns of the program.

Laboratory role The Laboratory performs in-house research and development, conducts program planning, selects subcontractors, and supervises subcontractors and demonstrations.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full support in all business management areas.

Authority This project has been in the financial plan for some time and has had a steady growth.

Budget and manpower

Summary of resources[a]—Electric Utility Load Management and New Technology Integration

	'78	'79	'80	'81	'82	'83	'84
Operating costs	1.4	4.0	5.0	5.0	5.0	5.0	5.0
Capital equipment	0	0.1	0	0.1	0	0.1	0
Subcontracting and procurement	0.8	3.1	4.2	4.2	4.2	4.2	4.2
Direct FTE	5	8	9	10	10	10	10
Indirect FTE	7	11	12	13	13	13	13

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Important milestones include completion of demonstrations of utility-controlled heat and cool storage for load management; testing of assessment methodologies; completion of field tests of communication systems; establishing feasibility of utility control of industrial loads; assessment of impact of dispersed generation on an isolated utility; establishing a large-scale demonstration test bed for distribution automation, load management, and integration of new dispersed technologies in a distribution system.

Subcontracts Subcontracts are undertaken only if the Laboratory has in-house expertise to ensure proper supervision. At least 15% of the work undertaken under management programs will be performed in-house.

We have currently released or plan to release 14 subcontracts, most of them with utility companies throughout the United States. These contracts are for demonstrations to develop data for assessing the impact of load management on the utility system and to establish cost benefits for the utility and its customers. The other contracts are related to survey and assessment of load management activities and to new technology integration. Ten of these contracts are for the demonstration of heat-and-cool storage devices in residences, and one is for the evaluation of utility-controlled load management of industrial customers. The utilities range from Pacific Gas and Electric, a large investor-owned utility, to the municipally owned system of the city of Burbank, California.

Related programs This work interfaces with the residential and commercial conservation efforts, the solar and special studies activities, and the Low-Temperature Thermal Energy Storage Program.

Technology transfer Because utility companies, consulting firms, and manufacturers are used as subcontractors, successful demonstrations could be put into practice on a wide scale in the near term.

References This program is covered by the following 189s: Technical Monitoring of Load Management Projects, C1 01 04 03 0, and DOE Technical Analysis and Monitoring for Field Tests of Communication Systems for Distribution Automation, C1 01 04 03 0.

Low-Temperature Energy Storage Systems

Assigned to Oak Ridge National Laboratory (Assigned to ASET)

DOE program Energy Technology; Program Office—Solar, Geothermal, Electric, and Storage; Division of Energy Storage Systems

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program Current emphases are on development of aquifers for seasonal storage of reject hot water or winter-generated chilled water and of systems using phase-change materials for short-term thermal storage for application to residential and commercial space heating and cooling. Responsibilities include concept definition, feasibility experiments, concept development, and demonstrations.

Laboratory role The Laboratory role is long-range and annual technical program planning, performing in-house research and development, selection of subcontractors, and management of subcontracts issued by Union Carbide Corporation, Nuclear Division.

Operations Office support ORO provides contract management/administration for interagency agreements and other contracts issued by DOE; monitors/evaluates overall program performance; provides liaison with other field units and with DOE Headquarters; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff and service support commensurate with the level of this assignment.

Authority This program has been included in previous ORNL institutional plans and has had steady growth.

Budget and manpower

Summary of resources[a]—Low-Temperature Energy Storage Systems

	'78	'79	'80	'81	'82	'83	'84
Operating costs	1.2	1.7	(4.0/7.5)[b]	(5.0/8.5)	(5.5/8.5)	(5.5/6.0)	(5.5/4.5)
Capital equipment	0	0.2	0.2	0.2	0.2	0.2	0.2
Subcontracting and procurement	1.0	1.4	(3.4/7.2)[b]	(4.3/8.2)	(4.7/8.2)	(4.7/5.7)	(4.7/4.2)
Direct FTE	0	0	(9/14)[b]	(10/15)	(10/15)	(10/15)	(10/15)

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] The program splits into base technology and project demonstrations beginning in FY 1980.

Milestones Major milestones include demonstrations of aquifer storage of winter chill and water heated by solar energy or energy wasted from industrial processes or power generation and development of reliable and economical phase-change materials. The phase-change materials will be demonstrated for different applications.

Subcontracts In FY 1978 we have 15 subcontracts such as that with Brookhaven National Laboratory for the study of encapsulation of phase-change materials in concrete masonry construction; with the New York Energy Research and Development Administration for test well drilling at JFK Airport; and with Auburn University for an aquifer thermal storage experiment. For FY 1979 and beyond we have currently planned an additional 14 contracts such as that with Rocket Research Corporation for the Bellingham Aquifer Storage Project and with others to be selected from responses to requests for proposals.

Related programs Thermal energy storage is a vital element to many conservation programs. This work relates to ORNL electric utility program; the residential and commercial program, especially heat pumps; and to the waste heat utilization efforts.

Technology transfer Demonstrations are important milestones, and successful ones will foster commercialization.

References The program is covered by the following 189: Low-Temperature Thermal Energy Storage, C8 01 01 02 1.

Environmental Impact Assessment for Fossil, Solar, and Geothermal Energy

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Energy Technology

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to ensure that DOE's environmental obligations under the National Environmental Policy Act are met and that environmental considerations are an integral part of fossil, solar, and geothermal technology research, development, and demonstration. ORNL will continue to develop and maintain centers of expertise in the environmental aspects of these technologies through preparation of site and

program environmental impact statements. In addition, ORNL will manage environmental impact assessment tasks and provide technical review and quality control of work done by other laboratories, universities, and subcontractors. The Laboratory is responsible for technical direction of the program, including coordination of activities by other contractors and definition of program requirements.

Laboratory role ORO manages the programs for the Assistant Secretaries of Energy Technology and Resource Applications, and the Laboratory is responsible for the technical direction of the program, including definitions of program requirements and coordination of activities of other contractors.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority Preliminary discussions with Energy Technology-Solar leave the solar role in question.

Budget and manpower

Summary of resources[a]—Environmental Impact Assessment for Fossil, Solar, and Geothermal Energy

	'78	'79	'80	'81	'82	'83	'84
Total program operating costs							
Fossil	1.0	3.0	3.5	4.0	5.0	3.5	3.0
Solar	0	0.5	0.4	0.5	0.5	0.6	0.6
Geothermal	0.5	0.6	0.6	0.6	0.5	0.4	0.3
Operating costs							
Fossil	1.0	1.6	1.6	1.6	1.6	1.6	1.6
Solar	0	0.3	0.2	0.2	0.2	0.2	0.2
Geothermal	0.4	0.5	0.5	0.5	0.3	0.3	0.3
Subcontracting							
Fossil	0	1.5	2.0	2.5	3.0	2.0	1.5
Solar	0	0.2	0.2	0.2	0.3	0.4	0.4
Geothermal	0.1	0.1	0.1	0.2	0.2	0.5	0.5

[a]1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Major milestones in the environmental analysis activities are keyed to programmatic decision points. Specific reports have been stated, however, with completion dates as follows: fossil—six project-specific draft environmental impact statements completed during mid-to-late FY 1979; geothermal—approximately two project-specific environmental statements and eight project-specific environmental assessments per year; and solar—four programmatic environmental assessments due by the end of FY 1979.

Subcontracts ORNL currently has five technical assistance subcontracts to provide technical assistance in the preparation of environmental assessments and statements: (1) Science Applications, Inc., Oak Ridge, Tennessee; (2) Lockheed, Huntsville, Alabama; (3) NUS, Inc., Rockville, Maryland; (4) Coastal Environments, Inc., Baton Rouge, Louisiana; and (5) Roy F.

Weston, Inc., Pennsylvania. Participation ranges from a small percentage of total analysis to the preparation of a completed document in the subcontractor's shop. In addition, other subcontractors are available on short notice to provide assistance or finished products in all sections of the United States.

Related programs The environmental analyses prepared under this management activity each relate to a specific DOE program or project and are therefore an integral part of other DOE programs. In addition, environmental research programs that provide project and environmental data are used in performing environmental analyses, and close interaction is maintained.

Technology transfer Environmental impact assessments and environmental impact statements are the principal product of this management activity. These documents include information gathered by other DOE facilities and by the private sector. Upon approval by DOE the documents become public information and are available upon request to interested parties.

In the course of preparing environmental assessments and statements, ongoing consultation with DOE program and project managers and with affected industry and public participants is provided by ORNL staff in order to resolve environmental conflicts at the earliest possible stage in program or project activities.

References This program is covered by the following reference documents: Geothermal Loan Guaranty (B&R No. 42 04 89 001) Environmental Analysis; Environmental Analysis of Geothermal Energy (B&R No. AE 07 01 000) 00004; Biomass Environmental (B&R No. 42-04) Assessment; Fossil Energy Environmental (B&R No. AA 03 04 03 0) Project, 00076; Program Plan for Fossil Energy Environmental Project, FY 1978, October 1977; and Environmental Impact Assessments (B&R No. AA 06 04 01) for Enhanced Oil Recovery, 00147.

Residential and Commercial Conservation in Buildings and Appliances

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Conservation and Solar Applications, Division of Buildings and Community Systems

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program This work consists of several closely related projects to reduce energy required for heating, ventilating, and air-conditioning (HVAC) systems and appliances for residential and commercial buildings. The in-house work is integrated with the objectives of subcontracts. A comprehensive heat pump program is under way; its objective is both near-term and long-range conservation. An innovative residential heating and cooling system is being demonstrated. A national plan is being developed for insulation materials and standards. Energy-saving appliances and structures are being developed, and models are being designed to forecast future energy needs for residential and commercial buildings.

Laboratory role The Laboratory performs in-house research and development, conducts program planning, selects subcontractors, and supervises subcontractors and demonstrations.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This program has been previously approved and has had steady growth.

Budget and manpower

Summary of resources[a]—Residential and Commercial Energy Conservation in Buildings and Appliances

	'78	'79	'80	'81	'82	'83	'84
Operating costs	3.7	5.1	6.0	6.0	6.0	6.0	6.0
Capital equipment	0	0.1	0.1	0.1	0.1	0.1	0.1
Subcontracting and procurement	2.5	2.9	3.0	3.0	3.0	3.0	3.0
Direct FTE	14	20	22	22	22	22	22
Indirect FTE	19	27	29	29	29	29	29

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Major milestones include heat pumps with improved performance and reliability, energy-efficient appliances, thermal insulation standards, and innovative structures and HVAC systems.

Subcontracts Subcontracts are undertaken only if the Laboratory has in-house expertise to ensure proper supervision. At least 15% of the work undertaken under management programs will be performed at ORNL.

Major subcontractors include Honeywell, to determine the economic competiveness of the Annual Cycle Energy System (ACES) concept with conventional heating and cooling systems; the University of North Dakota, to develop a split-air evaporator ice maker evaporator; R. G. Werden, for consultation and advice on the ACES concept; EUS, to develop and test a high efficiency electric water heater; Columbus Products, to develop and demonstrate prototype motor compressors for refrigerator-freezers and room air conditioners; and the National Bureau of Standards, for testing and evaluations of various residential and commercial appliances.

Related programs Many elements of the residential and commercial conservation program interact with the Low-Temperature Thermal Energy Storage Systems Project. The ANFLOW system developed by ORNL may prove an economic substitute for septic tanks and may permit greater innovation in structures.

Technology transfer Industry and architect engineering firms are used as subcontractors to expedite application and commercialization.

References This program is covered by the following 189s: Annual Cycle Energy System Implementation, C3 01 01 00 0; Innovative Structures, C3 01 01 00 0; Energy Conservation in Buildings and Appliances, C3 01 04 00 0; Management of Residential and Commercial Appliance Program, C3 01 04 00 0; Residential and Commercial Heat Pump Program Management, C3 01 04 00 0; Management of the Thermal Envelope Systems and Insulation Materials, C3 01 07 00 0; and Engineering-Economic Models of Energy Use, C3 01 02 00 0.

Waste Heat Utilization

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Conservation and Solar Applications, Division of Industrial Conservation

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program Heat rejected from generating electricity and industrial operations is estimated to total over 20 quads, which is almost one-third of the nation's energy consumption. Use of low-temperature waste energy is being investigated as a source for heat pumps, heating greenhouses, and producing aquatic protein. Also being considered is the optimum of reject heat temperature for cogeneration. For an integrated industry, such as a paper mill or a steel mill, studies are to be undertaken to use energy now being rejected from one operation as a source for another operation. Planned, integrated industrial parks can enable energy rejected by one industry to be a prime source for a neighbor. Integrated community systems offer the same advantages as cogeneration in an industrial park.

Laboratory role The Laboratory performs in-house research and development, conducts program planning, selects subcontractors, and supervises subcontractors and demonstrations.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units, expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority Work in cogeneration, community systems, and use of reject heat has been under way for some time. In 1977 a major integrated emphasis was proposed and incorporated in the *Institutional Plan.*

Budget and manpower

Summary of resources[a]—Waste Heat Utilization

	'78	'79	'80	'81	'82	'83	'84
Operating costs	0.3	1.2	1.4	1.9	2.4	2.4	2.4
Capital equipment	0	0	0.1	0	0.1	0.1	0
Subcontracting and procurement	0	0.4	0.4	0.7	1.0	1.0	1.0
Direct FTE	3	7	8	10	10	10	10
Indirect FTE	4	9	11	13	13	13	13

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Major milestones include a cogeneration demonstration with Gulf States Utility and neighboring industries, a district heating demonstration at Minneapolis, community systems demonstrations, and cascaded use of energy by industry.

Subcontracts Management roles involving subcontracts are undertaken only if the Laboratory has in-house expertise to ensure proper supervision. At least 15% of the work undertaken will be performed in-house, but the major effort will be subcontracted. The projected subcontracting effort will primarily involve three types of firms: architect engineers, utility companies, and industrial firms. The subject will be to demonstrate the use of low-grade reject heat.

Related programs Interfacing programs are residential and commercial appliances and the Low-Temperature Thermal Energy Storage Systems Program managed by ORNL.

Technology transfer Major milestones are demonstrations by applying existing technology to energy-saving systems. Successful demonstrations promote commercialization.

References This program is covered by the following 189s: Low Grade Reject Heat Utilization Program, C4 01 01 04 0; Industrial Energy Conservation Management and Technical Support and District Heating/Minneapolis and St. Paul, AG 04 09 02; Beneficial Uses of Waste Heat, AG 04 09 02; and Process Heat Applications, AG 04 09 02.

Shallow Land Burial (Nonnuclear)

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Waste Management

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to develop environmentally sound techniques for managing all types of solid wastes produced by our society. This includes wastes produced as a result of nonnuclear energy production, manufacturing activities, and municipal activities. There have been individual programs to study the management of various types of solid waste, and the purpose of this program is to provide a focal point for these activities and to minimize duplication of effort. Shallow land burial of nuclear-type wastes has received considerable attention during the past few years, and much of what is being learned is directly applicable to nonnuclear wastes. With the increasing emphasis on nonnuclear energy production and, in particular, the expanded role of coal as an energy source, the proper management of the wastes produced by these technologies will become of increasing public concern. Through this program, it is also expected that more emphasis can be placed on the recovery of resources from wastes for reuse in the economy.

Laboratory role It is expected that chemical research, technology development, and environmental studies will be carried out. Coordination and evaluation of shallow land burial studies conducted elsewhere will be provided. The demonstration and then transfer of technology to industry and municipalities will be pursued.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment was discussed on August 7, 1978, during the field review of ORNL's *Draft Institutional Plan.*

Budget and manpower

Summary of resources[a]—Shallow Land Burial

	'78	'79	'80	'81	'82	'83	'84
Operating costs[b]	2.4	10.0	15.0	18.0	20.0	21.0	21.0
Capital equipment	0	0.5	1.0	2.0	2.2	1.5	1.0
Subcontracting and procurement	0	7.5	12.0	14.8	16.7	16.9	16.9
Direct FTE	30	30	33	35	37	44	44
Indirect FTE	39	39	44	46	48	58	58

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] The cost estimate shown here (which includes all work related to this area) will be revised following further discussions with DOE Headquarters.

Milestones The first major milestone will be the completion of a detailed overall program plan in the first quarter of FY 1979. This plan in turn will define milestones for the development and demonstration of various shallow land burial technologies. It is expected that there will also be milestones to assess current practices for the management of solid wastes.

Subcontracts This program lead role will manage shallow land burial research and development (R&D) activities at DOE multiprogram laboratories, including work at Los Alamos Scientific Laboratory, Scientific Research Laboratory, Hanford Engineering Development Laboratory, Idaho National Engineering Laboratory, Battelle Pacific Northwest Laboratories, Rockwell-Hanford and Rock Flats, and Sandia. Contracts with universities, commercial firms, and consultants are anticipated. Approximately 75% of the work will be done by organizations outside ORNL.

Related programs Related DOE programs include several in the area of low-level nuclear waste management (activity migration in soils, waste volume reduction, etc.) and several under the Director for Energy Research in the coal program (resource recovery from fly-ash and coal conversion residues, ash disposal, etc.). Several programs under the Assistant Secretary for Environment are also pertinent to this program (environmental control R&D, environmental monitoring, environmental data bases, etc.).

Technology transfer A primary goal of the program will be to transfer technology on shallow land burial to industries and to federal, state, and local governments. During the course of the program, it is expected that both universities and industry will become involved through the use of subcontracts.

References Only the 189s that are either fully or partially on shallow land burial and resource recovery are listed. Some of these programs are also listed in the lead mission proposals for low-level waste management, the Fossil Energy Materials Technology Management Center, and residential and commercial energy conservation.

The following 189s (and several others in preparation) relate to these activities: 00083, 00006, OH1024, 0003, 00076, ON 4909A, ON 5109A, ON 7309A, ON 5709A, ON 0109A, ON 67309A, and ON 7509A.

Environmental Impact Assessment for Nuclear Fuel Cycle and Waste Management

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Environment and Safety (EV)

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of the proposed program is to provide overall management responsibility for the National Environmental Policy Act (NEPA) activities required in support of DOE programs in the nuclear fuel cycle and waste management areas.

Laboratory role ORNL will be responsible for the technical management of environmental impact assessments and statements for DOE nuclear fuel cycle activities as required by NEPA. The role will involve definition of requirements and coordination of in-house activities and of other contractors. These contractors may include other national laboratories, universities, and private consultants. The program is oriented in response to the Administration policy of developing safe and environmentally acceptable energy sources.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up

actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority Proposed role.

Budget and manpower

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

	'78	'79	'80	'81	'82	'83	'84
Total program operating costs	0	3.2	3.2	3.4	3.9	4.1	4.2
Operating costs	0	1.9	2.0	2.1	2.4	2.5	2.7
Capital equipment	0	0.2	0.03	0.03	0.03	0.03	0.03
Subcontracting and procurement	0	1.1	1.2	1.3	1.5	1.6	1.7
Direct FTE	0	21	21	21	24	25	25
Indirect FTE	0	28	28	28	32	33	33

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Major milestones will be (1) development and coordination of activities, (2) procurement of major subcontracts, (3) production of NEPA documents per schedule as developed in Item 1, and (4) coordination with existing DOE programs in waste management.

Subcontracts ORNL currently uses a large number of private subcontractors. This program will be supported by subcontractors from other national laboratories, universities, and private consultants.

Related programs ORNL now provides major assistance to DOE and the Nuclear Regulatory Commission in the nuclear fuel cycle areas. These include environmental assessment of mining and milling, fuel fabrication, reactor construction and operation, and waste handling.

Technology transfer Part of the existing effort at ORNL in environmental assessments includes extensive interaction with universities, state and local governments, and private industry.

References This program is covered by the following 189s: Environmental Statement Project—Reactor, B0001; Environmental Statement Project—Fuel Cycle Facilities, B0279; and Reactor Radwaste Generic Study, B0171.

Health and Environmental Effects of Synthetic Fossil Fuel Technologies

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Environment, Office of Environmental Research

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to develop a data base that permits judgments to be made of the environmental acceptability of synthetic fossil fuel technologies. Areas of study to achieve this objective include chemical and physical characterization and monitoring of synthetic fossil fuel products and effluents; biological and health effects of these materials; environmental transport, fate, and effects of pollutants; and integrated assessments.

Results of these and related studies are applied to health and environmental, monitoring, and testing activities in the Gasifiers in Industry Program (i.e., University of Minnesota-Duluth, Pike County, Kentucky; and Land O'Lakes, Perham, Minnesota) and in coal liquefaction projects (e.g., H-Coal, Cattlesburg, Kentucky).

The program is responsive to the mandates of Congress and to the Administration's concern in identifying and mitigating potential health and environmental effects in fossil fuel applications and thereby permitting accelerated use of the nation's fossil energy resources.

Laboratory role The Laboratory is responsible for identifying problem areas and support requirements; for the direction of the onsite and offsite programs in cooperation with DOE Headquarter's Program Office and Operations Office, including the activities of subcontractor support; and for coordinating its area of responsibility with other DOE contractors involved in related fossil energy activities.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority The Life Sciences Synthetic Fuels Program has been functional at ORNL since 1975 and has been identified in previous institutional plans. Assignment of lead responsibility for the development and implementation of monitoring and testing activities at selected coal gasification and coal liquefaction facilities was made by the acting ASEV during FY 1978 and appears as an approved function in the FY 1979–FY 1984 *Institutional Plan.*

Budget and manpower

Summary of resources[a]—Health and Environmental Effects of Synthetic Fossil Fuel Technologies

	'78	'79	'80	'81	'82	'83	'84
Operating costs	4.1	6.3	7.2	7.6	7.2	6.6	5.9
Capital equipment	0.8	1.1	0.3	0.5	0.3	0.3	0.3
Subcontracting and procurement	0.3	0.9	0.2	2.4	1.9	0.5	0.1
Direct FTE	61	82	88	93	88	81	72

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Implementation of the Environmental and Health Monitoring and Testing Program at the University of Minnesota-Duluth (UMD) project begain in FY 1978. Program plans will be completed for the Pike County project and the H-Coal project in FY 1979 and for the Land O'Lakes project in FY 1980. Program implementation for these anticipated three-year projects will begin the same year. Program development for other liquefaction projects (i.e., Solvent Refined Coal Demonstration) can begin in FY 1980–FY 1981 if requested.

Subcontracts Major subcontracts are in place with the University of Minnesota for assistance with monitoring and sampling at the UMD project. These subcontracts include support from experienced vendors of sampling protocols and equipment; they will require at least 25% of the

total effort. Future subcontracts to implement other applied field projects (i.e., use of the Pikeville College staff, Pikeville, Kentucky) are expected to range from 40 to 70% of the total project costs.

Technology transfer Direct transfer of information occurs with university staff and representatives of state and local government by their involvement with the field projects. Similarly, involvements of both the Environmental Protection Agency and the National Institute for Occupational Safety and Health in the UMD project ensure timely access to new data. Results of studies are also transferred by participation in various scientific and industry-oriented symposia and workshops (e.g., Symposium on Potential Health and Environmental Effects of Synthetic Fossil Fuel Technologies, September 25-28, 1978, Gatlinburg, Tennessee, sponsored by DOE's environmental programs and hosted by ORNL.

References This program is supported through the following 189s: GK0101012—000688; GK 0101031—3078; GK0101033—01684C, 01684E, 01684F, 01684G, 01684H, 01684I; GK0101041—800060, 800158, 800300; GK0101052—600114; GK01020201—000145, 000146, 000147, 001562, 001700, 002360, 002361, 004086, 004087, 004089, 002587, 002590; GK0102022—000173, 000174, 000181, 000184, 000237, 001474, 001476, 001566, 001569, 001570, 002375, 002559; GK0102023—002373, 000154, 000183, 002374, 002526, 004090; GK0102031—002382, 003079; GK0102032—000680, 001693; GK0102033—001711; GK0102041—001603; GK0102043—001607, 001707, 001710, 001711, 001722, 002548, 002613, 002943; and HK0101000—000169, 000283, 000286, 001588, 001560, 001701.

Ecosystem Modeling for Regional Environmental Resource Analysis

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Environment and Safety (EV)

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to develop and apply ecosystem models to regional environmental and energy resource problems. Technical simulation models will analyze energy resource depletion, environmental risks, ecological benefit-cost ratios and will devise strategic scenarios for an optimum mixture of energy technologies (fossil, nuclear, solar, geothermal, etc.) in regions of the United States. The program is oriented in response to the Administration's policy of maximizing the use of domestic coal reserves while maintaining or enhancing environmental quality. The Laboratory is responsible for technical direction of the program, including coordination of activities by other contractors and definition of program requirements.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment was proposed, and was not disapproved, in the last *Institutional Plan.*

Budget and manpower BRC numbers—GK 01 01

Summary of resources[a]—Ecosystem Modeling for Regional Environmental Resource Analysis

	'78	'79	'80	'81	'82	'83	'84
Operating costs	0.7	1.3	1.4	1.5	1.6	1.7	1.8
Capital equipment	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Subcontracting and procurement	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Direct FTE	6	17	18	18	18	18	18
Indirect FTE	2	6	6	6	6	6	6

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Major milestones include the application of ecosystem energy, watershed hydrology, and nutrient transport models to selected regions by late 1979. In early 1981, coupling with agricultural system and regional landscape pattern models will be interfaced with resource analyses of energy sources and distribution.

Subcontracts Major subcontracts include the University of Tennessee, Knoxville—systems analysis (7% of total effort); Southern Illinois University, Carbondale—regional analysis (5%); Virginia Polytechnic Institute, Blacksburg—regional analysis (5%); the University of Wisconsin, Madison—agricultural models (7%); the University of Wisconsin, Milwaukee—regional analysis (5%); the University of Minnesota, St. Paul—regional models (5%) and the University of Wyoming, Laramie—resource analysis (5%).

Related programs Related DOE programs requiring technical coordination with this one are the Regional Studies Program; all coal (and other fossil), uranium, geothermal, and hydroelectric development programs, Fuels from Biomass, and Carbon Dioxide Effects.

Technology transfer Technology transfer and commercialization responsibilities will be developed in conjunction with ORO and the ORNL Office of Technology Transfer.

References This program is covered by the following 189s: Systems Ecology, 00607; Eastern Deciduous Forest Biome, 00611; Ecosystem Models for Energy, 00962; Spatial Data System, 01668; Regional Studies Program, 01684; RARE II, 03214; Forest Island Dynamics, (NSF); National Coal Utilization Assessment, 02976; Numeric Information, EPA; New DOE Data Resources for Global CO_2; and New DOE Remote Sensing for Global C in Biosphere.

Policy Analysis (Integrated Nuclear Assessment, Siting, and Water Availability)

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Environment, Office of Technology Impacts (OTI), Division of Policy Analysis, Division of Technology Assessment, Division of Regional Assessments, Division of Environmental Impacts

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The Office of Technology Impacts has initiated several assessments of the potential nationwide effects of the National Energy Plan. ORNL has been given lead laboratory responsibility with respect to integrated nuclear assessment, siting, water availability, regional energy, and economic disaggregation.

Laboratory role In the tasks associated with integrated nuclear assessment, ORNL will develop an overall plan for the assessment and will provide support for environmental development plans (EDPs) for various activities in the fuel cycle. In the other lead laboratory areas of responsibility, ORNL will provide input to the OTI programs of other laboratories on regional energy and economic disaggregation, projections on siting of energy facilities, and assessments of water availability for power generation and other energy facilities.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority OTI Program Guidance for FY 1978 and FY 1979. The lead responsibility assignment was not addressed in the *Institutional Plan* for 1978 through 1984.

Budget and manpower BRC numbers—GK 01 01 04, GK 01 01 06

Summary of resources[a]—Policy Analysis

	'78	'79	'80	'81	'82	'83	'84
Operating costs	0.39	0.47	0.50	0.56	0.56	0.28	0.28
Capital equipment	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Subcontracting and procurement	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Direct FTE	6	7	7	8	8	4	4
Indirect FTE	7	9	9	10	10	5	5

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones Major milestones include the draft Integrated Nuclear Assessment Plan (October 1978); assessment of phosphate mining (September 1979); summary reports on EDPs (September 1979); draft reports on energy and economic disaggregation, siting, and water availability (July 1979); and final reports on energy and economic disaggregation, siting, and water availability (September 1979).

Subcontracts Subcontracts will consist of minor personal-service consulting agreements.

Related programs Related DOE programs requiring technical coordination include ORNL activities on regional studies and other OTI-supported programs on environmental policy analysis, technology assessments, and environmental impacts. Other DOE contractors have similar programs that are integrally related to these activities and that use the results for direct input into their programs. Other related programs include radio-direct surveys of inactive uranium mills and formerly used Manhattan Engineering District and Atomic Energy Commission sites, environmental assessment of advanced breeder fuels, model evaluation of breeder reactor activity releases, assessment of radiation doses resulting from releases of ^{222}Rn and ^{226}Ra from uranium mining and milling activities, and development of "as-low-as reasonably-achievable" guides for the nuclear fuel cycle.

Technology transfer There will be none.

References This program is covered by the following 189s: Regional Studies Program (DTA), 002976; Regional Studies Program (DRA), 001684; Integrated Nuclear Assessments Program, 000613; and Environmental Policy Analysis, 002224.

Effects of Atmospheric CO_2 on the Terrestrial Biosphere

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Environment, Office of CO_2 Research, Division of Environmental Research

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objectives of this program are to resolve whether the carbon of the terrestrial biosphere is an important source or sink of excess atmospheric carbon dioxide (CO_2) and to determine how the balance and distribution of carbon of the terrestrial biosphere might be changed by climatic shifts from credible changes in CO_2 concentration. The program is oriented toward providing essential information on the climatic risks associated with increased atmospheric CO_2. The Laboratory is responsible for technical direction of the program, which includes coordination of subcontractors.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment was proposed, and was not disapproved, in the last *Institutional Plan.*

Budget and manpower BRC number—GK 01 02 03 3

Summary of resources[a]—Effects of Atmospheric CO_2 on the Terrestrial Biosphere

	'78	'79	'80	'81	'82	'83	'84
Operating costs[b]	0.1	1.5	1.7	1.8	1.7	1.6	1.3
Capital equipment	0	0.1	0.1	0.1	0.1	0	0
Subcontracting and procurement	0	0.1	0.1	0.1	0.1	0.1	0.1
Direct FTE	2	17	19	19	18	17	15
Indirect FTE	1	6	6	6	6	6	5

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

[b] Includes $450,000 of work for others [National Science Foundation (NSF)].

Milestones Major milestones include development of terrestrial submodels (FY 1980) and incorporation in a global circulation model (FY 1981); development of instrumentation to determine vertical fluxes of CO_2 (FY 1981); climate reconstruction from past biotic evidence (FY 1981); climate/biosphere projections (FY 1982); determination of effects of disturbance on soil carbon (FY 1983); and major analysis and synthesis of research (FY 1984).

Subcontracts Major subcontracts include the University of California-Berkeley (analysis of global soil carbon pools and dynamics), and Southern Illinois University and Virginia Polytechnic Institute (analysis of carbon distribution and model development). Of the current effort, 13% is subcontracted. There will be expansion of the Laboratory component of the program with further subcontracts in areas of expertise not covered by Laboratory.

Related programs This program requires technical coordination with DOE's Office of CO_2 Research, Division of Environmental Research.

Technology transfer We will have direct relationships with the university community. We will maintain contacts with the Institute of Ecology, the Man and the Biosphere Program, the Scientific Committee on Problems of the Environment, and other national and international overview programs.

References This program is covered by the following documents: The Role of Terrestrial Ecosystems on the Global Carbon Cycle and the Effects of Climate Change on Carbon Amounts and Distribution, NSF; Global Carbon Cycles and Climatic Risks, 01669; Carbon Turnover for Terrestrial Ecosystems, NEW; Elevated CO_2 Effects on Terrestrial Ecosystems, NEW; Bioclimatology of Energy Impacts, NEW; Instrumentation for CO_2 Concentration and Vertical Flux Determination, NEW; Application of Remote Sensing Tools to Quantifying Carbon in Ecosystems and Ecosystem Changes, NEW; and Information Support for Analysis of Global Carbon Dynamics and Climate Change, NEW.

Materials and Structures Technology Center (MSTC)

Assigned to Oak Ridge National Laboratory (assigned to ASET)

DOE program Energy Technology (ET)-Fission; ET-Fusion; ET-Fossil; Conservation and Solar Applications—Conservation

Supporting operations office Oak Ridge Operations Office (ORO)

Technical program The objective of this program is to develop high-temperature structural design technology, including analysis methods, failure criteria, simplified design methods, and confirmatory structural tests. Associated materials behavior and properties for structural materials currently approved by the American Society of Mechanical Engineers will be determined in support of high-temperature structural design (HTSD). Advanced materials will be developed, as will manufacturing and in-service nondestructive examination (NDE) techniques to ensure component reliability for demonstration and commercial plants.

Laboratory role DOE provides policy, guidance, and overall direction for program planning and implementation. DOE approves program plan including scope, tasks, priorities, major deliverables, significant milestones, schedules, and costs. DOE provides resources and retains final accountability.

The MSTC prepares the national program plan with the understanding and agreement of DOE, ORO, and managers of participating laboratories. It coordinates key milestones with other DOE technology centers and projects.

ORNL is currently acting in a prominent role for HTSD method, materials properties, and NDE. In-house programs provide expertise for management of technology areas.

Operations Office support ORO provides contract management/administration; assists in development of the program management plan; monitors/evaluates performance; provides liaison with DOE Headquarters; serves as field focal point and provides management guidance to other participating field units; expedites business management interfaces and follow-up actions; and makes recommendations to DOE Headquarters on corrective changes in management, program scope, and funding. ORO provides technical staff support commensurate with the level of this assignment and full service support in all business management areas.

Authority This assignment is proposed. Informal correspondence has been initiated: D. B. Trauger, letter to G. W. Cunningham, Materials and Structures Technology Center, September 12, 1978.

Budget and manpower

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

	'78	'79	'80	'81	'82	'83	'84
Operating costs	38.0	39.0	40.0	40.0	40.0	40.0	40.0
Capital equipment	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Subcontracting and procurement	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Direct FTE	380	390	400	400	400	400	400
Indirect FTE	505	520	530	530	530	530	530
ORNL operating costs	9.1	9.4	9.6	9.6	9.6	9.6	9.6
MSTC operating costs	0	1.9	2.0	2.0	2.0	2.0	2.0

[a] 1978, 1979, and 1980 costs are in millions of current dollars and reflect a 7% escalation factor. Others are in millions of constant 1980 dollars. Personnel numbers are in full-time equivalent (FTE) person-years.

Milestones The HTSD, materials development back-up, and NDE manufacturing and in-service inspection development will provide demonstration and commercial plant designers the required technology on an interim basis during the five-year period. Refinements as required will be provided on a continuing basis.

Subcontracts MSTC participants will include (1) DOE laboratories—Argonne National Laboratory (ANL), Hanford Engineering Development Laboratory (HEDL), Idaho National Engineering Laboratory (INEL), ORNL, and Energy Technology Engineering Center (ETEC) and (2) industrial laboratories directly funded by DOE—General Atomic, General Electric, Rockwell International, and Westinghouse Advanced Reactors Development Laboratory. These organizations will subcontract and administrate fractions of their programs as required. The general ratio for all participants approximates 10%. The ORNL in-house ratio to the national program managed by MSTC is approximately 24% (see the budget and manpower item).

Related programs Coordination will be maintained with other technology centers in fission (Nuclear Standards Office—ORNL), components (ANL), fuels and materials (HEDL), fuel cycle (ORNL), and fusion, fossil, and conservation (laboratories as identified by DOE).

Technology transfer DOE, ORO, all MSTC participants, and other related technology centers will be kept informed through consolidated monthly technical summary reports, quarterly management cost and milestones reports, and a technical quarterly or semi-annual progress reports. All participants and the U.S. industrial community will be further informed by independently generated topical reports distributed in a consistent manner by MSTC in collaboration with DOE's Technical Information Center.

References For the sodium breeder program, there are approximately 30 applicable 189s nationwide and 7 at ORNL (OH048, OH0103, OH024, OH028, OH038, OH050, and OH061). For other fission, fusion, and fossil programs, the information will be requested from DOE.

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