Argonne National Laboratory

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OPERATING PLAN FY 1998

October 1997

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This October 1997 *Operating Plan* describes Argonne activities planned for FY 1998 roughly a month before the beginning of the fiscal year.

Contents

I. Introduction

This document is the first edition of Argonne's new *Operating Plan.* The *Operating Plan* complements the strategic planning in the Laboratory's *Institutional Plan* by focusing on activities that are being pursued in the immediate fiscal year, FY 1998. It reflects planning that has been done to date, and it will serve in the future as a resource and a benchmark for understanding the Laboratory's performance. The heart of the *Institutional Plan* is the set of major research initiatives that the Laboratory is proposing to implement in future years. In contrast, this *Operating Plan* focuses on Argonne's ongoing R&D programs, along with cost-saving measures and other improvements being implemented in Laboratory support operations.

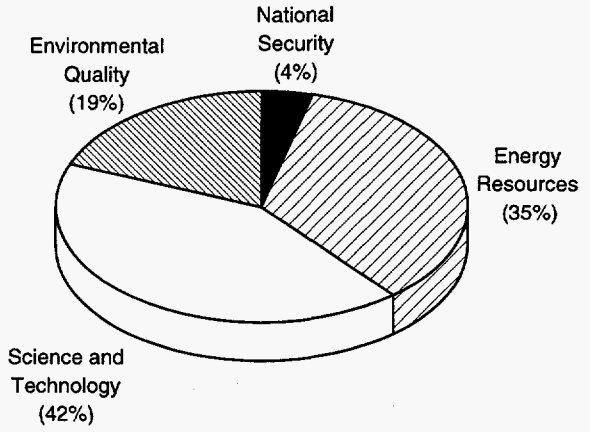

Figure I.1 Argonne Funding by DOE Business Line (Based on FY 1997 data, including work for sponsors other than DOE.)

A. Background and Missions

Argonne National Laboratory is a large multiprogram laboratory operated by the University of Chicago for the U.S. Department of Energy (DOE). Major Laboratory mission areas include fundamental science, national research facilities, energy technologies, and environmental technologies, as well as national security and technical evaluation. (See the *Institutional Plan* for a more detailed discussion.) To accomplish its mission for the Department and the nation, Argonne strives continually to advance the frontiers of science and to use its leading-edge capabilities in science and engineering to provide quality solutions for customers and stakeholders.

Argonne supports DOE in pursuit of the Department's four lines of business:

- Science and technology
- Energy resources
- Environmental quality
- National security

The distribution of Laboratory funding across these four DOE business lines is depicted in Figure I.1.

B. The Argonne Vision

Argonne's vision is to be a world-class provider of high-quality science, technology, engineering, and technical services, with the excellence of its research recognized by DOE, by other public and private sponsors, and by the many scientists and engineers from across the country who are research collaborators or users of Argonne's facilities.

The Laboratory regards three business goals as critical to achieving this vision:

- To understand and serve the needs and desires of the Laboratory's customers and stakeholders
- To lead in responding to market opportunities, as measured by quality of solutions, cycle time, and customer satisfaction
- To earn and maintain trust as a national research performer, as a regional science and technology resource, and as a valued neighbor in the community

Three underlying goals are essential to the success of the business goals above:

- Manage the recruitment and development of human resources to maximize the long-term creativity and productivity of Laboratory staff
- Provide continuous improvement in management and administrative systems as a prerequisite to achieving and maintaining efficient, cost-competitive performance
- Evaluate and reward organizational and individual performance on the basis of objective performance measures

C. The Role of the *Operating Plan*

Argonne's new *Operating Plan* is being established as an integral part of the Laboratory's annual planning and budgeting cycle. Whereas the Laboratory's Strategic Plan — as reflected in its published *Institutional Plan* — presents what the Laboratory wants to do over a multiyear time horizon, the *Operating Plan* describes the Laboratory's planned activities for the immediate fiscal year, on the basis of the best information about congressional appropriations and DOE funding plans available at the beginning of the fiscal year.

Figure I.2 depicts Argonne's planning and budgeting cycle, which is the larger context within which to understand the role of the *Operating Plan*. Argonne's Strategic Planning Council, comprising senior management and chaired by the laboratory director, reviews the strategic plans of the Laboratory's individual planning units and sets overall priorities and strategies. Decisions of the Council regarding major research initiatives and other longer-run issues are reflected in the Laboratory's Strategic Plan and its *Draft Institutional Plan* document, which are prepared in the late winter and early spring. Those strategic decisions and priorities then inform the selection of projects for the Laboratory Directed R&D (LDRD) program.

The field work proposals submitted by Argonne to DOE in April 1997 (middle section of Figure I.2) include plans for FY 1998 research that generally are consistent with the President's budget request for that year (though proposals for FY 1999 are by then a more open issue). "Congressional Appropriations and DOE Funding Approvals for FY 1998," as they are understood and projected in September 1998, are crucial to the plans in this *Operating Plan*. Initiation of FY 1998 research at Argonne in October 1997 is an action labeled "Execute FY 1998 *Operating Plan*" in Figure I.2, reflecting the role of this document as the Laboratory's summary of near-term plans for its work.

Budget formulation and execution at DOE are represented in the bottom section of Figure I.2. The Department's development of its FY 1999 budget during the summer and fall of 1997 will directly affect Argonne's *Operating Plan* next year.

Current strategic planning at Argonne provides the context for the *Operating Plan*, but the FY 1998 activities described in this document largely reflect strategic planning and research program development pursued by the Laboratory during prior years. Figure I.2 would have to extend into past years to indicate the origins of the activities described in this *Operating Plan*, prepared in the summer and early fall of 1997.

D. Contents of *Operating Plan*

The main body of the *Operating Plan* is organized into three chapters:

- Operating Plan for Scientific and Technical Programs (Chapter II)
- Operating Plan for Operations (Chapter III)
- Financial Operating Plan (Chapter IV)

The description of Argonne's scientific and technical programs presented in Chapter II is the most comprehensive that the Laboratory publishes. Organized by DOE secretarial office or other research sponsor, this description complements the spring *Draft Institutional Plan* by explaining the wide range of FY 1998 activities that represent first steps toward the Laboratory's longer-run strategic goals. FY 1998 budget authorization funding levels for major programs are given for each DOE secretarial office. (Laboratory-wide budget data are presented and analyzed in Chapter IV.)

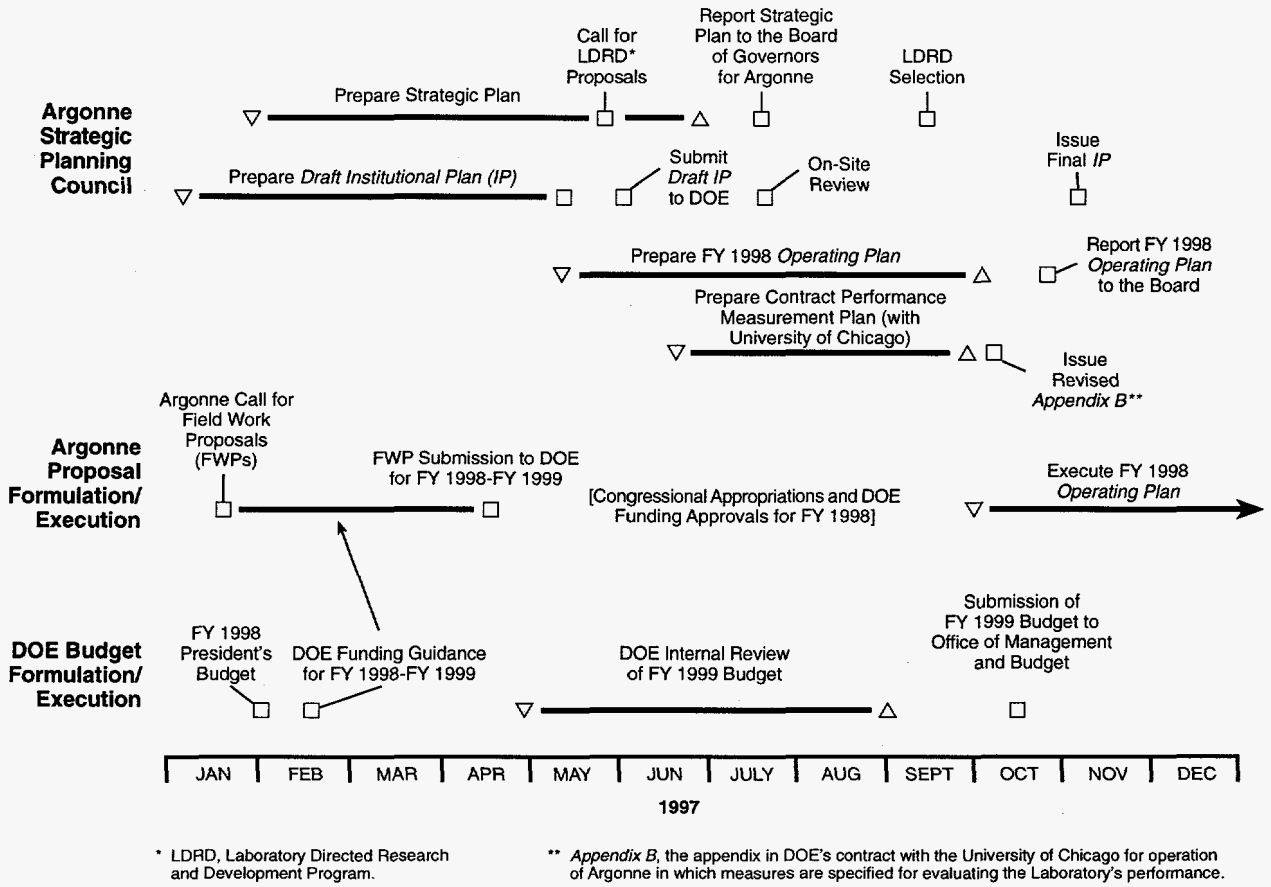

Figure I.2 Argonne's Planning and Budgeting Cycle

Chapter III describes initiatives planned for Argonne's supporting operations in FY 1998, based on the Laboratory's *Draft Institutional Plan* and on the FY 1998 plans for scientific and technical programs presented in Chapter II. A pervasive objective is increasing the cost-effectiveness of these activities. Separate sections summarize plans for the following support areas:

- Human resources
- Environment, safety, and health
- Environmental management
- Site and facilities operations
- Information and publishing services
- Business and financial management
- Technical support
- Communication and outreach

For each area, Chapter III identifies key initiatives to be pursued in FY 1998 and discusses them in terms of goals, objectives, scope, and major milestones. A general overview introduces the chapter.

Chapter IV analyzes Argonne's overall FY 1998 budget in terms of both budget authorization (BA) and budget obligation (BO). The difference between BA and BO totals will determine the change in the carryover funding that will be available to facilitate the Laboratory's transition into FY 1999. Argonne is addressing recent declines in its BA and carryover funding through a three-pronged strategy:

- Optimize the Laboratory's BA funding in FY 1998, with the minimum goal of halting the downward trend of the last three years

- Stabilize the part of the Laboratory's workforce that works directly on scientific and technical programs
- Balance the Laboratory's operating budget with its new BA funding through expenditure reductions in areas other than the direct programmatic workforce

Chapter IV briefly outlines and explains this strategy and describes promising initial results from its implementation.

As indicated above, Chapters II and III — the two longest chapters in this *Operating Plan* — address, respectively, the scientific and technical programs that directly conduct Argonne's research and the supporting operations that provide the infrastructure and services needed by the research programs. Table I.1 shows the financial scope of these two sides of Argonne in FY 1996 and FY 1997.

In summary, Argonne's new *Operating Plan* is developed in the early fall as a complement to the Laboratory's strategic planning in the early spring. It provides more comprehensive information about activities planned for the immediate fiscal year than is available from any other single source. As indicated by Figure I.2, this document is a key element in a planning and budgeting cycle for Argonne that has been substantially refined and crystallized over the past year. As this first edition of the *Operating Plan* is read and used, there will be close attention to opportunities for improving the document and its utilization, to make it in future years an even more valuable instrument in the planning, management, and execution of the Laboratory's work. As always, planning at Argonne is a continuing process that involves the entire workforce, not an end in itself.

Table I.1 Laboratory Expense ($ million BO)

Expense	FY96	FY97
Program	301.4	294.2
Support	174.8	165.9
Total	476.2	460.1

II. Operating Plan for Scientific and Technical Programs

The primary driver of Argonne's *Operating Plan* is its plans for serving DOE and other sponsors through its scientific and technical programs. This chapter describes these ongoing programs, with particular attention to plans for FY 1998 as they are understood roughly a month before the beginning of the fiscal year. (Plans for many programs are not finalized until later in the year.)

Table II.1 summarizes FY 1998 budget authority (BA) operating funds that Argonne expects to receive at the beginning of the fiscal year. The Office of Energy Research and the Office of Nuclear Energy, Science and Technology remain the Laboratory's largest customers. Other major DOE program offices sponsoring Argonne research are Energy Efficiency and Renewable Energy, Fossil Energy, Environmental Management, and Nonproliferation and National Security. The Laboratory also performs work for other DOE contractors; for non-DOE federal agencies, such as the Nuclear Regulatory Commission and Department of Defense; and for private firms and other nonfederal organizations. Discussion of Argonne work in this chapter is organized by sponsor, as indicated in Table II.1. (The Laboratory's internal organization sometimes differs, as when a cross-cutting Argonne program serves multiple DOE offices.)

Argonne's R&D programs are designed primarily to serve DOE missions. In broad terms, the Laboratory's research goal for each of the Department's four business lines is as follows:

- *Science and Technology*: To contribute significantly to the science and technology base needed to accomplish DOE and other national technology development goals; to develop and operate national user facilities that support the advancement of U.S. science and technology; to develop innovative experimental concepts and instrumentation that support fundamental research in energy and matter; to enrich science and mathematics education in the United States.

- *Energy Resources*: To develop technologies that improve the safety and reduce the costs of fission energy systems; to develop, test, and carry to proof of concept new energy efficiency technologies.

- *Environmental Quality*: To continue to strengthen existing programs and broad capabilities in environmental sciences and technology, while undertaking research that contributes significantly to the cleanup of DOE sites and the solution of other national environmental problems.

- *National Security*: To apply the Laboratory's unique technical resources, in nuclear technology and other areas, to define

Table II.1 Resource Summary by Major Program
($ in millions BA operating funds)

Program	FY96	FY97	FY98
Energy Research	180.4	172.9	176.3
Nuclear Energy, Science and Technology	95.8	89.2	92.0
Energy Efficiency and Renewable Energy	17.4	19.6	21.6
Fossil Energy	5.2	3.9	4.1
Environmental Management	52.1	49.3	40.2
Defense Programs	1.9	0.9	0.9
Nonproliferation and National Security	12.2	13.9	16.1
Other DOE Program Offices	4.5	2.3	2.2
Work for Other DOE Contractors	25.5	36.2	32.0
Work for Sponsors Other than DOE	71.0	70.2	72.0
Total Laboratory Operating Funding	466.0	458.4	457.4

and solve problems encountered in the development of advanced arms control, nonproliferation, verification, and defense technologies.

Argonne's major initiatives point to the future of the Laboratory beyond the FY 1998 horizon of this *Operating Plan*, so they are featured in the spring *Institutional Plan*. During FY 1998 the Laboratory will be developing the following major initiatives, which fall within three of DOE's major business lines:

- Science and Technology
  - Exotic Beam Facility
  - Center for Computational Science and Technology
  - APS Beamlines
  - IPNS Enhancement
  - Mechanistic Biology
- Energy Resources
  - Nuclear Energy Security
  - Transportation Technology
  - Industries of the Future
- Environmental Quality
  - Mixed Waste Treatment and Waste Form Development
  - D&D Technology Center

Much of the detailed description of Laboratory programs in this chapter previously was part of the spring *Institutional Plan*, now a more streamlined, forward-looking, strategic document. The present chapter still discusses "programmatic initiatives" that, in comparison with the major initiatives identified above, are more closely related to research within a single program area and typically require fewer resources; in the future, discussion of programmatic initiatives will be moved more completely to the *Institutional Plan*.

A. DOE Programs

1. Energy Research

a. Overview

Argonne conducts work in the basic energy sciences (which include materials sciences, chemical sciences, and engineering and geosciences), fusion energy, biological and environmental research, high energy and nuclear physics, computational and technology research (which includes mathematics and computer science, as well as advanced energy projects), and the Laboratory Technology Research Program. Major Laboratory research facilities include the Advanced Photon Source (APS) and the Intense Pulsed Neutron Source (IPNS), which are both used for materials sciences and other applications, and the Argonne Tandem-Linac Accelerator System (ATLAS), which is used for nuclear physics. In addition, the Laboratory supports the Basic Energy Sciences Advisory Committee and its panels and promotes extensive interactions between Argonne and the academic community through, for example, participation by students and faculty in the Laboratory's research. See Table II.2 for program funding.

Research in materials sciences at Argonne comprehensively addresses the properties of condensed phases and the scientific bases for new materials. A continuing mission is the development, operation, and use of state-of-the-art collaborative research facilities, such as the Electron Microscopy Center for Materials Research, the IPNS, and the Basic Energy Sciences Synchrotron Radiation Center.

The Laboratory has completed construction of the APS, which is used for materials research and many other applications across an extraordinarily broad range from basic science to developmental engineering. Like earlier Argonne facilities, the APS serves users from universities, industry, and national laboratories.

Table II.2 Energy Research Program Funding
($ in millions BA)

Major Program Title (B&R Code)	FY96	FY97	FY98
Total Basic Energy Sciences (KC)	122.2	120.8	123.7
Materials Sciences (KC-02)	27.7	27.6	28.4
Advanced Photon Source (KC-02)	75.9	75.9	78.2
Chemical Sciences (KC-03)	18.0	16.7	16.5
Engineering and Geosciences (KC-04)	0.6	0.6	0.6
Fusion Energy Sciences (AT)	5.2	2.5	2.8
Biological and Environmental Research[a] (KP)	11.5	10.5	10.4
High Energy Physics (KA)	7.9	7.8	7.6
Nuclear Physics (KB)	14.2	14.4	14.9
Energy Research Analysis (KD)	0.3	0.0	0.0
Total Computational and Technology Research (KJ)	15.3	16.9	16.9
Mathematical, Information, and Computational Sciences (KJ-01)	11.5	12.3	13.0
Laboratory Technology Research (KJ-02)	3.0	3.1	3.0
Advanced Energy Projects (KJ-03)	0.8	1.5	0.9
University and Science Education (KT)	2.6	0.0	0.0
Multiprogram Energy Laboratories — Facilities Support (KG)	1.2	0.0	0.0
Total	180.4	172.9	176.3

[a]In addition to new BA funding received directly from the DOE Office of Biological and Environmental Research, Argonne receives funding via transfers from other DOE contractors. In Table II.1, this funding is included in "Work for Other DOE Contractors." In FY 1997, $2.0 million was received for work on global climate change; a similar amount is expected in FY 1998.

Research in chemical sciences at Argonne encompasses a broad spectrum of fundamental investigations into atomic and molecular phenomena. There are formal programs in reactive intermediates in condensed phases, electron transfer in chemical systems, the photochemical energy sciences, chemical dynamics in the gas phase, metal cluster chemistry, photoionization-photoelectron spectroscopy, coal chemistry, the separation science and chemistry of the heavy elements, atomic physics, fluid catalysis, and advanced battery research.

In the geosciences, Argonne studies the atomic-scale processes occurring at mineral-fluid interfaces.

The Laboratory's role in the fusion energy program is R&D on fusion nuclear systems and studies of reactor design and systems. Argonne is the lead laboratory for the DOE blanket technology program.

Biological and environmental research at Argonne seeks to explore fundamental processes and to apply and develop methodologies for determining health and environmental effects of energy-related toxicants. The programs include basic mechanistic studies dealing with primary physical and chemical interactions of molecules at short time scales, long-term determinations of chronic biological and environmental effects, transport and deposition of trace substances, and the environmental effects of energy use.

Argonne's theoretical and experimental investigations in high energy physics seek deeper understanding of the structure of matter at the most fundamental level. Required experiments usually employ large particle accelerators, but one major project is being carried out in an underground laboratory without use of accelerated particles. The Laboratory's nuclear physics program pursues comprehensive understanding of all aspects of the structure, dynamics, and interactions of atomic nuclei. This program also develops, operates, and uses accelerators such as the superconducting ATLAS, a national user facility for studying heavy-ion reactions that has been upgraded to provide ion beams for all elements up to uranium.

Argonne's research in mathematics and computer science focuses on designing methods, algorithms, and tools for large-scale numerical and symbolic computations. Mathematicians and computer scientists collaborate with computational scientists on software and methods for applications such as global climate modeling, computational chemistry, computational biophysics, and materials science. Research includes development of new algorithms and adaptation of both production and state-of-the-art research codes to exploit advanced computer architectures and incorporate scientific visualization graphics. This

work emphasizes cooperation with various scientific organizations at Argonne and with universities and industrial firms. The Laboratory's newly established Center for Computational Science and Technology offers a massively parallel IBM SP computer and a CAVE virtual reality environment for large-scale calculations.

b. Materials Sciences (KC-02)

Argonne's research in materials sciences includes comprehensive studies over the entire spectrum from fundamental interactions near absolute-zero temperatures to studies of the bulk properties of solids exposed to high temperatures, radiation fields, and stresses. This research provides the scientific basis for advancing virtually all energy technologies through optimizing use of existing materials and development of new materials.

Major areas of research at the Laboratory include advanced materials, defects and radiation effects, and surface science and corrosion. The unifying theme of these studies is improving our basic understanding of materials — especially properties important for energy systems — and using this understanding to develop better materials.

Prominent in Argonne's materials sciences programs are its national research facilities serving users from universities, industry, and other laboratories: APS, IPNS, and the High Voltage Electron Microscope-Tandem Accelerator Facility.

Advanced Materials

Argonne is developing advanced materials by coupling experimental and theoretical methodologies to increase understanding of the basic phenomena controlling their properties. This research makes extensive use of major user facilities at the Laboratory, including the IPNS, where neutron-scattering investigations are conducted. Work at IPNS uses neutron powder diffraction to evaluate the crystal structure of complex materials; inelastic scattering to study dynamical aspects of materials; small-angle diffraction to investigate short-range order; and polarized-neutron studies of surface, structural, and magnetic properties. Commissioning of the Laboratory's Basic Energy Sciences Synchrotron Radiation Center, which is now beginning operations, will be completed in FY 1998. This Center will greatly facilitate application of the APS to research on advanced materials. Associated work is already under way at other facilities, such as the National Synchrotron Light Source at Brookhaven National Laboratory.

Argonne's research on superconductivity and magnetism investigates the synthesis and structure-property relationships of complex compounds having interesting superconducting or magnetic properties. At present, this work is largely devoted to high-temperature ceramic superconductors (including synthesis of materials), fundamental studies related to the mechanisms of superconductivity, investigations of the dynamics of magnetic vortex motion, and development of materials more easily used in technical applications.

The Laboratory's research on layered and thin-film materials investigates free surfaces, layered and superlattice systems, magnetic rare-earth and transition metals, ceramic materials, and superconducting transition metals. The Laboratory also conducts research to develop new permanent magnets by using thin-film methods.

Argonne's research on non-oxide superconductors focuses strongly on investigating the synthesis and properties of organic superconductors. Although superconducting transition temperatures for these materials are much lower than for ceramic superconductors, the two kinds of materials share many features, and Argonne research has notably increased transition temperatures for the organic materials.

The Laboratory's research on condensed matter theory concentrates on developing basic theoretical methods and concepts, applying these methods to complex systems by formal techniques and computer modeling, and complementing experimental research at Argonne and elsewhere. This theoretical work emphasizes superconductivity, the electronic structure of complex materials, and magnetism. Strong collaboration with the Laboratory's computer science program aims at using advanced computer systems to solve

complex problems, such as the behavior of magnetic flux lattices in high-temperature superconductors. A growing area of interest is the properties of thin-film and polycrystalline complex oxides, including ferroelectric materials and materials showing very large magneto-resistivity.

Defects and Radiation Damage

Argonne's research on defects and radiation damage focuses on characterizing the structure, phase transformations, and properties of solid materials (crystalline and amorphous alloys, intermetallic compounds, and ceramics) and on investigating processes that are significantly affected by point, line, and planar defects in crystalline materials. Included in these research programs is the High Voltage Electron Microscope-Tandem Accelerator Facility, which is operated as a national user facility within the Laboratory's Electron Microscopy Center for Materials Research.

Argonne combines experimental and theoretical techniques to study the properties of interfacial structures and grain boundaries. The main goal is to elucidate problems related to ceramics processing. The theoretical work includes detailed calculations of electronic structures, investigation of dynamical phenomena via approaches such as molecular dynamics and Monte Carlo calculations, and phenomenologically based models. The experimental studies use techniques such as conventional, high-resolution, and analytical electron microscopy and secondary-ion mass spectrometry. A new facility is being established at the APS to support *in situ* studies of materials prepared by metal-organic chemical vapor deposition.

Research on irradiation and kinetic effects investigates microstructural processes and phase stability problems that occur during irradiation at elevated temperatures, to provide basic knowledge needed for fission and fusion technologies. The microstructural processes and mechanisms occurring during ion bombardment and ion implantation are studied over wide energy and temperature ranges. Primary emphasis is on understanding the influence of neutron irradiation on physical properties, the effects of neutron irradiation on reactor components and fuel materials, and the effects of radiation on properties such as amorphization.

Surface Science and Corrosion

Argonne's research on surface science and corrosion focuses on surface and interfacial science that is relevant to energy technologies. The program also develops state-of-the-art instrumentation providing extremely precise characterizations of surfaces.

Research on particle and photon interactions with surfaces has pursued theoretical and experimental investigations of fundamental issues such as sputtering mechanisms, electron-induced desorption of neutrals from polycrystalline surfaces, and strongly segregating alloy systems forming self-sustaining surface coatings. Recent work has included the development of methods for preparing high-quality diamond thin films.

The Laboratory's research on interfacial materials chemistry has focused attention on molecular sieve materials, which provide extensive opportunities for designing new catalysts by using a very wide array of experimental techniques and theoretical modeling. This work has led to the development of methanation catalysts having potential commercial value. A recent emphasis has been the development of catalysts for control of automobile emissions.

Research on aqueous corrosion is investigating fundamental phenomena at temperatures and pressures relevant to environments in fission reactors. A parallel theoretical effort is simulating solid-liquid interface phenomena. A unique aspect of this work is its integration of advanced theoretical methods with high-temperature/high-pressure electrochemical kinetic measurements and surface spectroscopies. This program also uses advanced synchrotron techniques to characterize electrode surfaces in working electrochemical cells.

Research on the chemistry of materials at high temperatures is using various theoretical and experimental techniques to determine the structural, thermodynamic, and electronic properties of ordered and associated solutions, including ionic alloys and metal/molten salt systems.

Advanced Photon Source

Construction of the APS is complete, and operations are under way. Accelerator systems and user support operations are committed to delivering the highest level of reliability and service to APS users. For FY 1998, APS plans to deliver 3,750 hours of operating time to users. The number of hours scheduled for users will continue to increase in subsequent years. During FY 1997, availability at the APS reached nearly 90%; that is, nearly 90% of the beam time scheduled was ultimately delivered to users.

The APS provides dedicated technical, administrative, and safety support to the rapidly growing population of APS users. Fourteen collaborative access teams (CATs) presently occupy 20 of the 35 sectors possible at the APS. These teams pursue diverse scientific programs in materials sciences, chemistry and physics, structural biology, pharmaceutical research, and state-of-the-art applications of microimaging and microanalysis for geoscience, environmental science, and agriculture. At present, the CATs are engaged in various stages of construction, installation, testing, and use of the 40 X-ray beamlines available to them. All 40 beamlines are expected to become completely operational for research before the end of FY 1998. Several proposals to establish additional CATs have been approved in preliminary form by the APS Program Evaluation Board.

Accelerator systems R&D at the APS is focusing on supporting day-to-day accelerator operations (in the near term), improving operations (in the mid term), and advancing the state of the art in producing synchrotron radiation (for the long term). Near-term efforts to improve reliability of accelerator operations involve (1) regular observation of systems performance, tracking problems, and remedies and (2) development of procedures for defining and scheduling routine maintenance. In FY 1997, the APS global feedback system was commissioned, reducing beam size and opening angles by at least a factor of 10. Planned for FY 1998-FY 1999 are a number of performance upgrades to enhance beam current, position monitoring, and emittance and to improve radio-frequency acceleration systems and power supply systems. Research on advanced concepts will begin to address testing of self-amplified stimulated-emission (SASE) free-electron laser approaches, microfabrication of accelerator structures, production of slow positrons, and the use of intense X-ray beams to bond materials.

Experimental facilities research at the APS continues to focus on advancing X-ray beamline optics and instrumentation; on the design, fabrication, and testing of insertion devices with specialized capabilities; and on developing the scientific basis for implementing new X-ray research beamlines. The Synchrotron Radiation Instrumentation CAT, which is directed by APS, operates three sectors for studies of optics and instrumentation and is developing plans for a fourth sector. In FY 1997-FY 1999, this CAT will establish at the new sector — with collaborators from the Purdue X-ray physics group and the Australian user community — the capability to measure magnetic circular dichroism from 0.5 keV to 80 keV. Key to this advance is joint construction of a prototype helical undulator with scientists at the Budker Institute at Novosibirsk, Russia. APS scientists will also design and build an extra-long undulator for use in FY 1998 to demonstrate the SASE principle for wavelengths of 50-100 nm. This device, with its required diagnostics, will be used to address (1) the transfer of coherence through beamline optics and (2) thermal problems anticipated in the use of nanosecond photon pulses from a free-electron laser. Also planned is exploration of other concepts for dedicated sources and instrumentation needed to implement specialized types of X-ray measurements, in order to use fully the remaining capacity of the APS.

Intense Pulsed Neutron Source

Argonne's IPNS is DOE's most cost-effective neutron source for research on condensed matter. It is officially designated a national user facility, serving the needs of universities, industry, and other government laboratories. Investigations range broadly and include determinations of the structure of high-critical-temperature superconductors, magnetization depth profiles at the surfaces or interfaces of materials, diffusion at polymer interfaces, the potential of hydrogen in metal hydrides, and structure and dynamics in amorphous solids and liquids. Other studies focus

on the role of template molecules in the crystallization of zeolites, residual stress states in steels and composite materials, high-energy excitations in mixed-valent and itinerant magnets, and second-phase formation in metal alloys. Long-wavelength neutrons from cold liquid and solid methane moderators, in conjunction with the unique time structure of the pulsed neutron source, enable a number of valuable techniques, such as (1) the reflection of neutron beams to investigate magnetic surface phenomena and polymer diffusion and (2) quasielastic scattering to observe molecular rotation and motion.

In FY 1997, IPNS operated for 21 weeks under DOE sponsorship and for 2 weeks as part of the National Science Foundation's Science and Technology Center for High Temperature Superconductivity. Operating at a record 96.1% reliability, the accelerator system delivered 3,621 hours of beam for users. On the basis of current budget projections, IPNS is scheduled to deliver 3,800 hours to users in FY 1998.

c. Chemical Sciences (KC-03)

Argonne's research in chemical sciences encompasses a broad spectrum of fundamental investigations into atomic, molecular, and macroscopic phenomena. These investigations provide the scientific foundations needed to develop new energy technologies. Argonne's program in chemical reactivity now involves 11 major research areas: (1) reactive intermediates in condensed phases, (2) electron transfer processes in chemical systems, (3) photochemical energy sciences, (4) chemical dynamics in the gas phase, (5) photoionization-photoelectron spectroscopy, (6) metal cluster chemistry, (7) coal chemistry, (8) fluid catalysis, (9) the separation science of the heavy elements, (10) the chemistry of the heavy elements, and (11) the electrochemical and structural properties of electrodes and electrolytes in lithium batteries.

Argonne's research on reactive intermediates in condensed phases focuses on the chemistry of short-lived intermediates of radiolysis (such as radicals, radical ions, and the excited states of molecules) and the roles of solvents and matrices in modulating their reactivity. Separate research addresses solid-state chemistry and high-energy chemistry. The former work aims to unravel the influence of the structural order of solid matrices on chemical processes such as proton transfer, on the reactivity of transient intermediate species, and on energy disposal modes after irradiation. The high-energy research explores the dynamical behavior of highly excited species and excited radical ions generated by ultrashort (picosecond and subpicosecond) pulses of electrons and energetic photons. A new study in this area is assessing the role of nonthermalized intermediates in high-energy chemistry. To develop the capability for research in the subpicosecond time domain, Argonne proposes to construct a laser-driven linac (see below).

Argonne's research on electron transfer will continue to focus on investigating the basic principles that govern the rates of electron transfer processes. Investigations in this area are exploring new theoretical directions and advanced approaches, such as combining linac and laser excitation to study in such systems the photochemistry of radicals and radical ions and of photoinduced electron transfer reactions. Successes in experimental exploration of the dependence of electron transfer rates upon distance, energy, molecular structure, and temperature are providing a foundation for definitive tests of theoretical models and for complementary development of theory and experiments.

Argonne recently began to study the fundamental radiation chemistry of radicals and radical ions of nitrogen oxides in homogeneous and heterogeneous systems. Theoretical investigation of the energetics of the radicals and their reaction pathways is planned. This research is closely coupled to the research proposed below in the initiative "Fundamental Chemistry of Radioactive Waste," which bears directly on the needs of DOE-Environmental Management.

Argonne's research in photochemical energy sciences seeks to understand the mechanisms of electron transfer and optimized charge separation in natural photosynthetic systems and in molecular systems that mimic photosynthetic energy conversion mechanisms and to use this knowledge to guide the design of molecular photoconversion systems. These systems are studied by using a variety of spectroscopic techniques (such as time domain electron paramagnetic resonance; neutron

and X-ray scattering; X-ray absorption techniques; and ultrafast time-resolved optical spectroscopy), synthesis, and theory. Research recently begun aims to characterize nuclear reorganization inextricably coupled to the photochemistry associated with natural photosynthetic systems. In addition, the Laboratory uses its capabilities in synthesis to produce new tailored structures that help to resolve key issues in achieving rapid and controlled electron and charge transfer in synthesized systems.

Argonne's research on chemical dynamics combines theoretical work on the energetics and dynamics of chemical reactions with experimental work on chemical dynamics and kinetics. This broad effort, which is especially important to combustion science, will also contribute to a general understanding of the fundamentals of chemical reactivity. Theoretical investigations of the reactivity of large molecules, such as aromatic radicals, will continue, as will important new theoretical and computational work to develop quantum chemistry codes for advanced parallel processors. Argonne is playing a leading role in the exploitation of this opportunity through collaborative programs such as Argonne's Center for Computational Science and Technology initiative. The Laboratory is investigating radical reactions through experimental studies of state-selective chemistry in a flow reactor. Work on the chemical kinetics of combustion reactions has moved to the study of atom-radical reactions. Related photoionization-photoelectron experimentation aims to establish the thermodynamic properties of reactive intermediates important in combustion. Plans call for these two areas of research to be more strongly coupled. This wide-ranging experimentation provides a strong foundation for testing new theoretical models of chemical reactivity.

Argonne's research on metal cluster chemistry considers the chemical reactivity, product composition, kinetics, chemisorption reactions, catalytic properties, and structures of metal clusters ranging in size from 4 to 200 atoms. In closely linked experimental and theoretical studies, this program is developing a relationship between cluster structure and reactivity. Plans call for studies of metal cluster oxides, bimetallic clusters, and alloy clusters; investigation of the catalytic properties of size-selected transition metal clusters collected on appropriate substrate materials; initiation of a program to conduct X-ray spectroscopic studies at the APS; and continuing theoretical dynamics studies, especially on bimetallic cluster systems. One particular future thrust will involve the study of unimolecular reactions on cluster surfaces in real time. Another will expand theoretical work aimed at formulating correlations between the structural, magnetic, and optical properties of clusters and will initiate studies on constrained clusters. With theoretical efforts addressing reactive intermediates in condensed phases, electron transfer processes in chemical systems, and photosynthesis and solar energy conversion and with theoretical effort in the area of metal cluster chemistry, most of the Laboratory's research on chemical reactivity strongly links theory and experimentation.

In the area of chemical energy, Argonne's research on the characterization and reactivity of coals and coal macerals has focused on identifying the most important organic structures in coals and separated coal macerals and on the relationship of these structures to the chemical and thermal reactivity of the materials. Future research will address a wide range of vital issues in coal chemistry, including ecosynthesis of coals and macerals, the origin of long-chain alkyl aromatic compounds, pathways for hydrogen atom transfer, the structural chemistry underlying the problem of cross-linkage, development of multidimensional nuclear magnetic resonance imaging techniques, the synthesis of large-pore catalysts for converting heavy liquids derived from coal and related materials to fuel, and evaluation of the potential of synchrotron X-ray absorption spectroscopy for studies of the structure of coal and catalysts.

The central objective of Argonne's research in fluid catalysis is to explore new catalytic chemistry for transforming simple precursor molecules (such as carbon monoxide, methane, methanol, nitrogen, and hydrogen, which are frequently used in industrial processes) to desired products. This research employs supercritical fluids and novel strategies based on using toroid nuclear magnetic resonance techniques to study catalytic reaction chemistry *in situ* at high pressure and temperature. Plans for experimentation in supercritical water are closer to fruition, following the development of an all-metal chamber (with electrical connections on its

exterior walls) capable of withstanding the corrosive environment associated with that medium. New research will continue to exploit supercritical media for studying basic processes in catalysis, explore the potential of metallo-macrocycles in aliphatic hydrocarbon activation chemistry in the solution phase, and investigate ceramic precursor transformations that are associated with the synthesis of advanced materials.

Argonne's work in separation science develops and characterizes new separation processes and improved reagents applicable to environmental remediation and waste management. A central focus is the design, preparation, and evaluation of new extractants. Research will continue on the design and synthesis of new extractants in which the solvating molecule is built into the structure of the extractant so that intramolecular extraction can occur. Another focus will be the development of new classes of multifunctional extractants with enhanced selectivity for metal ions. In addition, the Laboratory plans to synthesize extended molecular structures in which molecular recognition occurs in two distinct stages, resulting in a precipitate that enables separation of metal ions.

In its work on heavy-element coordination chemistry, the Laboratory emphasizes design of new ligands, spectroscopy studies of the f-elements in various coordination environments, and investigations probing the influence of f-elements on the cooperative properties of materials containing them. Coordination chemistry research is linked with work in separations science, in order to expand investigations in areas likely to illuminate important issues relating to environmental restoration and waste management. Also being sought are new options for waste disposal and site cleanup and for actinide monitoring and safeguards. Research will continue to develop structure-property relationships for actinide ions in crystalline and amorphous phases, such as glass containing nuclear waste. Other work will investigate the structure and heavy-element-encrypting properties of heteropolyanion clusters.

Argonne conducts fundamental experimental and theoretical studies to elucidate and resolve key issues that limit the performance of rechargeable lithium batteries used in nonautomotive applications. Argonne has initiated a search for materials suitable for novel or modified electrodes, at the same time seeking detailed understanding of the relationship between the structure and the electrochemical properties of the electrodes. One such study relates to preparation of carbon electrodes that exhibit superior performance as the negative electrode. The promising approach being employed here is synthesis by design, exploiting template synthesis techniques. Argonne is also exploring the utility of *in situ* nuclear magnetic resonance spectroscopic imaging for studying electrode-electrolyte interfaces and solid-state ion transport mechanisms in lithium-polymer electrolyte batteries. In addition, experimental and theoretical approaches, including neutron and X-ray scattering and *ab initio* molecular orbital theory, are being coupled to elucidate the structure, dynamics, and ion transport properties of lithium-polymer electrolytes. Further issues under study include the factors that influence film growth at electrolyte-electrode interfaces, the fundamentals of dendrite formation on lithium anodes, and the transport numbers of lithium ions. This combined approach will provide enhanced understanding of the behavior of electroactive materials and guidance in tailoring their structures.

Initiative: Fundamental Chemistry of Radioactive Waste

Argonne proposes a new integrated program in the fundamental chemistry of radioactive waste. This program of experimental and theoretical research will respond to a national need for fundamental knowledge of the chemistry underpinning technologies for the cleanup and disposal of radioactive waste, a need highlighted, for example, by "hydrogen burping" problems in DOE waste tanks. Further related issues requiring research include developing more efficient, cost-effective separation techniques for treating mixed waste, transuranic waste, and high-level waste; creating and characterizing new waste forms; oxide degradation processes that could limit some plutonium disposal options; and developing monitoring and characterizing sensor systems for research in waste management applications. Argonne is uniquely qualified to undertake this initiative through its core capabilities in chemical separations science, heavy-elements chemistry, radiation chemistry, and theoretical chemistry, as

well as through its facilities for research with radioactive materials, including its cobalt-60 irradiation facility, the facility for actinide studies at the APS, and its megacurie and kilocurie hot cells.

Argonne is planning research on all of the issues relating to radioactive waste identified above. One initial effort involves investigating the chemistry of nitrogen oxides in homogeneous and heterogeneous systems, in connection with understanding the generation and reactivity of radiolytically produced nitrogen oxides in waste tanks. Nonlinear laser spectroscopy of actinide ions within representative glass matrices is being used to develop correlations between electronic energy levels and structural defects induced by microscopic radiation damage in glass waste forms. Use of X-ray absorption spectroscopy has shown that modifying a clay mineral surface by adding an organic coating is a good technique for sequestering uranium. Already planned is research leading toward relativistic quantum codes suitable for addressing issues in heavy-elements chemistry.

Building on these activities, Argonne plans a major research program with the following objectives:

- To study radiation chemistry in highly concentrated waste solutions and suspensions in order to improve understanding of the fundamental processes contributing to the radiolytic generation of chemical products in waste tanks
- To develop new separations procedures that can both provide the underlying technology to meet the challenges posed by mixed waste and continue contributing to the solution of high-level waste problems, such as removal of the fission products cesium, strontium, and technetium from high-level waste
- To investigate radiation effects in waste forms — especially bubble formation and transport in silicate glasses — and also develop new waste forms suitable for nuclear waste stabilization, including ceramic materials that are superior hosts for plutonium disposal
- To advance relativistic quantum code development sufficiently for simulation of systems containing a large number of atoms (including several that are heavy elements), thereby increasing the contribution of chemical theory to the radioactive waste management program (work supported in part as a Grand Challenge Application from the DOE Office of Computational and Technology Research, Mathematical Information and Computational Sciences Division)

Required resources for this initiative are summarized in Table II.3. Funding is sought from the Chemical Sciences Program (KC-03) and the Environmental Management Science Program (EW-45).

Table II.3 Fundamental Chemistry of Radioactive Waste ($ in millions BA; personnel in FTE)

	FY97	FY98	FY99	FY00	FY01	FY02	FY03
Costs							
Operating	1.3	2.4	3.6	4.0	4.0	4.0	4.0
Capital Equipment	-	0.3	0.4	0.5	0.5	0.5	0.5
Construction		-	-	-	-	-	-
Total	1.3	2.7	4.0	4.5	4.5	4.5	4.5
Direct Personnel	5.2	9.6	14.4	16.0	16.0	16.0	16.0

Initiative: Linear Accelerator Upgrade — Ultrafast-Pulse Radiolysis Facility

Argonne proposes to upgrade its present linac to a new pulse radiolysis facility that will enable the study of the very fast chemical phenomena that are important for understanding (1) the radiolytic processes occurring in radioactive waste and (2) other fundamental issues in chemical reactivity, such as the chemistry of reactive intermediates, charge and electron transfer and transport, and ion solvation. (See the related initiative, "Fundamental Chemistry of Radioactive Waste," and the discussion above of Argonne's work on reactive intermediates and electron transfer.) This new laser-driven electron accelerator device will revolutionize generation and detection capabilities in pulse radiolysis experiments.

Many basic research studies needed to investigate these fundamental issues are not possible with any existing accelerator, because the

required time resolution is not attainable, and detection capabilities are limited. The new facility will supply the needed shorter pulses with synchronized laser beams for pump-probe measurements. It will also provide a much higher current in 50-ps pulses, which will facilitate many studies of fast phenomena that are not presently possible. Even the study of rapid charge transfer reactions in liquids and gases should become possible.

The new pulse radiolysis facility will include a linear accelerator based on novel technology for the injector and acceleration sections and will reuse much of the existing linac transport system in a simplified configuration. The facility will have a laser-driven photocathode, with a portion of the laser light available to provide precisely synchronized probe light for optical detection. Design goals are electron pulses with energy greater than 10 MeV and a charge per pulse of 3 nC for a pulse that is less than 1 ps wide and 50 nC for a pulse that is 50 ps wide. Differences in pulse length depend on the ability to keep the charge together in space (space charge limitation). Construction will comprise (1) computer simulations to determine machine configurations for the generation of the larger pulses (> 50 nC) and ultrashort pulses (< 1 ps); (2) reconfiguration of the present experimental hall for simpler operation and maintenance and removal of old components; and (3) design, construction, and assembly of a laser-driven photocathode, accelerating cavities, an excitation laser, supports, control systems, and focusing systems. The accelerator will employ the L-band linac radio-frequency system and the klystrons from the present linac. Advantage will also be taken of the experience of Argonne's high energy physics group in building high-current, short-pulse accelerators using laser-driven photocathodes.

This new accelerator will be designed to be user friendly, allowing establishment of a pulse radiolysis user facility serving researchers from both inside and outside Argonne. Funding is sought from the Chemical Sciences Program (KC-03). Required resources are summarized in Table II.4.

Table II.4 Linear Accelerator Upgrade — Ultrafast-Pulse Radiolysis Facility
($ in millions BA; personnel in FTE)

	FY97	FY98	FY99	FY00	FY01	FY02	FY03
Costs							
Operating	-	-	-	-	-	-	-
Capital Equipment	-	-	-	-	-	-	-
Construction	-	-	3.0	0.4	-	-	-
Total	-	-	3.0	0.4	-	-	-
Direct Personnel	-	-	1.0	1.0	-	-	-

d. Atomic, Molecular, and Optical Physics (KC-03)

The primary goal of Argonne's program in atomic, molecular, and optical physics is to establish a fundamental understanding of how X-rays interact with atoms and molecules. Enabling studies use two unique facilities at the Laboratory: the APS and ATLAS. The APS provides intense, high-brilliance, polarized, tunable X-ray pulses that for the first time allow comprehensive studies of the structure and dynamics of isolated atoms and molecules at "atomic" length scales. Studies planned for the APS will investigate photoprocesses in prototypical systems in the range of hard X-rays and will provide a fundamental basis for the X-ray diagnostics used in other disciplines, such as Compton scattering studies of electron momentum distributions in materials, X-ray diffraction studies of large molecules, magnetic scattering studies of materials, and investigations of core-hole shifts in complex chemical environments. The study of atomic structure in few-electron systems at intermediate Z values, as planned at ATLAS, provides guidance and motivation for theoreticians working on the relativistic many-body problem in the regime where both electron correlation and relativistic and quantum electrodynamic effects are simultaneously important. The development of sophisticated detector technology required for the basic APS and ATLAS programs will further enable the examination of atoms under extreme conditions (such as intense fields provided by a laser) with an X-ray probe and the study of nonlinear optical interactions. A major milestone for FY 1998 is full implementation of the COLTRIMS and X-ray

spectrometer and their use in experiments at the APS.

e. Engineering and Geosciences (KC-04)

Argonne is applying synchrotron radiation techniques to fundamental problems in the geosciences. Specific techniques being used include static and time-resolved X-ray scattering, X-ray spectroscopy, and X-ray standing-wave studies of geologic materials under controlled conditions. The objective is to gain new insights into the atomic-scale processes occurring at mineral-water interfaces, in aqueous electrolyte solutions, and in minerals and rocks under a wide range of physical conditions. Success will allow better prediction of complex macroscopic geologic transport phenomena, particularly those occurring in natural rock-water systems. These phenomena are crucially important for a wide range of energy technologies.

f. Magnetic Fusion (AT)

Argonne's work on the development and technology of magnetic fusion includes studies of fusion nuclear technology, fusion reactor materials, and reactor designs. The work on fusion nuclear technology concentrates on the first-wall blanket and shield systems. The materials research focuses on advanced structural and blanket materials. The design effort emphasizes nuclear systems for the International Thermonuclear Experimental Reactor (ITER) and design of advanced tokamak power reactors. ITER is a joint effort of the European Community, Japan, Russia, and the United States.

Argonne plays a lead role for the part of the ITER study that addresses first-wall/blanket/shield systems. The work includes designing the first-wall/blanket/shield and the plasma facing components and defining the nuclear test program and test modules. This design work includes assessment of materials databases; neutronic, stress, and thermal-hydraulic analyses; and investigation of plasma physics issues related to plasma-wall interactions. Overall, Argonne is a major participant in the engineering design, which will be completed for ITER in FY 1998.

Argonne's studies of blanket technology for magnetic fusion include both liquid metal and ceramic breeder blankets. Argonne investigates phenomena related to magnetohydrodynamic (MHD) aspects of liquid metal blankets, properties of ceramic breeder materials and beryllium, insulators for liquid metal blankets, breeder neutronics, small blanket module tests, and transient electromagnetic effects. Liquid metal MHD is studied in the Argonne Liquid Metal Experiment (ALEX) facility. The current focus is development of electrically insulating coatings on vanadium alloys. The insulator coating greatly reduces the MHD pressure drop, enhancing the capabilities of liquid metal systems. ALEX was recently upgraded to operation with liquid lithium for these tests.

Argonne's research on fusion materials focuses on first-wall/blanket materials. Primary emphasis is on developing vanadium alloys and studying corrosion and compatibility in environments relevant to nuclear fusion. The research on vanadium alloys currently focuses on developing baseline data on mechanical properties and investigating the effects of neutron irradiation on mechanical properties. In collaboration with Japanese researchers, Argonne has developed a method for investigating the effects of higher, fusion-relevant rates of helium generation in alloys during fission reactor irradiations. Work on corrosion and compatibility focuses on vanadium alloys in liquid lithium and their interactions with the hydrogen plasma and the ambient environment.

In studies on advanced reactors, Argonne continues to collaborate on advanced nuclear design with the University of California at Los Angeles. Argonne's work in this collaboration focuses on developing advanced blankets and impurity control systems that emphasize simplified designs and inherent safety.

g. Biological and Environmental Research (KP)

Argonne's human health and environmental research program encompasses studies in life sciences (KP-11) and environmental processes (KP-12). These studies include investigations in the general areas of biophysics, molecular and

cellular biology, DNA sequencing, statistical studies of health effects on human and animal populations, atmospheric science, microbiology, and ecology.

Life Sciences (KP-11)

Argonne's studies in the life sciences include work in biophysics, structural biology, molecular and cellular biology, genome sequencing, and health effects.

Biophysical studies investigate relationships between the structure and function of proteins and other large biological molecules. X-ray crystallography, computational modeling and simulation, gel filtration chromatography, and other biophysical methods are used to analyze protein structures and their interactions with small ligands and with other proteins. Studies of the structure of antibodies, photosynthetic reaction centers, enzymes, and chaperonins help determine their functions. Site-specific mutagenesis of immunoglobulin light chains and the photosynthetic reaction center complex provides insight into alterations in function caused by single amino acid changes and allows testing of predicted relationships between structure and function. Integrated structural and solution studies elucidate chaperone-assisted protein folding.

Argonne operates a national user facility for structural biology research at the APS. The Structural Biology Center uses one sector of the APS for diffraction studies of large biological molecules. (Each APS sector consists of an insertion device X-ray source and its adjacent bending magnet X-ray source.) A related project is developing an ultrafast detector for protein crystallography at synchrotron X-ray sources. This detector, based on a charge-coupled device, can be used at existing synchrotron sources as well as at the APS.

In a study simulating enzyme reactions, Argonne has devised a unique computational method that combines quantum mechanical and molecular modeling schemes and uses fast, semi-empirical computational methods on massively parallel computers. Methods with this power and capacity will allow data gathered from synchrotron studies at the Structural Biology Center to be related to the fundamental structures of the system, possibly even for time-dependent phenomena.

Argonne has begun a program to study the cellular and molecular biology of organisms living at extremely high temperatures — up to (or even slightly above) the boiling point of water. These so-called hyperthermophiles belong to a primitive group known as archaea. The Laboratory is exploring the basis for the extreme thermostability of their proteins and seeking potential uses for these molecules in biotechnology, bioremediation, and medicine. Also of interest are the mechanisms by which proteins fold at such high temperatures. The heat shock proteins, which are found in all organisms, are being studied; these proteins have been implicated in fundamental cellular processes and have relevance to treating diseases in humans.

In Argonne's genome program, work on developing the method of sequencing by hybridization on oligonucleotide microchips has established its practical validity. Current efforts aim toward a production-scale laboratory capable of sequencing one million base pairs per day. Development of microchips for diagnosis and analysis in medicine, biology, and biotechnology is also under way. Another project is developing the technique of "modular primer walking," which eliminates the primer synthesis step needed in conventional sequencing by primer walking.

Argonne's health effects research investigates how radiation and chemicals affect human and animal health. These studies focus primarily, but not exclusively, on gene expression and structure-function relationships in critical cellular proteins, as well as on cancer-related questions.

Argonne's biostatistical research involves studying mortality in populations from a biological perspective, seeking common patterns of mortality between species, studying how aging-related mortality is modified by exposure to radiation, and developing mathematical models to predict age-specific mortality risks in humans from the mortality patterns observed in laboratory animals. These studies involve data generated by computer simulation, data on humans from the National Center for Health Statistics, and a large collection of mortality data from studies on laboratory animals. This research is intended to provide a

deeper understanding of why organisms die and why they die when they do.

A study of the molecular effects of radiation is seeking to identify the nature of induced cellular responses, by investigating the mechanisms of the early transcriptional events accompanying radiation exposure and identifying genes important in radiosensitivity. Sensitive assays for gene expression using technology provided by Argonne's genome program have been developed. A related project examines the molecular mechanisms underlying radiation-induced lung tumors and lymphomas, focusing on the effects of deletions or mutations in oncogenes.

Argonne's protein mapping group is using two-dimensional gel electrophoresis (2DE) to analyze protein expression in both normal and challenged mammalian cells. Relational databases for data on mouse and human proteins are being built. These databases include information on the relative positions of proteins in 2DE patterns, subcellular location, and changes in abundance or 2DE position in response to altered cellular conditions. Through identification of specific proteins, the molecular mechanisms that lead to observed protein changes can be understood.

Studies on the control of growth and differentiation in human cells seek to define molecular processes that govern replication, malignant transformation, differentiation, and programmed cell death (apoptosis) in various human cell types and tissues. Critical gene products — such as growth-modulating factors, protein kinases and phosphatases, adhesion molecules, and related proteins — are being characterized and tested for their function and role in signal transduction processes that initiate these events. A number of these proteins (including MRP8 and MRP14, two growth-inhibiting peptides, and inosine monophosphate dehydrogenase, a growth-controlling enzyme) have been expressed in bacterial systems and are being crystallized for structure-function analyses. Results from these studies promise better understanding of the proteins' structures and their roles in cellular replication, malignant transformation, differentiation, and apoptosis.

Environmental Processes (KP-12)

Argonne's environmental research encompasses atmospheric studies and measurements and investigations of fundamental ecosystem adjustment.

Argonne participates in the Computer Hardware, Advanced Mathematics, and Model Physics (CHAMMP) program through membership in a working group that includes the National Center for Atmospheric Research and Oak Ridge National Laboratory.

For the Global Change Assessment Research Program, the Laboratory is working with the National Center for Atmospheric Research to study climate surprises and their incorporation into integrated assessment models.

Argonne participates in DOE's Atmospheric Radiation Measurement (ARM) Program by establishing field sites for scientific research, conducting specialized research projects, and supporting development of new research directions. The field sites are designed for experiments on solar and infrared radiative transfer and on the atmospheric properties that influence climatologically significant energy flows. Parameterizations will be developed for general circulation models and related models, to improve substantially their accuracy in predicting climate change. To sample important spatial and temporal variations in atmospheric conditions, at least three fixed field sites will be required.

For the ARM Program, Argonne leads efforts in instrumentation of the field sites, in site operations at the first site established, and in the data communication and management associated with the instrumentation. In specialized research, Argonne conducts experiments and develops parameterizations on the surface energy balance and other surface properties, to provide adequate descriptions of surface boundary conditions for large-scale models. The experiments rely on micrometeorological observations and observations of the atmospheric boundary layer, which are obtained by using both ground-based remote sensing and surface stations to measure air-surface exchange rates.

In atmospheric studies, the Laboratory investigates the transport and dispersive properties of the lower atmosphere with ground-based, remote-sensing equipment such as Doppler acoustic sounders, radars, and laser anemometers and with direct-sensing devices deployed at the surface or carried aloft by balloons. Mathematical descriptions of transport and diffusion are developed and tested against experimental data.

Dry deposition refers to the delivery of trace atmospheric substances to the surface without the aid of precipitation. For DOE's Atmospheric Chemistry Program (ACP), Argonne is conducting experimental, theoretical, and modeling studies on the air-surface exchange of energy-related trace substances, especially sulfur oxides, nitrogen oxides, ozone, and organic substances. Field studies use micrometeorological techniques and environmental enclosures. The Laboratory is developing models for use in regional and global studies that require estimates of dose to the surface or atmospheric mass budgets.

Argonne contributes to experimental investigations of the chemical and physical processes associated with the atmospheric sources and the fates of trace chemicals. The Laboratory studies the effects of energy-related trace chemicals on the photochemistry of the atmosphere and the long-range transport of these substances and their transformation products to continental receptor areas.

Through field studies, laboratory modeling, and development of analytical techniques, Argonne chemists are examining the effects of organic oxidants (such as peroxyacyl nitrates, organic peracids, and organic hydroperoxides) on gaseous, aqueous, and aerosol species in the atmosphere. State-of-the-art spectroscopic systems are used to investigate the effects of ultraviolet-B radiation and longwave radiation on organic oxidants. The goal is to elucidate the roles of organic compounds in atmospheric chemistry in urban areas and on regional and global scales.

Argonne is studying daily temporal and spatial variabilities in column ozone over portions of the Northern and Southern Hemispheres for the years 1979-1992. This work for the ACP involves analysis of comprehensive data obtained by the Total Ozone Mapping Spectrometer carried on the Nimbus 7 satellite. Central questions include the frequency of extreme total ozone events, their time trends, and the mechanisms generating the extremes and their variability.

Argonne staff lead the scientific coordination for the ACP. The ACP scientific coordinator works to enhance overall scientific progress with researchers at 8 DOE laboratories and approximately 20 universities and non-DOE laboratories. The project also supports activities of the North American Research Strategy for Ozone (NARSTO) program coordinator, who is employed by a private company. The NARSTO program is a Canadian-U.S.-Mexican effort to provide the scientific and engineering basis for policy-making related to tropospheric ozone.

For the Terrestrial Carbon Processes Program, Argonne is investigating processes involved in the storage and turnover of carbon in soil. An understanding of soil carbon dynamics is needed to determine the potential strength of terrestrial ecosystems as carbon sinks and to predict the roles of ecosystems in the global carbon cycle. Because organic matter incorporated into soil aggregates is physically protected from decomposition, the Laboratory is using conceptual models of aggregate formation, stabilization, and degradation as the basis for identifying and isolating measurable carbon pools with significant functional relationships to soil carbon dynamics. Laboratory studies are being conducted on samples from field experiments to determine whether the amounts and characteristics of these measurable carbon pools are affected by elevated atmospheric concentrations of carbon dioxide.

For DOE's Program for Ecosystem Research, Argonne is conducting laboratory and field studies on the mechanisms that control mycorrhizal symbiosis in plant-soil systems within a changing global environment. The objective is to determine whether a primary mechanism controlling the mycorrhizal fungus provides the balance between photosynthate supply to the roots and a host's need for nutrients. In addition, a model-based study is assessing the potential effects of climate change on forest ecosystems in the United States. The aim is to make models of forest growth more realistic by accounting for the tolerance of trees to climate variability and for the resistance of vegetation to change.

Initiative: Argonne National Atmospheric Observatory

Improving the accuracy of short-term and medium-term weather forecasts — for periods of hours to months — would save billions of dollars and hundreds of lives annually. However, improving forecasts depends on obtaining a much better understanding of extremely complex atmospheric phenomena. New technologies in remote sensing, instrumentation, computation, and data handling give atmospheric scientists an unprecedented opportunity to make significant advances quickly, if the technologies are integrated effectively at relevant spatial scales. Accomplishing this challenging task in a way that provides open access for the broad scientific community can best be accomplished by a national laboratory.

Argonne proposes to build on its existing capabilities in atmospheric science, remote sensing, advanced computation, information processing, and facility management to develop an Argonne National Atmospheric Observatory for the study of atmospheric phenomena. The overall objective is to make available to all qualified users continuous, long-term observations from state-of-the-art instruments distributed over a large area in a meteorologically important region of the country and thereby to create a key national asset for progress in atmospheric research.

Like other large national research facilities, the Argonne National Atmospheric Observatory will provide shared state-of-the-art instruments and infrastructure for a broad community of scientists, which experience has shown to be the most efficient way to foster research across entire fields of science. Sharing of instrumentation eliminates unnecessary duplication. Neither industry nor academia alone could deploy instrumentation at the spatial scales and density proposed or support its long-term, continuous use, but both industry and academia will benefit greatly from its availability.

The Argonne National Atmospheric Observatory will be designed so that the basic measurements obtained are readily available to all interested scientists for their own research. This approach will facilitate the seamless integration of fundamental studies with mission-driven research. Active participation of national laboratory scientists will ensure advancement across the entire relevant science and technology base.

The atmospheric research to be conducted will benefit the nation by promoting production and use of energy that are both effective and environmentally protective. This research will also provide benefits in the areas of defense, agriculture, water resource management, mitigation and public safety relating to natural disasters, and safe and efficient aviation and other transportation.

A prototype user facility, focusing on studies of the planetary boundary layer, is being developed in southern Kansas (within the Cloud and Radiation Testbed [CART] site of the DOE ARM Program). Experiments began in 1997. Integration of the prototype facility with the facilities of the larger CART site will continue through 2002. Funding is sought from the Biological and Environmental Research (KP) program. Resources required are summarized in Table II.5.

An environmental assessment for the entire CART site (DOE/EA-0680) was submitted in March 1992, and a finding of no significant impact was issued in June 1992. The proposed work is not expected to differ significantly in environmental impact from the tasks reviewed in 1992.

Table II.5 Argonne National Atmospheric Observatory ($ in millions BA; personnel in FTE)

	FY97	FY98	FY99	FY00	FY01	FY02	FY03
Costs							
Operating	0.8	1.2	1.2	1.7	2.1	2.9	2.9
Capital Equipment	0.6	0.3	0.1	0.1	0.2	0.5	0.5
Construction	-	-	-	-	-	-	-
Total	1.4	1.5	1.3	1.8	2.3	3.4	3.4
Direct Personnel	4.0	6.0	6.0	7.5	10.0	15.0	15.0

h. High Energy Physics Research (KA-04)

High energy physicists use complex detector facilities to advance knowledge of the fundamental laws of nature. These facilities typically require substantial engineering efforts and collaboration among many institutions.

Argonne scientists continue to play special roles in the design and use of such research facilities, starting with the development of imaginative physics perspectives. The Laboratory also provides specialized capabilities in technology, engineering, and project management.

Argonne's accelerator-based research programs include the Collider Detector at Fermilab (CDF); the ZEUS detector at the electron-proton colliding beam facility (HERA), now in operation at the Deutsche Elektronen Synchrotron (DESY) Laboratory in Hamburg, Germany; polarized proton experiments at Brookhaven National Laboratory; and the ATLAS (A Toroidal LHC ApparatuS) detector at the Large Hadron Collider (LHC) at the CERN laboratory in Geneva, Switzerland. (This detector is not related to the Argonne Tandem-Linac Accelerator System, also known as ATLAS.)

Argonne, in collaboration with eight U.S. universities, provided the central calorimetry for the ZEUS detector at the HERA collider and is now using the detector to study electron-proton collider physics. Collection of ZEUS data from electron-proton collisions began in 1992 with participation by resident Argonne physicists. Most have now returned to the Laboratory and are analyzing data, particularly for determining proton structure and for hadronic final states. In FY 1998 Argonne, in collaboration with U.S. universities, is adding a presampler system to the detector's barrel calorimeter. The presampler will improve energy measurements in regions where inactive material precedes the calorimeter.

The current highly successful CDF program at Fermilab produced data that led to the first observation of the "top" quark, a key element of fundamental particle physics. Using data gathered between 1992 and February 1996, the CDF program is now seeking to refine measurements of the mass and other properties of the top quark. The improved capabilities of the Fermilab collider make this goal feasible. The 1992-1996 data permit more precise measurements of the masses of the Z° and W bosons, two other key elementary particles that underlie the "weak" nuclear forces in nature. Argonne is building several components for the upgrading of the CDF detector, which is presently under way in preparation for Run 2 of the Tevatron collider. A major FY 1998 milestone is a vertical-slice test of prototype electronic upgrades.

Argonne's long-standing expertise in the use of spin as a probe of elementary particle interactions will be applied to studies using colliding beams of polarized protons at Brookhaven's RHIC (Relativistic Heavy Ion Collider) accelerator. Argonne and others are designing and developing an electromagnetic calorimeter for the STAR detector at RHIC. An experiment is under way to test the source of polarized protons at the Alternating Gradient Synchrotron at Brookhaven.

Not all research in high energy physics involves experiments using particle accelerators. The Soudan 2 iron plate, gas calorimeter detector is now taking data in a laboratory deep underground in northern Minnesota. Installation of detector modules for Soudan 2, fabricated by Argonne and Rutherford Laboratory, ended with completion of 930 tons of detector in FY 1993. Data collection will continue through FY 1999. The power of the detector to search for unusual nucleon decay modes, monopoles, and neutrino oscillations from cosmic ray event sources will increase as additional data are collected. While it conducts the lengthy search for nucleon decay, the collaboration is also using the detector to measure the ratio υ_μ/υ_e for neutrinos produced in the atmosphere by cosmic rays. Data from Soudan 2 have confirmed previous experimental measurements of this ratio, which appears to be anomalous. One interpretation of the anomalous ratio is that neutrinos have mass and are able to "oscillate" into other species of neutrinos. Confirmation of this interpretation would have far-reaching implications for both particle physics and cosmology.

To investigate the possibility of neutrino oscillations, Argonne has led the formation of a new collaboration ("MINOS"), whose proposal to aim neutrinos from Fermilab toward a new detector in the Soudan mine was recently approved. In FY 1998 Argonne will complete design of the MINOS detector, write the technical design report for the project, and prepare for the required production fabrication.

Argonne's theoretical research in high energy physics aims at establishing models of strong

interaction phenomena and applying the models to experimental data. Current activities include (1) calculations leading to new experimental tests of perturbative quantum chromodynamics (QCD) and to systematic understanding of scale-breaking phenomena such as inverse power, higher twist effects, nuclear dependent effects in short-distance processes, spin effects at high energy, and the phenomenology of high-energy collider experiments and (2) fundamental studies of hadronic diffraction scattering in the context of QCD.

The Laboratory's program of numerical computation to probe the nonperturbative aspects of QCD through lattice gauge theory calculations is exploring a new regime, the dynamical fermion lattice QCD computation of the hadron mass spectrum.

Experimental facilities, apparatus, and techniques are needed for particle physics research. Argonne's program in this area includes work on particle detectors and accelerator R&D. The Argonne Wakefield Accelerator is currently being designed and constructed to demonstrate the feasibility of accelerating electron bunches to 1 GeV, with gradients exceeding 100 MeV/m, by means of intense preceding bunches of electrons with lower energy (i.e., two-beam acceleration). An intense, short-pulse, laser-driven electron gun has been developed to provide the intense driver beams. In FY 1998 the wakefield transformer concept will be tested.

Argonne's development of advanced detectors focuses on calorimetry and gas trackers. In calorimetry, the Laboratory is continuing to develop the technology of scintillator tiles read out by wavelength-shifting fibers. A prototype calorimeter using this advanced technique is being prepared for the ATLAS detector at LHC. Optimization of wire tracking chambers is under way for both the MINOS and CDF experiments. Particular attention is being given to the gases employed, both to enhance the lifetime of the detector in a radiation environment and to minimize flammability. A significant milestone for the ATLAS detector program in FY 1998 will be release of the procurement for all production steel.

Initiative: ATLAS Detector at the LHC

The mechanism of electroweak symmetry breaking remains one of the most fundamental questions facing particle physics. Following cancellation of the Superconducting Super Collider (SSC), the LHC project at CERN — approved by the CERN council in December 1994 — is the only planned accelerator where this central topic can be studied, although its energy will be lower than that planned for the SSC. Argonne has formed a collaboration of university groups and Argonne staff members to work on the barrel hadronic calorimeter and the trigger system for the ATLAS detector at the LHC. Together with its university collaborators, Argonne will build and instrument one of three major subsections of the hadronic calorimeter and will design and build the key Level 2 supervisor and region-of-interest builder trigger systems. The calorimeter will use scintillating-tile technology that was developed for the SSC, while the trigger systems will build on Argonne's work for the ZEUS detector.

Resources required for work on the ATLAS detector at the LHC are summarized in Table II.6. Funding is sought from the High Energy Physics Program (KA-04).

Table II.6 ATLAS Detector at the LHC
($ in millions BA; personnel in FTE)

	FY98	FY99	FY00	FY01	FY02	FY03	FY04
Costs							
Operating	1.0	1.1	1.0	0.8	0.8	0.8	0.8
Capital Equipment	1.0	1.5	1.7	2.0	1.0	0.2	0.0
Construction	-	-	-	-	-	-	-
Total	2.0	2.6	2.7	2.8	1.8	1.0	0.8
Direct Personnel	7.1	8.5	7.5	9.0	7.0	6.0	5.0

Initiative: MINOS Long-Baseline Detector

The nature and properties of the fundamental fermions (six quarks and six leptons) are presently under intense scrutiny in high energy physics research. Among the questions of greatest interest are the masses of the three neutrino species and their possible mixing. Although all observations so far are consistent with zero masses for all

neutrinos, that answer seems unlikely on theoretical grounds. Moreover, a number of experiments have produced anomalous results that could be explained by finite neutrino masses, by quantum mechanical mixing between the three types of neutrinos, or by both. For example, measurements of atmospheric neutrinos — including results from Argonne's Soudan 2 detector — indicate that the ratio of muon-type neutrinos to electron-type neutrinos may change after their creation in cosmic ray collisions high in Earth's atmosphere.

The MINOS detector will make a highly sensitive search for oscillations of neutrinos from one type into another, by detecting neutrinos from Fermilab's new main injector after they have traveled underground 730 kilometers to the Tower-Soudan mine, the present home of the Soudan 2 detector. Argonne is providing leadership in several areas of development for the experiment. Argonne also plans to build much of the expanse of tracking detectors that are sandwiched between the 10 tons of magnetized steel plates constituting the detector.

Resources required for design and construction of the MINOS detector are summarized in Table II.7. Funding is sought from the High Energy Physics Program (KA-04).

Table II.7 MINOS Long-Baseline Detector
($ in millions BA; personnel in FTE)

	FY98	FY99	FY00	FY01	FY02	FY03	FY04
Costs							
Operating	1.0	1.1	1.1	0.8	0.8	0.8	0.8
Capital Equipment	0.6	1.0	1.0	0.6	0.4	0.4	0.2
Construction	-	-	-	-	-	-	-
Total	1.6	2.1	2.1	1.4	1.2	1.2	1.0
Direct Personnel	8.0	8.0	8.0	6.0	6.0	6.0	5.5

i. Nuclear Physics (KB)

Argonne plays a major role in U.S. research in nuclear physics. The Laboratory's program focuses on (1) low energy heavy-ion physics; (2) medium energy nuclear physics, which emphasizes the use of lepton beams (at Fermilab, the Thomas Jefferson National Accelerator Facility [TJNAF], and DESY) as probes into the nuclear medium; and (3) nuclear theory, which focuses on developing a fundamental understanding of nuclear dynamics and subnucleonic particles in the nucleus. The experimental work in heavy-ion physics is largely performed at ATLAS (the Argonne Tandem-Linac Accelerator System). A designated national user facility, ATLAS is based on superconducting radio-frequency technology developed at Argonne. The accelerator was recently upgraded to provide ion beams for all elements up to uranium. In conjunction with ATLAS, Argonne has a leading program in accelerator development.

Major FY 1998 milestones for Argonne's nuclear physics programs are as follows:

- Conduct R&D and prepare a proposal for an advanced exotic beam (isospin, or ISOL) facility.
- Move Gammasphere to ATLAS and operate it.
- Provide 6,000 hours of beam on target for research during the year that Gammasphere is operational at ATLAS.
- Complete and install the RICH counter in HERMES at DESY.
- Conduct quantum Monte Carlo calculations with fully realistic interaction for mass-8 nuclei.

Medium Energy Nuclear Physics (KB-01)

Argonne's research in medium energy physics promotes understanding of the properties of nuclear matter by studying the fundamental interactions of nuclear constituents and the manner in which they are modified in the nuclear medium. The principal goal of this research is to understand the role of the quark-gluon structure of nucleons in shaping the character of nuclear forces. Argonne scientists meet this goal by leading and collaborating in large research projects at major national and international facilities.

Argonne has made a major commitment to participate in research at TJNAF in Virginia. Laboratory staff already have a major presence in the TJNAF program. They have completed construction of a broad-purpose short-orbit

spectrometer that is generally available to users at TJNAF. Initial research operations are predominantly in TJNAF's Hall C, where the Argonne group has focused its efforts. Of the six experiments run in the first year of operation, two were led by Argonne spokesmen, and two others heavily involved Argonne researchers. Argonne staff lead four additional experiments that are expected to take data in the next two years.

A substantial portion of Argonne's work in medium energy physics has been devoted to developing a new technology for producing polarized hydrogen and deuterium targets for internal use in storage ring experiments. A collaboration between Argonne and a group of Soviet physicists at the Institute of Nuclear Physics in Novosibirsk pioneered some of these techniques at the 2.5-GeV VEPP-III electron storage ring. This work provided proof of principle for key elements of a broad North American-European experiment, titled HERMES. The objective of HERMES is to study the spin structure of the nucleon by using internally polarized hydrogen, deuterium, and helium targets at the HERA electron storage ring. HERMES has run very successfully for two years and is expected to continue for another five years. Argonne has primary responsibility for the hadron identification systems in the HERMES spectrometer.

Experiments at Fermilab use the highest-energy lepton and hadron probes to measure directly the quark distributions of nuclei. Following measurements of deep inelastic scattering of muons from nuclei, new measurements of muon pair production in proton reactions will concentrate on the properties of the sea of anti-quarks that exist in the proton.

Heavy-Ion Nuclear Physics (KB-02)

Heavy-ion nuclear physics at Argonne combines a variety of activities, including research using ATLAS, operation of ATLAS, assistance to outside ATLAS users, development and improvement of ATLAS's experimental system and relevant experimental techniques, and development of new technology for superconducting linacs that will lead to continuing improvements in the ATLAS facility.

Heavy-ion research using ATLAS constitutes the major program in Argonne's Physics Division. The aim of the program is to study the behavior of nuclei under carefully selected conditions. Unique features of the ATLAS facility include the ability to generate precise beams of heavy ions with excellent energy and time resolution and easy variability of beam energies. These features permit a wide range of research investigating relationships between nuclear structure and dynamics. Of particular interest is the study of rapidly rotating nuclei. Argonne researchers pioneered investigations of very deformed nuclei in the heavy-mass region.

ATLAS is a national user facility, attracting physicists from many U.S. and foreign institutions. Its user group includes members from over 80 institutions. Outside users, assisted by a liaison physicist, are involved in more than 90% of all experiments. A program advisory committee allocates running time among proposed experiments.

Argonne continues to investigate general aspects of superconducting technology for accelerating heavy ions. The choice of work is guided primarily by questions about the technology of ATLAS, especially ATLAS's new positive-ion injector. Most of this work addresses superconducting accelerating structures, electron-cyclotron-resonance heavy-ion sources, and time-of-flight technology for pulsed beams. The Laboratory has extended this work to include investigations into certain basic properties of radio-frequency superconductivity. Emphasis will be on the low-frequency range that has special importance for low-velocity accelerating structures. Results are expected to be of interest for all radio-frequency superconductivity.

ATLAS can accelerate all ions up to uranium with excellent beam qualities and high intensities. It is the prime accelerator for investigating heavy-ion reactions in the neighborhood of the Coulomb barrier. To exploit its new capabilities, the experimental area at ATLAS has been enlarged, and several major new experimental systems have been installed. Among them is an eight-meter-long Fragment Mass Analyzer (FMA) that is being used to isolate very rare isotopes produced in nuclear reactions and to study their decays.

Gammasphere, the national gamma-ray facility, will be transferred from Lawrence Berkeley National Laboratory to Argonne's ATLAS, starting in September 1998. The device will be coupled with the FMA for studies of the properties of nuclei at the proton-drip line and beyond. Further research with Gammasphere will exploit other unique capabilities, such as its ability to employ very heavy beams (lead-208 and uranium-236) and exceptional timing.

The Laboratory is currently involved in an initiative to study the physics and technology involved in extending the heavy-ion research at ATLAS to radioactive beams. In addition to R&D on the technology, radioactive beams at ATLAS have already been used in several experiments that have provided important information on problems in nuclear astrophysics. This research is expanding as part of a broad-based program employing radioactive beams at a future exotic beam facility based on ATLAS. (See Section IV.B of the 1997 *Institutional Plan.*)

Nuclear Theory Physics (KB-03)

Theoretical nuclear physics research at Argonne addresses a broad range of problems involving the structure and dynamics of hadrons and nuclei. There is a strong emphasis on comparing theory to data provided by experimental groups at Argonne and at research facilities around the world. Principal areas of research include nuclear dynamics with subnucleonic degrees of freedom, nuclear forces and nuclear systems, heavy-ion reactions, and nuclear structure studies.

The Laboratory's work includes modeling quantum chromodynamics in meson and baryon structure, developing reaction theories for medium-energy nucleon-nucleon interactions and meson production, and studying electron scattering within the framework of relativistic Hamiltonian particle dynamics. Recent accomplishments include (1) a successful description of threshold pion production and (2) QCD predictions, based on a Dyson-Schwinger equation framework, for a wide range of pion and kaon observables. Other work involves constructing realistic nucleon-nucleon potentials that give very precise and highly accurate fits to elastic scattering data and subsequent use of these potentials in detailed many-body calculations of the properties of few-body nuclei, light closed-shell nuclei, hypernuclei, nuclear matter, and neutron stars.

Theoretical heavy-ion research at Argonne addresses the structure and reactions of neutron-rich nuclei produced at radioactive beam facilities and coupled-channel calculations of reactions near the Coulomb barrier. Nuclear structure research concentrates on effective two-body interaction studies of deformed and superdeformed nuclei observed at ATLAS. Several of these projects require major numerical simulations using state-of-the-art computers, including Argonne's massively parallel IBM SP. Many Argonne projects involve collaborators at domestic and foreign universities and at other national laboratories.

j. Energy Research Analysis (KD)

Argonne is supporting DOE and the National Acid Precipitation Assessment Program (NAPAP) through development and operation of the Tracking and Analysis Framework, an assessment tool for policy analysis that integrates credible scientific models. The tool will be used by NAPAP in developing its assessment reports for Congress.

k. Mathematics and Computer Science (KJ-01)

The overall goal of Argonne's program in mathematics and computer science is to advance the state of the art of large-scale scientific computing. Recognizing the importance of strong interactions between applied computational mathematics, computer science, and computational science, researchers focus on advanced methods for solving scientific and engineering problems.

Argonne's research addresses both numerical and nonnumerical computing. Numerical studies focus on designing parallel algorithms for unstructured mesh computations, exploiting interior point methods for solving optimization problems, providing a new methodology for computing derivatives, and devising software tools for high-performance computer systems.

Nonnumerical efforts center on designing and using a powerful automated reasoning program to obtain proofs of mathematical theorems.

A vital part of this work is collaboration with computational scientists at Argonne and worldwide to ensure that computing science results are transferred to scientific applications. For example, a project related to materials science is investigating vortex dynamics in high-temperature superconductors. Computational chemistry studies point toward commercial applications involving environmental restoration and waste management, combustion, and chemical processing.

Essential to all this work is Argonne's Center for Computational Science and Technology, which features a massively parallel IBM SP computer. Via advanced networks, this facility is also available to outside collaborators. A significant increase in KJ-01 funding is anticipated in FY 1998 for upgrading and supporting the SP computer.

Argonne continues to participate as a partner in the National Science Foundation's Center for Research on Parallel Computation. The Center brings together scientists from several universities and national laboratories to harness the power of advanced computers for solving scientific problems. Center funding supports research in parallel computing and maintenance of advanced computers at Argonne.

Using advanced computers and immersive virtual reality environments, Argonne is exploring new approaches to collaborative science and technology applications.

During FY 1998 Argonne plans achievement of the following significant objectives, in pursuit of the indicated long-term goals:

- Integrate computational, visualization, mass storage, and multimedia server capabilities in a single "Quad" machine in the Argonne Center for Computational Science and Technology. Goal: A new generation of computational science applications that couple massive computation with immersive visualization.
- Develop collaborative management tools, browsers, interfaces, and distributed visualization tools that will allow convenient, rapid, and dynamic research interactions among scientists at geographically dispersed centers. Goal: A new era of scientific collaboration that transcends geographic, disciplinary, and organizational boundaries.
- Design the parallel tools and numerical software infrastructure, such as ALICE (the Advanced Large-Scale Integrated Computational Environment), that will serve as enabling technology for computational science simulations. Goal: A common framework for diverse software tools used in computational science applications.
- Develop Laboratory-wide strategic computational science applications. Goal: Advances at the frontiers of science, in such areas as computational chemistry, biocatalysis, materials modeling, tomographic and crystallographic imaging, and characterization of reactor material.

l. Laboratory Technology Research Program (KJ-02)

The Energy Research-Laboratory Technology Research (ER-LTR) program provides a bridge from basic to applied research. With ER-LTR funding, Argonne further develops technologies that, with additional technical work complementing the Laboratory's existing research programs, could result in near-term products or processes with commercial applications.

The ER-LTR program has three major elements: (1) mortgages of existing projects, (2) quick-response mechanisms, and (3) multiyear cooperative R&D agreements (CRADAs). Quick-response mechanisms — including personnel exchanges, small CRADAs, technology maturation projects, and technical assistance — address specific, near-term needs of industry and provide immediate results. The following types of quick-response mechanisms are used:

- Personnel exchanges allow Laboratory scientific staff to work collaboratively with their industrial and academic counterparts to share ideas, processes, cultures, and techniques. The maximum level of funding is $50,000.

- Small CRADAs are cooperative R&D arrangements, primarily with small businesses, focused on near-term technology applications. The funding maximum is $100,000 for a project of one year or less.

- Technology maturation projects are designed to move Laboratory technologies with commercial potential to a point where industry may engage in cooperative research or license the technology. The maximum funding level is $100,000, for a performance period of one year or less.

- Technical assistance projects provide small businesses with a means of quickly solving immediate technical problems. Assistance is limited to $5,000 per project. The problems addressed arise frequently throughout the year and tend to be particularly thorny or troublesome for the small business.

Multiyear CRADAs involve cooperative R&D under a formalized industry-laboratory agreement. These arrangements involve well-defined, formally approved project plans to transfer Laboratory technologies to the industrial partner(s), generally with the dual goals of helping the partner and strengthening the Laboratory program. In more specific terms, these cooperative projects (1) enhance a specific Laboratory core capability that directly serves one or more of DOE's four mission areas (energy, environment, science and technology, and national security); (2) have high technical merit, matching unique capabilities of all the partners so that the investment of each is leveraged; (3) enable industry to perform pre-commercial research that alone it would be unable to undertake; and (4) meet specific industry needs for enhanced competitiveness to create new jobs or retain established jobs. Laboratory partnerships, which may not exceed $250,000 in annual DOE funding, are designed to provide three years of funding prior to demonstration or implementation by industry or the Laboratory.

Because of a drastic decrease in federal support for the ER-LTR program, Argonne's funding for FY 1997 was approximately $3 million (down from $10.5 million in FY 1995, but up slightly from $2.5 million in FY 1996). Particularly hard hit was research on high-temperature superconductivity and industrial partnerships. Continuing projects will be supported from new funding or carryover. Initiation of two or three new multiyear projects is expected in FY 1998.

m. Advanced Energy Projects (KJ-03)

For the Advanced Energy Projects Program, Argonne is working on four projects.

The first project is exploiting recent developments in the field of carbon chemistry and in the technology of broad-beam ion sources to develop a method of direct carbon film deposition that (1) circumvents the need for high substrate temperatures, (2) results in high deposition rates, (3) is capable of covering large areas uniformly, and (4) reduces or eliminates the need for the presence of hydrogen during deposition. Achievement of this last goal will enable growth of diamond films with high crystalline perfection and very low impurity content, opening a wide range of possible industrial applications.

The second project will develop a new class of materials for use in producing energy-efficient image-processing microdevices. These materials will exploit the photorefractive effect, a light-induced change in the refractive index of a nonlinear optical material that results from photogeneration of a space charge field caused by directional charge transport over macroscopic distances within a solid. The only high-quality photorefractive materials commercially available today are expensive single crystals of inorganic materials such as barium titanate. Argonne is proposing a new approach that combines cheap, easily processed organic materials with a built-in method to obtain the solid-state order necessary to achieve photorefractivity comparable to that seen in inorganic crystals. This approach uses organic molecules that undergo a transition to a liquid crystalline phase above ambient temperatures. Self-ordering in the liquid crystalline phase, followed by cooling to an ordered molecular solid, will impart both good optical nonlinearity and directional photoconductivity to thin solid films of these materials. These solid films have the potential for greater photorefractive sensitivity and faster response times than any material developed to date.

The third project will develop knowledge about the chemistry of iron and sulfur in subsurface reservoirs that can be exploited to improve U.S. oil production from souring reservoirs. This project involves (1) studies of origins and interrelationships for microbiologically mediated and chemically produced sulfides under various relevant conditions, (2) characterization of iron-sulfur species by use of a suite of spectroscopic and analytical techniques, and (3) development of Mössbauer spectroscopy for field measurement and identification of iron-bearing solids obtained from drillings. The resulting comprehensive knowledge of the exact chemical and physical states of iron in production zones and waters can guide chemical treatment programs and increase oil production.

The fourth project will develop novel photocatalysts that will sequester heavy metal ions and convert them to their readily recoverable metallic forms. The catalysts will be designed by modifying the surface of colloidal titanium dioxide by using various chelating agents to enhance the redox properties of titanium dioxide and the adsorption of heavy-metal ions. Also to be investigated is development of photocatalysts for simultaneous recovery of heavy metals and destruction of organics. This work promises to be the basis for a new technology for removing heavy metals from contaminated groundwaters and aqueous waste streams encountered at DOE and industrial operations.

In the future, Argonne plans to explore the advantages of advanced oxidation technology for the destruction of chelating agents and the recovery of metals. This methodology, which will involve the photolysis of hydrogen peroxide solutions, will have the potential to reduce significantly the volume of waste encountered in many hazardous and nuclear process streams and in contaminated sites.

2. Nuclear Energy, Science and Technology

a. Overview

Argonne's nuclear technology program includes (1) termination activities for the Experimental Breeder Reactor-II (EBR-II) and associated facilities and (2) nuclear technology R&D in the areas of electrometallurgical treatment of spent nuclear fuel; nuclear reactor safety, for plants both in the United States and in Russia and Eastern Europe; and nuclear technologies supporting the current generation of light-water reactors. Table II.8 summarizes funding for the Laboratory's Nuclear Energy, Science and Technology programs.

Table II.8 Nuclear Energy, Science and Technology Program Funding[a] ($ in millions BA)

Major Program Title (B&R Code)	FY96	FY97	FY98
Total Nuclear Energy Research and Development (AF)	92.6	87.5	90.5
Nuclear Technology Programs (AF-11)	1.7	2.8	0.0
Electrometallurgical Treatment (AF-50)	25.0	19.3	20.0
Facility Shutdown and Program Termination (AF-95)	64.2	65.2	65.5
Other AF	1.7	0.2	5.0
Uranium Programs Activities (CD)	3.2	1.8	1.5
Total	95.8	89.3	92.0

[a]In addition to the new BA funding directly from DOE-Nuclear Energy, Science and Technology described above, Argonne receives funding via transfers from other DOE contractors. In Table II.1, this funding is included in "Work for Other DOE Contractors." In FY 1997, $8.4 million was received; a similar amount is expected in FY 1998.

b. Facility Shutdown and Program Termination (AF-95)

The highest priority among all termination activities at Argonne is a timely and safe shutdown of EBR-II. The reactor was officially shut down on September 30, 1994, after 30 years of operation. The continuing goal is to place EBR-II in an industrially and radiologically safe shutdown condition by the end of FY 2000, in preparation for its transfer to the DOE Office of Environmental Management for ultimate decommissioning. This process involves removal and temporary storage of reactor fuel, removal and processing of sodium from the primary and secondary systems, and then safe closure of the reactor system.

The EBR-II shutdown also includes treatment of discharged spent fuel. The EBR-II driver fuel

contains highly enriched uranium even at discharge (53-75% uranium-235), raising concerns about *in situ* criticality upon disposal in a repository. The EBR-II spent fuel also contains reactive materials that may not be placed in a repository. Accordingly, EBR-II spent fuel must be treated to remove its high fissile content and reactive materials before permanent disposal in a repository. An electrometallurgical technique will be used for this treatment, employing the refurbished and reequipped Fuel Conditioning Facility (FCF). Treatment of EBR-II driver fuel, which began in June 1996, is scheduled for completion in 1999. Treatment of EBR-II blanket assembly fuel will begin in April 1998; accelerated operations are scheduled to start in March 1999.

Reactivation of the Sodium Processing Facility (SPF) is a key element of the plan to shut down EBR-II. Constructed in the late 1980s to convert Fermi-1 sodium to sodium hydroxide, the facility has been modified to implement an additional processing step to produce sodium carbonate. The primary and secondary sodium from EBR-II can then be converted into a nonreactive low-level waste for storage in the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory. The safety case for the SPF is being developed. Processing of secondary sodium is scheduled for completion in June 1998. Completion of sodium processing is scheduled for May 1999. Applications for required environmental permits have been completed or are under development. Work continues on the facility's application under the National Emission Standards for Hazardous Air Pollutants.

The main mission of the Fuel Manufacturing Facility has been to fabricate dummy assemblies to replace the driver and blanket assemblies removed from EBR-II. Current activities include (1) stripping plates from the Zero Power Physics Reactor (ZPPR) that contain highly enriched uranium, (2) casting the uranium to provide feedstock for DOE reactor fuel programs, and (3) conducting materials characterization and performance testing related to waste forms generated in the EBR-II Fuel Treatment Project demonstration. Upon completion of these tasks, the facility will be placed and maintained in an industrially and radiologically safe shutdown condition, except for areas required to support other shutdown activities and continuing programs.

The ZPPR, Transient Reactor Test Facility, and Argonne Fast Source Reactor are being placed and maintained in an industrially and radiologically safe shutdown condition. Although the reactors are being shut down, some or all of the facilities and the storage vault will continue to be used to support other activities for DOE-Environmental Management, such as development of the plasma hearth process and study of gas generation at the Waste Isolation Pilot Plant. The vault of the ZPPR may be used for storage of products from treatment of EBR-II spent fuel.

In addition, DOE is currently evaluating the ZPPR facility as a candidate location for fabrication of lead test assemblies of mixed oxide fuel, which would be irradiated in U.S. light-water reactors as part of the Department's effort to dispose of weapons plutonium. DOE is also currently reviewing the potential need for irradiation testing of the type that can be accomplished with the Transient Reactor Test Facility. Depending on the outcome of this evaluation, the Department may wish to restart the reactor.

The FCF and the Analytical Laboratory will play central roles in the treatment of EBR-II spent fuel. The FCF has been totally rebuilt to modern safety standards and provided with new processing equipment. The FCF has been prepared for a hot demonstration of electrometallurgical treatment of spent fuel from EBR-II.

The Hot Fuel Examination Facility, along with the associated Neutron Radiography Reactor Facility, is a versatile, modern hot cell facility. It is being operated and maintained to support the fuel transfers and waste transfers associated with the shutdown of EBR-II, as well as to support the redirected program and other ongoing DOE-Environmental Management programs.

c. Electrometallurgical Treatment (AF-50)

Argonne has initiated a major effort to adapt electrometallurgical technologies developed at the Laboratory to the conditioning of spent nuclear fuel from DOE reactors. A total of approximately 2,700 metric tons of this material has accumulated within the DOE complex. This government-owned fuel was used in a variety of nuclear reactors, including reactors for the production of national defense materials, experimental and research reactors, and commercial reactors. The fuel presents special problems that demand prompt attention. Arising from over 40 years of evolution in nuclear power, the material reflects a wide diversity of fuel types, cladding materials, levels of enrichment in the fissile isotopes of the actinide elements, and degrees of chemical reactivity. The DOE inventory includes spent nuclear fuels that have undergone serious degradation during storage, are highly enriched in fissile isotopes, are chemically reactive or contain reactive materials, and cannot be expected to retain their integrity or remain stable over an extended period of wet or dry storage.

Argonne's electrometallurgical treatment technique has great potential for application to the various types of DOE spent nuclear fuel, in order to enable ultimate disposal. This technique uses a simple, compact processing system that is both economical and technically sound and is applicable in its current stage of development to over 90% of the DOE spent fuel inventory. The technique will reduce waste volume and, by implementing a common treatment approach at each site, should reduce costs. Major subtasks in the program include treatment of metallic spent fuels, treatment of oxide spent fuel, development of a process for waste treatment, and waste form production and qualification. The overall goal is to complete the development of the electrometallurgical treatment technology for application to selected types of DOE spent nuclear fuel and to demonstrate the technology successfully in a timely fashion. Argonne's research on conditioning spent fuel from DOE reactors has focused on increased throughput, oxide fuels, qualification of waste forms, and other issues.

In FY 1998 Argonne's electrometallurgical treatment program is focused on three major activities: (1) technical support for the demonstration project for treatment of EBR-II driver fuel and blanket assemblies, (2) development of high-throughput electrorefining technology that will make economically feasible the treatment of large tonnages of spent nuclear fuel, and (3) development of durable high-level waste forms for immobilization of the fission products and actinide elements extracted during the electrometallurgical treatment of spent fuel.

Technical support to the EBR-II demonstration project involves development of operating procedures that improve the quality of the treatment products. For example, the amount of noble-metal fission product elements present in the recovered metallic uranium must be limited to facilitate storage and eventual disposition of the recovered uranium; accordingly, means to control the fission product content of the recovered uranium will be established and tested during FY 1998. Another FY 1998 task is the development of a crucible material that will sustain repeated evaporative extraction of residual electrolyte salt from the uranium product. These technical support activities are directed toward successful completion of the demonstration project by June 1999.

High-throughput electrorefining technology is essential to the timely treatment of EBR-II blanket assemblies and to the treatment of other low-enriched fuels in the DOE spent fuel inventory. This technology has advanced to the point that a prototype unit capable of a daily throughput of one ton has been tested successfully. A smaller version of this electrorefiner, the Mk-V electrorefiner, has been installed in the FCF for treatment of EBR-II blankets. During FY 1998, the high-throughput electrorefiner design will be refined, principally by improving uranium removal and collection.

Early in FY 1998, reference waste forms were selected for the electrometallurgical treatment. The ceramic waste form, containing actinide elements and active fission products such as cesium and strontium, is a composite of borosilicate glass and a synthesized natural mineral, sodalite. The characteristics of this waste form compare very favorably with those of the standard high-level waste form being produced for disposal of defense wastes. During the balance of

FY 1998, extensive characterization of the reference ceramic waste form will be conducted; the effects of plutonium and uranium on waste form behavior are to be established by the end of the year. The reference metallic waste form consists of noble-metal fission products immobilized in a matrix that is an alloy of stainless steel and zirconium; the matrix alloy is derived largely from the cladding material used in EBR-II fuel and blanket assemblies. In FY 1998 both the metal and ceramic waste forms will undergo a series of tests to generate data supporting evaluation of the acceptability of the waste forms for disposal in a mined geologic disposal system. The likely acceptability of the two electrometallurgical treatment waste forms will be a major factor in assessment of the EBR-II demonstration project in mid 1999.

d. Nuclear Technology Programs (AF-11, CD-10)

The DOE nuclear technology programs at Argonne now focus on issues and problems associated with the current generation of nuclear power plants, both in the United States and worldwide. Specific focuses are enhancement of fuel cycle safety (for Soviet-designed plants in Russia and Eastern Europe, as well as U.S. plants) and development of D&D technology.

Safety considerations continue to be important for the future of nuclear energy. DOE is developing programs to promote improvements in safety technology and in the international dissemination of safety information, with emphasis on the former Soviet Union and on Soviet-designed reactors elsewhere.

Argonne's work on international nuclear safety reached significant milestones in 1995 and 1996, when an International Nuclear Safety Center (INSC) was established for DOE. An initial database at the Center, accessible through the Internet, already contains large amounts of information on design and safety analysis (including safety analysis methods) for U.S. and Russian Federation reactors. The intent is to include all available public information of this kind. Argonne is adapting its state-of-the-art methods of structural and safety analysis to Russian reactor designs. In addition, the Laboratory is measuring materials' properties to support experiments by the Russian Federation on in-vessel retention of melted core materials. The Laboratory is also developing a database of peer-reviewed assessments of materials' properties for use in safety analyses. The second version of the INSC database is scheduled for completion in June 1998.

In July 1996, a Russian International Nuclear Safety Center was created. Since that time, the Russian center and the DOE center at Argonne have begun collaborations on eight research projects, including database development, validation of safety codes, structural analysis, and studies of the thermophysical properties of materials. The collaborative studies of materials' properties are being performed in conjunction with a research program coordinated by the International Atomic Energy Agency.

An Argonne staff member has been working at the Russian center in 1997 to assist in developing a safety research strategic plan for Russian reactors. This collaboration was recommended by a panel assembled by the Nuclear Energy Agency of the Organization for Economic Co-operation and Development. A seminar organized by Argonne staff on accident management includes industry participation to encourage the transfer of relevant Western technology to Russia.

In addition to the nuclear technology programs discussed above, the DOE Office of Nuclear Energy, Science and Technology is supporting several other programs through the INSC at Argonne.

Argonne has a major role in developing DOE's plans for nuclear energy research. Laboratory staff participate in research in four key areas: reactor operations technology, reactor materials research, spent fuel minimization, and nuclear risk management. In reactor operations technology, the Laboratory uses advanced computation to exploit improved phenomenological modeling, as well as capabilities in plant signal validation, diagnosis, transient management, and plant systems control. Research on reactor materials and spent fuel minimization exploits Argonne's capabilities to handle and characterize irradiated fuel and components.

Facilities at Argonne-West are being evaluated for their roles in research on spent fuel minimization; necessary upgrades of the facilities are being planned. Argonne's research in nuclear risk management focuses on defining, addressing, and resolving issues relating to severe accidents at light-water reactors. Scheduled for September 1998 are (1) the issuance of a report titled *Accident Management — Status of Technology* and (2) completion of a multivariate state estimation technique for data monitoring and analysis at a designated commercial nuclear plant.

For Uranium Programs Activities (CD-10), Argonne is developing a computerized model to help DOE manage a stockpile of over 500,000 metric tons of depleted uranium currently being stored as uranium hexafluoride in steel cylinders at various DOE sites. In its analysis of cylinder management, conversion of uranium hexafluoride to oxides or metal, and disposal options, the model projects risks to humans and the environment, as well as cost impacts. Argonne is also developing the programmatic environmental impact statement for DOE's long-term management of the material.

The DOE work in the area of space power and propulsion has declined for several years. Presently, Argonne supports DOE's program to develop a radioisotopic generator for missions of the National Aeronautics and Space Administration. The prospects for growth in work on space power and propulsion are not good, but the Laboratory plans to continue support for ongoing work.

Argonne supports DOE's International Nuclear Safety Program, which assists Russia, Ukraine, and Eastern European countries operating Soviet-designed reactors. Older Soviet-designed reactors do not meet Western safety standards and are a significant concern. The DOE program provides direct assistance to improve the safety of these plants and generally to improve the safety culture and infrastructure in recipient countries. Argonne provides technical support to DOE in plant safety evaluation and risk assessment, along with technical assistance to DOE and Russia in the development of generic off-site emergency preparedness systems for communities and regions near Russian nuclear power plants. With colleagues from Ukraine and the European Community, Argonne engineers have actively participated in international work aimed at developing a program to address the problems and risks associated with the deteriorating Chornobyl sarcophagus. Argonne's funding for these activities is received through Pacific Northwest National Laboratory.

3. Energy Efficiency and Renewable Energy

Argonne conducts important work for the Assistant Secretary for Energy Efficiency and Renewable Energy in support of programs including Electric Energy Systems, Industrial, and Transportation. Argonne's technology center for the commercialization of superconductivity also plays an important role. See Table II.9 for program funding.

Table II.9 Energy Efficiency and Renewable Energy Program Funding[a] ($ in millions BA)

Major Program Title (B&R Code)	FY96	FY97	FY98
Solar and Renewable Resource Technologies (EB)	3.5	2.8	4.0
Building Technology, State and Community Sector (EC)	0.2	0.6	0.5
Industry Sector (ED)	4.4	5.0	4.0
Transportation Sector (EE)	9.2	10.9	12.9
Emergency Energy Act of 1979 (EF)	0.1	0.0	0.0
Policy and Management (EH)	0.0	0.3	0.2
Total	17.4	19.6	21.6

[a]In addition to the new BA funding directly from DOE-Energy Efficiency and Renewable Energy described above, Argonne receives funding via transfers from other DOE contractors. In Table II.1, this funding is included in "Work for Other DOE Contractors." In FY 1997, $1.4 million was received; a similar amount is expected in FY 1998.

a. Systems Technology (EB-50)

A major Argonne experimental research program is improving the properties of high-temperature superconductors and developing fabrication methods suitable for their commercial

production. Teaming relationships with industrial partners arranged through the Laboratory's High-Temperature Superconductivity Technology Center are a key aspect of this work.

Argonne's applied research to develop better high-temperature superconductors and technologies to use them is strongly linked to the Laboratory's basic research on superconductivity. The Laboratory is working with several wire-making companies to increase the critical current density in long lengths of wire. Following up earlier successful inventions, the Laboratory is also pursuing several near-term applications, including high-temperature-superconducting down-leads for electrical connections to devices cooled with liquid helium (being developed with several individual companies) and a low-loss magnetically levitated bearing with a wide variety of potential applications (being developed in cooperation with Commonwealth Research Corp.). Under contracts with Tokyo Electric Power Co., the Laboratory has developed 2,000-ampere current leads for a fault-current interrupter.

The High-Temperature Superconductivity Technology Center is managed and staffed by Argonne scientists, with technical support partly provided by students from colleges and universities across the nation. By combining state-of-the-art facilities with highly qualified technical support, the Center is attracting industrial participation. The Center provides a focal point for interactions between Argonne scientists and engineers involved in industrial process design and product development. Associated college training programs are an important source of skilled employees to U.S. industry.

For the DOE Office of Utility Technology, Argonne is assessing potential applications of high-temperature superconductors. Work on implications for the electric power industry is being supported by that office and by organizations in foreign countries, including Canada, Denmark, Finland, Germany, Israel, Italy, Japan, the Netherlands, Norway, Sweden, Switzerland, Turkey, and the United Kingdom. Recently, Austria and Russia expressed interest in participating.

b. Building Technologies (EC)

In cooperation with Bethel New Life, Commonwealth Edison, the Chicago Housing Authority, and the Habitat Company, Argonne is conducting field tests of energy conservation measures for both substantial and moderate rehabilitation of housing in inner-city Chicago neighborhoods. The Laboratory is also providing technical assistance for energy-conserving modifications to commercial buildings as part of DOE's Rebuild America Program.

Argonne has joined the "Chicago Partners in the American Dream," an alliance to create 5,000 new home ownership units in low-income Chicagoland communities. Argonne will assist in the application of technologies and techniques that increase energy efficiency. Argonne is also assisting the development of 500 energy-efficient row houses in a low-income neighborhood of Baltimore by using superinsulation measures defined in Illinois.

Argonne's broad capabilities in information technology are available to assist in urban redevelopment projects in at least two important ways. First, new Internet-based information retrieval technologies developed by Argonne for DOE (the Facility Profile Information Management System, for example) can be used by local communities for better consolidation, retrieval, integration, and evaluation of data concerning land use, which is currently a serious deficiency in many redevelopment programs. Second, new spatial analysis techniques that use geographic information systems, decision analysis, and visualization technologies, such as the Dynamic Environmental Effects Model, can serve as planning tools for urban redevelopment.

In collaboration with industrial firms and universities, Argonne is developing advanced technologies and components that will make district heating and cooling more efficient and a greater contributor to energy efficiency. Pioneering research with advanced energy transmission fluids has demonstrated that pumpable ice-water slurry can be used in place of chilled water to deliver cooling. As an energy transport fluid, ice slurry has high energy density, so it improves the thermal-hydraulic performance of chilled-water cooling systems up to fivefold,

reduces system capital costs by reducing the sizes of pipes and storage tanks up to tenfold, and improves utility load management systems, thereby saving energy and cost. The Laboratory has collaborated with Northern States Power and the Electric Power Research Institute to design and install a small field test of this new concept that uses ice slurry for district cooling. Because of potential adverse effects on pump efficiency and pipe pressure drops, related work is addressing the fundamentals of heat transfer and pressure drop in ice slurry flows. Industrial interest is high abroad, as well as in the United States. The Laboratory is currently exploring the possibility of conducting a large-scale ice slurry demonstration in collaboration with a local utility and equipment manufacturers.

Argonne assists the Technical and Financial Assistance Office in two areas: (1) evaluating the impacts of specific programs or projects (such as evaluating Institutional Conservation Programs or third-party financing of multifamily buildings) and (2) providing technical assistance to regional DOE state and local program offices (for example, holding conferences, conducting feasibility studies, and speaking at regional meetings).

c. Industry Sector (ED)

Argonne's work for DOE's Industry Sector program includes support for Industry Visions of the Future, which addresses the major energy users and waste producers, including the petroleum refining, chemicals, forest products, steel, aluminum, metal casting, and glass industries.

In collaboration with U.S. industry, Argonne has begun to develop a number of innovative technologies that will reduce the approximately 12 billion tons of waste produced by U.S. industries each year. This work also emphasizes reducing industrial energy consumption attributable to the inefficiencies associated with waste materials. An important focus is on the chemical industry, which is the nation's largest generator of wastes and also one of its largest consumers of energy.

Argonne's continuing research on ways to increase utilization of scrap metals is currently focusing on base metals and the residuals that result from their commercial recovery and processing from scrap (e.g., salt cake and automobile shredder residue). The objective is to develop, in collaboration with industry, new technologies to economically recycle components and materials from cars and other consumer durables (such as appliances, carpeting, and roofing), while maximizing net energy benefits. The research scope includes recycling of obsolete goods and residues from manufacturing and secondary processing; the research also addresses the redesign of goods to facilitate later recycling. This work emphasizes involvement with individual companies and with trade associations such as the Institute of Scrap Recycling Industries; the Aluminum Association; the Remanufacturing Industries Council, International; the American Plastics Council; and the Vehicle Recycling Partnership among Ford, General Motors, and Chrysler.

Argonne and Metal Recovery Industries, U.S., Inc., developed a new process to separate and recover steel and zinc from scrap galvanized steel. The process currently is being demonstrated at pilot scale; establishment of the first commercial demonstration plant is being negotiated.

Argonne is developing a process to recover plastics for recycling from obsolete automobiles and white goods after the metals have been removed. The process uses physical separation followed by chemical separation, and it significantly decreases the volume and cost of the waste disposal that is ultimately necessary. Cost-sharing arrangements for demonstrating a continuous process for recovering automotive polyurethane foam have been negotiated; a 70-pound-per-hour pilot plant started operations in 1997. Also negotiated are cost-sharing arrangements for commercial demonstration of a process for recovering acrylonitrile butadiene styrene (ABS), a high-value engineering plastic; plant start-up is targeted for late 1997.

Argonne is evaluating physical and chemical separation techniques for recovering the metallic and flux contents of salt cake from secondary aluminum smelters. If it is not recycled, the waste salt cake must be deposited in landfills at substantial cost. The Laboratory is also examining opportunities for producing high-volume

aluminum-based chemicals and specialty products from the recovered aluminum oxides.

Argonne has developed a process for producing competitively priced lactic acid esters from waste carbohydrates such as food processing waste or corn starch and has used lactic acid to produce plastic and other chemical products that are nontoxic and biodegradable. Argonne's technology can produce higher value products while reducing waste disposal problems and replacing petroleum feedstocks. The Laboratory has developed a new technique involving electrodialysis desalting and water-splitting membranes to purify the lactic acid economically and avoid the production of a troublesome gypsum by-product. Attention now centers on additional processing steps required to purify the lactic acid for use in new nontoxic, biodegradable products such as solvents, biodegradable plastics, and plasticizers. Using a technology for the ethyl lactate process that it patented, Argonne is working on a replacement for many chlorinated solvents currently in use. The replacement is to be nontoxic, environmentally friendly, and competitive in cost. Negotiations with companies interested in commercializing the process are under way.

Argonne is working with a spin-off company, NTEC Ed Sep, in its development of new applications in the chemical industry for two-stage electrodialysis. The major focus is applications reducing pollution from processes being used by major manufacturers.

Under a cost-shared program with industry, Argonne developed state-of-the-art computer software that simulates the metal casting process. Industrial application of the software has produced castings at a significantly lower cost. Now Argonne is extending this work to modeling of the welding process, aiming at additional savings in production costs.

Argonne is supporting DOE with economic analysis of (1) energy-intensive industries (based on confidential plant-level census data) and (2) the economic benefits of programs addressing energy efficiency, advanced motor vehicles, and renewable energy. Results include a forecast of the potential for improving U.S. energy efficiency in 2010 and years beyond.

Argonne is cooperating with the National Renewable Energy Laboratory (NREL), Idaho National Engineering and Environmental Laboratory (INEEL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL) on R&D aimed at converting biomass materials to useful chemicals. The initial objective is the economic production of succinic acid and downstream products. Argonne is addressing (1) metabolic engineering to improve the tolerance to succinic acid of the microorganisms involved, (2) separations and purification, and (3) product development. ORNL is examining novel reactor designs, which may lead to new methods for removing product streams; NREL is conducting economic analysis, program management, and research on biomass processing; INEEL is examining the life cycle costs of potential products; and PNNL is mainly developing new products. Argonne, ORNL, NREL, and PNNL have entered into a CRADA with Applied Carbo Chemicals to commercialize the advances made in producing succinic acid.

The Laboratory is helping DOE's Office of Industrial Technologies identify and evaluate the R&D needs of the petroleum refinery industry. The objective is to ensure that the petroleum industry will be able to respond to market forces that affect the operations and economics of refineries while it meets demands for enhanced energy efficiency, effluent management, and waste minimization.

Argonne is developing technology for advanced fluidized catalytic cracking in the refinery industry, which is expected to (1) tailor product yields more closely to meet mandated gasoline reformulations, (2) reduce emissions, (3) increase thermal efficiency, (4) produce more transportation fuel per barrel processed, and (5) improve cost competitiveness. The Laboratory is working on validated design tools and associated databases that will be available to all industrial organizations interested in pursuing individual commercial opportunities.

The Laboratory is working with several major oil companies and Heat Transfer Research, Inc., to understand the mechanisms that control surface fouling. Equipment that is more resistant to fouling can use less energy, produce more output, and cost less to buy, operate, and maintain.

Fouling in the U.S. petroleum refining industry is estimated to cost over $2 billion annually. Also significantly affected are the chemical processing, pulp and paper, and electric utility industries. Program goals are (1) to provide validated methodologies for the design and development of heat and mass transfer devices used in process industries, (2) to develop and apply new experimental techniques to enhance understanding of controlling heat and mass transfer processes, and (3) to identify and examine the technical feasibility of advanced and innovative industrial concepts. The program's relevance to U.S. industry has been marked over the last two years by the initiation of CRADAs with U.S. equipment manufacturers and end users, effectively doubling the program's size.

Argonne is conducting research in collaboration with the forest products industry in several areas, including the removal of nonprocess inorganics from process water, the application of neural networks to the pulping and paper-making processes, and the development of advanced drying equipment.

d. Transportation (EE)

Argonne evaluates advanced transportation technologies, such as improved engines, energy-conserving components and systems, new materials, and alternative fuels (particularly innovative approaches to using methanol, ethanol, and natural gas in cars and trucks). In addition to technical feasibility, Argonne assesses economic and environmental effects of new transportation technologies. Argonne analysts project fuel consumption and environmental impacts for transportation systems under various technical and economic scenarios. These analyses suggest promising applications for advanced energy-conserving technologies and opportunities for technology transfer.

Argonne experiments have shown that particulates and smoke can be virtually eliminated from the emissions of diesel-fueled compression ignition engines by enriching the oxygen content of the air supplied to the engine through use of an air separator membrane. This concept is being tested in a flexible-fuel passenger car capable of operating with 100% gasoline or a fuel mixture of up to 85% methanol. Initial results also show excellent decreases in emissions of carbon monoxide, hydrocarbons, and aldehydes, without significant increases in nitrogen oxides. In addition, the Laboratory has completed a study of the feasibility of applying oxygen enrichment to locomotive engines. This element of Argonne's Advanced Transportation Technology initiative (Section IV.F in the 1997 *Institutional Plan*) is being pursued in a three-year experimental study organized as a CRADA with the Association of American Railroads.

The Laboratory is investigating the use of advanced materials as a way to reduce thermal and mechanical stresses in critical components of two-stroke engines, an engine type currently used in recreational boats and potentially applicable to automobiles. This work is being pursued under a CRADA with Mercury Marine, a major manufacturer of two-stroke engines.

Argonne has markedly expanded its assessments of future transportation technologies, particularly advanced and alternatively fueled vehicles. For the DOE Office of Transportation Technologies, the Laboratory has evaluated the costs and benefits of various rates of R&D spending and marketplace introduction for new transportation technologies.

In FY 1992 Argonne, using several types of alternatively fueled vehicles, became the first site in the nation to perform intensive "Level 2" data collection under the Alternative Fuels Motor Vehicle Act. The current fleet at Argonne consists of 43 vehicles running on methanol, ethanol, and natural gas. The Laboratory's compressed natural gas (CNG) refueling facility supplies the test vehicles and also is used in research aimed at developing a low-cost CNG infrastructure. Argonne is the only DOE site testing all fuels and models that are currently used in the federal fleet.

Argonne research is suitable for a variety of applications in light-duty and heavy-duty vehicles. The Laboratory is assessing magnesium and magnesium-based alloys for structural and body components to reduce further the weight of light-duty vehicles. Advanced structural ceramics, such as silicon carbide and silicon nitride, and ceramic composites are being developed and evaluated for high-temperature applications in advanced power

conversion units. New dielectric fabrication processes and materials are being developed for energy storage using ultracapacitors. Flywheel-based energy storage concepts and designs are being pursued for heavy-duty vehicles, notably locomotives, but they will also be applicable to energy storage for light-duty vehicles. Advanced synthetic liquid lubricants are being evaluated to determine their tribological compatibility at elevated temperatures with advanced ceramics and new surface coatings.

The Laboratory's work in the field of tribology (friction and wear) emphasizes a number of concepts specifically relevant to transportation. Most notable is the development and testing of ultrasmooth diamond and diamond-like carbon coatings that improve the wear performance of ceramics and steels under the severe loads and temperatures anticipated in new engine systems such as diesels and gas turbines. In addition, high-temperature (up to 1,000°C), lubricious, wear-resistant compounds (oxides, fluorides, and carbon-based compounds) are being evaluated and developed to improve the fuel efficiency of small, compact gas turbines for light-duty vehicles being developed for the Partnership for a New Generation of Vehicles (PNGV, a presidential initiative involving seven federal agencies and the Big Three automakers). Both advanced and conventional coating techniques (e.g., electro-plating of nickel alloys) are being evaluated for corrosion and wear resistance when applied as low-cost polymer coatings that will be exposed to alcohol-based fuels. To improve manufacturing in the transportation industries, Argonne is developing electromagnetic forming of light-weight materials; evaluating cold and hot forming of lightweight alloys; and developing low-cost, environmentally benign solid lubricants for cold-forming steel and aluminum components for automobiles and heavier vehicles.

Argonne has played a key role in the PNGV, which aims to improve U.S. competitiveness in manufacturing, emissions, and fuel economy technologies. In the early stages of the PNGV, Argonne conducted technical analyses and led many initial planning efforts. The Laboratory is now assessing foreign technologies; analyzing transportation infrastructures; participating in many technology-specific PNGV teams; and organizing and participating in PNGV workshops on fuel cells, energy storage, and fuel processing.

Among the DOE laboratories, Argonne has one of the most diversified advanced battery research programs. Through the U.S. Advanced Battery Consortium (USABC, a partnership of the Big Three auto manufacturers and the Electric Power Research Institute), Argonne works with the private sector on the development of advanced batteries for electric vehicle propulsion. Work on lithium-polymer batteries, conducted under a USABC CRADA with 3M and HydroQuebec, includes testing and electrochemical characterization of cells, electrochemical modeling of cell processes and associated data acquisition, and development of new cathode material, as well as design of full-scale electric vehicle batteries. The Laboratory is also investigating ambient-temperature systems, such as lithium-ion, nickel-metal hydride, and various ultracapacitor systems. Laboratory staff use Argonne's Electrochemical Analysis and Diagnostics Laboratory to conduct full-scale tests for USABC on batteries developed in the private sector and postoperative analyses of failed battery cell components. Results from the Argonne Electrochemical Analysis and Diagnostics Laboratory help developers to qualify and improve the performance of their batteries.

In fuel cell research, Argonne is pioneering technology for converting hydrocarbon fuels to hydrogen-rich gas, directly on board vehicles. Exploiting the principle of partial oxidation, the Laboratory is developing compact, lightweight processors for gasoline, in close coordination with the development of fuel cell vehicles at General Motors. For solid oxide fuel cells, the Laboratory is exploring new materials that will allow substantially lower operating temperatures, an approach that is very promising for heavy-duty applications in trucks and buses. The Laboratory is also investigating anion-exchange membranes as electrolytes for fuel cells operating directly on methanol; this concept promises to overcome many limitations of conventional polymer-electrolyte methanol fuel cells, such as the methanol crossover problem. In addition, the Laboratory is modeling and analyzing fuel cell systems as part of DOE's contribution to the International Energy Agency project on fuel cells.

Argonne supports the Office of Transportation Technologies in technical management of its fuel cell R&D contracts with General Motors, Ford, and Chrysler. In 1995, the Laboratory began to develop a DOE fuel cell test facility to conduct independent tests of fuel cell stacks from various industrial developers. At the same time, the Laboratory has led efforts to develop standardized procedures for evaluating fuel cells.

Argonne research on nondestructive characterization of new ceramic and metal-matrix composite materials for transportation systems aims to improve processing and usage of the materials. Work will continue on the reliability of advanced methods using X-rays; lasers; and nuclear magnetic resonance, infrared, and acoustic techniques. Other applicable approaches include the use of microwaves, millimeter waves, and neutron diffraction.

Argonne is identifying materials-related research needed to develop a more durable, fuel-efficient heat engine and a lighter vehicle body for automobiles. Results will help DOE structure a complementary R&D program. Argonne will assist in identifying materials-related research needs for a lightweight, aluminum-intensive passenger car by conducting a field evaluation of an experimental prototype supplied by a major U.S. automaker.

Related to the PNGV is the FutureCar Challenge, a vehicle engineering research competition for university teams, focusing on incorporating advanced technologies in midsized cars to meet PNGV goals. Jointly with the U.S. Council for Automotive Research, Argonne will organize and manage this competition.

e. Federal Energy Management (WB)

The DOE Federal Energy Management Program supports activities that enhance energy management at the Laboratory. These activities include studies of the energy efficiency of existing buildings and the cost-effectiveness of possible improvements, actual retrofitting of existing buildings, and improvements in the efficiency of central plant systems.

4. Fossil Energy

a. Overview

The DOE Office of Fossil Energy has consolidated its research, development, and demonstration activities under two business lines: (1) coal and power systems and (2) natural gas and petroleum technology. Within those business lines, five specific product lines have been identified: (1) power systems, (2) environmental systems, (3) coal fuels and industrial systems, (4) upstream exploration and production, and (5) downstream processing. The Federal Energy Technology Center has been formed to consolidate the Morgantown and Pittsburgh Energy Technology Centers under a single management structure.

The Office of Fossil Energy is expected to continue its emphasis on industrial collaboration. Argonne participates in several CRADAs and other industrial collaborations on fossil energy research. Major objectives include improved processing of heavy petroleum crudes and residua, more efficient conversion of natural gas to syngas and other valuable chemicals, and development of a new generation of simulators for petroleum and natural gas reservoirs. See Table II.10 for program funding.

The DOE Computational Technology Program, supported by several secretarial offices, focuses on exploration and development for oil

Table II.10 Fossil Energy Program Funding
($ in millions BA)

Major Program Title (B&R Code)	FY96	FY97	FY98
Coal (AA)	2.2	1.5	1.7
Gas (AB)	1.6	1.5	1.6
Petroleum (AC)	1.1	1.0	0.6
Fuels Conversion, Natural Gas, and Electricity (AU)	0.3	0.1	0.1
Magnetohydrodynamics (AW-05)	0.0	0.0	0.1
Clean Coal Technology (AZ)	0.0	-0.2	0.0
Total	5.2	3.9	4.1

and gas. Argonne is conducting one of the projects in this area.

In response to DOE's evolving goals and objectives in fossil energy, Argonne conducts R&D on specific technologies for energy production, conversion, and utilization. The Laboratory also contributes to relevant basic science and to analysis of regional, national, and global environmental issues, including acid precipitation, air toxics, global climate change, and wetlands management.

b. Current Programs (AA, AB, AC, AU, and AW)

Argonne's R&D in fossil energy covers a wide spectrum, including environmental control technology; advanced technology in materials, transport, and multiphase flow; liquefaction, especially novel conversion from natural gas; wetlands and waste management for oil producers; fuel cells; upgrading of heavy crude oil and residuum; gas recovery, transport, use, and tracking; and environmental discharges.

Argonne's work in environmental control technology emphasizes the development and evaluation of new processes that offer more cost-effective control of emissions. Current research focuses on improving techniques for controlling hazardous air pollutants ("air toxics"), such as mercury, that are emitted when fossil fuels are burned. The Laboratory has developed sorbents based on chemical treatment of low-cost substrates as a more economical alternative to activated carbon for injection into power plant ductworks; in addition, Argonne's flue gas cleanup laboratory has studied the performance of several proprietary sorbents in collaboration with private industry. To decrease costs by removing several pollutants in a single process, the Laboratory now is studying techniques for converting mercury into soluble forms that can be captured in existing flue gas scrubbers. Argonne researchers have discovered beneficial reactions involving multiple pollutants (nitrogen oxides and mercury) that may lead to totally new commercial processes. Other work addresses the sources and sinks of mercury emissions; relative risks from utilities' emissions of hazardous air pollutants; and impacts from flue gas cleaning on emissions of air toxics, discharges to water, and generation of solid wastes.

Argonne is working in cooperation with filter vendors to investigate pulse cleaning and material behavior for ceramic-membrane dead-end filters and advanced ceramic candle filters. Analytical models are being developed to determine fluid mechanics and particle transport during filtration and reverse gas cleaning. Specimens exposed for extended periods (over 2,000 hours) to coal ash, alkali, and contaminants are evaluated for changes in physical and thermomechanical properties and microstructure. Theoretical models and experimental data are used in conjunction to predict survivability of filters under conditions anticipated in commercial service.

The Laboratory's work in advanced research and technology development focuses on three areas: materials, energy transport processes and mechanisms, and multiphase flow. In the area of materials applicable to advanced technologies for coal conversion and combustion, the Laboratory continues to develop (1) improved ceramics and ceramic-based composites, along with non-destructive techniques for evaluating ceramics at various stages of processing, and (2) improved metals and alloys.

Argonne's research on ceramic materials continues to emphasize development of non-destructive characterization methods. Current work focuses on methods of characterizing (1) density variations in ceramic composites for cleaning up hot gas streams and (2) *in situ* thermal properties of thermal-barrier coatings for advanced gas turbines. Research continues on the gaseous corrosion of metal alloys, with emphasis on (1) the development of protective scales and their effects on mechanical properties and (2) corrosion of thermal-barrier coatings.

The Laboratory is providing technical support for a field demonstration to evaluate technologies for the treatment and disposal of naturally occurring radioactive materials (NORM). At present, few waste management facilities will accept NORM wastes, a difficulty impairing the development of U.S. petroleum resources. For the field demonstration, Argonne is developing plans, guiding the development of risk assessments, and providing technical oversight.

In support of the DOE-Fossil Energy fuel cell utility program, Argonne is investigating technological issues important for industrial development. For solid oxide fuel cells, relationships between (1) interfacial geometry and composition and (2) electrochemical overpotential are being explored. For molten carbonate technology, the Laboratory is investigating electrolyte segregation in operating cells, as well as bipolar plate corrosion as a function of potential gradients. The Laboratory is also developing improved cathode materials under a direct contract with MC-Power and is exploring new fabrication methods for solid oxide fuel cells under a contract with the Electric Power Research Institute. The military is interested in sealants developed earlier by the Argonne program, for use in oxygen purification devices; manufacturers will be testing the material.

DOE's Advanced Extraction and Process Technology Program, managed by the Bartlesville Project Office, has selected Argonne to participate in four CRADAs with industrial collaborators to develop better technologies for upgrading heavy crude oil and residuum. These R&D projects are addressing the detection and mitigation of fouling on heat exchange surfaces; application of nuclear magnetic resonance to on-line sensors in process environments; and improved processes for upgrading residuum, improved catalysts, and better understanding of feedstock chemistry. Industrial partners include Amoco, Chevron, California Syncrude, and the Heat Transfer Research Institute.

Argonne is helping the Office of Fossil Energy wind down its proof-of-concept program for magnetohydrodynamics by performing environmental assessments of several sites used in the DOE program (to identify compliance and restoration issues associated with their transfer) and by assisting in the disposition of equipment stored at the Laboratory.

In support of the Office of Fuels Programs, Argonne has developed a personal-computer-based model of the U.S. natural gas system. The model combines a powerful geographic information system with an extensive database of technical, financial, and regulatory information on more than 2,500 natural gas companies, including interstate and intrastate pipelines, local distribution companies, producers, marketers, and end users. Recent applications include analyses of natural gas trade with Canada and Mexico.

In work on the coal and power systems business line for the Office of Planning and Environmental Analysis, Argonne focuses on air pollution issues as they affect the performance, cost, and market potential of advanced combustion systems. Current emphasis is on studying the role of nitrogen oxides from coal combustion in raising ozone concentrations in the eastern United States, through development and application of computer models of regional ozone formation. In other work, the potential of advanced coal technologies to improve air quality in the great Asian metropolitan areas is being studied through development of generic methodologies applicable to cities within the framework of Asia-wide regional air pollution transport models.

Initiative: Ion Transport Membranes for Production of Synthesis Gas from Natural Gas (AB-05)

Argonne has developed at bench scale a revolutionary new technology that promises to reduce significantly the cost of converting natural gas into liquid fuels, hydrogen, and high-value chemicals. Termed ITM Syngas (for Ion-Transport-Membrane Synthesis Gas), the new technology combines into one simple operation the separation of oxygen from air and the conversion of natural gas into syngas, thereby eliminating the need for an oxygen plant and significantly reducing the energy and capital cost of syngas production. This feat is accomplished through the use of novel, solid, mixed-conducting oxide ceramic membranes that conduct both oxide ions and electrons through their lattice structures at elevated temperatures.

Significant technical challenges remain before the commercial viability of ITM Syngas technology is proven. Basic research must be translated into viable membrane shapes and reactor designs that can be scaled up and integrated into robust, workable systems exhibiting performance like that observed at laboratory scale. DOE's Office of Fossil Energy has selected a team led by Air Products and Chemicals, Inc., to advance this technology through

a fully integrated unit at proof-of-concept scale. The total cost of this initiative is estimated to be $84 million; Argonne's research activities will require an estimated $3.8 million over 5.5 years (see Table II.11).

Table II.11 Ion Transport Membranes for Production of Synthesis Gas from Natural Gas ($ in millions BA; personnel in FTE)

	FY97	FY98	FY99	FY00	FY01	FY02	FY03
Costs							
Operating	-	0.6	0.6	0.6	0.6	0.6	0.3
Capital Equipment	-	0.1	0.4	-	-	-	-
Construction	-	-	-	-	-	-	-
Total	-	0.7	1.0	0.6	0.6	0.6	0.3
Direct Personnel	-	2.0	2.0	2.0	2.0	2.0	1.0

Argonne's contributions to this industry-led effort will focus on the development, synthesis, characterization, and testing of robust dense-phase ceramic components, including critical seals and transition materials. Testing will include multiple thermal and pressure cycles, to establish probable lifetimes and reliability of materials in commercial service. Reactor module designs will emphasize ease of fabrication and minimal commercial cost. Commissioning of high-pressure testing of ceramic-to-ceramic and ceramic-to-metal seals, using inert gas, is expected in early 1998; expected in early 1999 is atmospheric and high-pressure testing of ceramic membranes with critical seals in the reactors where natural gas is converted to syngas.

Beyond supporting the development of ITM Syngas technology, this initiative will enhance Argonne's growing capabilities in advanced ceramics, which underlie several of the Laboratory's core competencies (see Section II.B in the 1997 *Institutional Plan*). Related Argonne research is addressing ceramics-based high-temperature superconductors, fuel cell components, and membranes that are selectively permeable to molecules or ions other than those relevant for ITM Syngas. Argonne's work on ion-conducting membranes includes development of proton-conducting ceramics to separate hydrogen — the ultimate clean fuel — from gaseous mixtures such as syngas, coal gas, and biogas.

5. Environmental Management

Argonne supports the Office of Environmental Management in both defense and non-defense areas. See Table II.12 for program funding.

Table II.12 Environmental Management Program Funding ($ in millions BA)

Major Program Title (B&R Code)	FY96	FY97	FY98
Total Non-Defense (EX)	26.2	28.3	27.0
Environmental Restoration (EX-20)	15.4	12.9	14.0
Waste Management (EX-31)	10.9	13.3	10.9
Other EX	-0.1	2.1	2.1
Total Defense[a] (EW)	25.9	21.0	13.2
Environmental Restoration (EW-20)	5.3	0.9	0.2
Waste Management (EW-31)	8.4	3.6	2.2
Technology Development (EW-40)	11.6	9.5	4.2
Energy Research-Environmental Management Projects (EW-45)	0.0	3.9	4.3
Other EW	0.6	3.1	2.3
Total	52.1	49.3	40.2

[a]In addition to the new BA funding directly from DOE for Defense Environmental Management, Argonne receives funding via transfers from other DOE contractors. In Table II.1, this funding is included in "Work for Other DOE Contractors." In FY 1997, $12.1 million was received; a similar amount is expected in FY 1998.

a. Defense Environmental Management (EW)

Argonne's work on defense waste management technology is conducted for the DOE programs in high-level and low-level waste technology, interim waste operations, hazardous chemical defense waste, and decontamination and decommissioning (D&D) operations. Argonne also performs technical analyses of environmental compliance and remedial investigations at DOE sites and develops criteria for prioritizing DOE efforts to reduce waste and clean up existing problems.

Argonne projects that its new BA funding for Defense Environmental Management work will decrease by 30-35% in FY 1998. Projects experiencing the greatest decreases are pilot testing of the plasma hearth process (down approximately $2.5 million), work for the Waste Isolation Pilot Plant (down about $850,000), and

the CP-5 Reactor demonstration (down approximately $500,000).

Argonne's work on high-level-waste technology involves helping DOE address technical issues related to starting up waste processing facilities at the Savannah River and West Valley sites. Argonne is performing a series of long-term tests using glass fabricated from Savannah River Plant waste products. This glass is highly radioactive, and all testing is done remotely. The tests will (1) demonstrate the comparability of the physical and chemical behavior of the actual vitrified wastes and the simulated glass waste, (2) evaluate the effects of high radiation levels on glass performance, and (3) establish the performance of glass under long-term repository storage conditions. As part of this effort, Argonne has successfully used analytical electron microscopy to determine mechanisms of reactions in glasses and to describe actinide-bearing colloids that form from the glass and are suspended in solution. Argonne is conducting experiments that will help define the relative importance of small colloidal particles in the release of actinides from a repository.

Argonne's work in support of high-level waste disposal also includes experimental programs that examine the performance of simulated waste forms under conditions that mimic a deep geologic repository, in terms of moisture flow, temperature, and contact with various materials. Data revealing the chemistries and kinetics of relevant processes will be useful for the ultimate objective of licensing a repository. Recent work has focused on the candidate repository at Yucca Mountain in Nevada.

Argonne is developing the following new technologies for the Office of Science and Technology (OST) within the Office of Environmental Management: (1) a combined CSEX (CeSium EXtraction) and SREX (StRontium EXtraction) process to extract cesium-137 and strontium-90 simultaneously from waste sludge; (2) *in situ* magnetically assisted chemical separations; (3) immobilization (vitrification) of ion-exchange resins after use for cesium removal from high-level tank waste; (4) a plasma hearth process for destroying mixed and transuranic wastes; (5) ultrasonic sensors for measuring fluid viscosity and percent of solids (by volume); and (6) innovative processes for treating hazardous, mixed, and radioactive materials in soil and groundwater.

Other work for OST involves analytical chemistry and characterization: (1) evaluation of the management and performance of analytical laboratories and (2) field studies using a cone penetrometer. Argonne also supports the OST Subsurface Contamination Focus Group in the evaluation of research and the implementation of reactive barriers at cleanup sites.

The CP-5 Reactor at Argonne-East is hosting one of the first large-scale demonstrations in DOE's D&D focus area. The demonstration will include removal of the reactor's internal components, removal of the biological shield, decontamination of the fuel rod storage area, decontamination of radioactive material storage and handling facilities (including the fuel pool), and decontamination and dismantling of the building. The overall goal is to validate technologies for repetitive, reliable implementation; to acquire data on the performance of the technologies in the field; to assess the true costs of implementation; and to identify improvements in the technologies suitable for use within the DOE complex.

DOE's responsibilities for overseeing the transportation of hazardous and nuclear material have recently taken on new importance, particularly the responsibility for shipment of defense wastes and spent nuclear fuel. Argonne provides generic technical assistance to DOE on the development of department-wide transportation regulations and on issues associated with fleet transportation, traffic management, public relations, and state-of-the-art electronic systems for tracking shipments.

Argonne is supporting the Office of Environmental Restoration in a number of areas, including developing cost information for restoration activities, evaluating data on contaminated media at DOE facilities, analyzing information on compliance agreements for federal facilities, and implementing environmental information systems.

The Laboratory is also participating in the TechCon Program sponsored by the Office of Environmental Restoration, which seeks to bring application capabilities from the public and

private sectors to serve high-priority DOE remediation needs. At the same time, Argonne monitors results from emerging technology demonstrations to determine their applicability at other DOE sites and facilitates applications of these technologies where appropriate.

Argonne is evaluating the human health risks, environmental impacts, and sociopolitical impacts associated with alternative methods of recycling radioactive scrap metal. The Laboratory developed the technical basis for (1) DOE's "Recycle 2000" policy for recycling of radioactive scrap metal and (2) DOE's handbook on reuse and recycling as a way of controlling the release of nonreal property containing residual radioactivity.

Argonne participates in the DOE Spent Nuclear Fuel Program (1) through membership on technical working groups addressing fuel inventories; facilities for storage, characterization, and conditioning of spent nuclear fuel; and fuels for foreign research reactors and (2) through the development of technology for the safe interim storage, conditioning, and eventual disposal of spent nuclear fuel. In addition, Argonne has contributed to assessments of environment, safety, and health vulnerabilities associated with storage of these materials.

Compliance with the National Environmental Policy Act (NEPA) has been a major focus of the DOE Spent Nuclear Fuel Program. Argonne is providing transportation analyses and contributing to the programmatic environmental impact statement for the entire DOE spent nuclear fuels complex. Further participation in the DOE program is anticipated. Characterization facilities at both Argonne sites are important resources for this work. Furthermore, the electrometallurgical treatment technology being developed at Argonne has potentially important application in conditioning many types of spent nuclear fuel for eventual geologic disposal. This technology is being demonstrated at Argonne-West with irradiated EBR-II fuel and blanket assemblies in the FCF, pending completion of environmental reviews.

Contact-handled transuranic and alpha low-level mixed waste requires characterization and, in some cases, treatment to meet state and federal requirements under RCRA and the Federal Facilities Compliance Act. Characterization of waste is also required for performance assessment modeling needed to open DOE's Waste Isolation Pilot Plant as a permanent disposal facility. Currently, over 130,000 containers of this type of waste are stored for retrieval at the Radioactive Waste Management Complex operated by Lockheed Martin Idaho Technologies Company. To provide needed waste characterization capabilities, Argonne-West has developed the Waste Characterization Area, a new facility within its Hot Fuel Examination Facility. Over 200 drums have been characterized in this facility since 1994. Approximately 250 drums of waste will be characterized and repackaged in the facility each year through at least 2001. Characterization entails collecting gas and solid samples from various regions within the drum and the waste matrix, removing and visually examining waste contents, measuring or estimating various physical parameters, and repackaging the waste into a new container. Waste that does not meet acceptance criteria for the Waste Isolation Pilot Plant must be treated.

For the Regulatory Compliance Division, the Laboratory is developing site visualization software for programmatic environmental impact statements. This software provides time-based displays of DOE facilities and their environments.

In response to the report of the Galvin Task Force and other recent recommendations, the Office of Environmental Management has established a Basic Science Program to develop and implement targeted long-term basic research that will help to solve environmental problems. The goal is "transformational" or breakthrough approaches to problems that will significantly reduce overall cleanup costs and risks to workers and the public. As part of the program, Argonne received initial awards in late FY 1996 to address the following eight tasks: (1) superconducting open-gradient magnetic separation for the pretreatment of radioactive or mixed-waste vitrification feeds; (2) nitrogen oxides in nuclear waste; (3) the use of sonication for in-well softening of semivolatile organic compounds; (4) stable isotopic investigations of *in situ* bioremediation of chlorinated organic solvents; (5) *in situ* spectroelectrochemical studies of radionuclide-contaminated surface films on metals and the mechanisms of their formation and dissolution; (6) ion and molecule sensors using

molecular recognition in luminescent, conductive polymers; (7) the determination of transmutation effects in crystalline waste forms; and (8) investigation of microscopic radiation damage in waste forms by optically detected nuclear magnetic resonance and electron microscope imaging. In FY 1997 Argonne received four additional awards. Awards for two tasks were made directly to the Laboratory: (1) waste volume reduction using surface characterization and decontamination by laser ablation and (2) radiation effects on transport and bubble formation in silicate glasses. In addition, Argonne is part of a joint project with the University of Notre Dame to investigate directly the immobilization of radionuclides in the alteration phases of spent nuclear fuel. The Laboratory is also collaborating with the University of Cincinnati on a task to develop ultrahigh-sensitivity heavy-noble-gas detectors for long-term monitoring and for monitoring of air. All of the Basic Science Program awards received by the Laboratory are for a duration of three years.

b. Non-Defense Environmental Management (EX)

Argonne projects that its new BA funding for Non-Defense Environmental Management work will remain approximately stable from FY 1997 to FY 1998. On-site work is expected to decrease by $2-2.5 million, or approximately 10%, while support for work at other sites increases by a like amount. However, total FY 1998 BO (budget obligation) costs incurred by the Laboratory will decline by approximately 10%.

As part of the Formerly Utilized Sites Remedial Action Program, Argonne assists in developing, applying, and evaluating approaches for assessing former sites of the Manhattan Engineer District and the Atomic Energy Commission that handled radioactive materials, in order to determine the potential for risk to public health and safety and whether decontamination is needed. Argonne also supports cleanups by conducting and reviewing environmental analyses associated with these sites. To accelerate characterization activities, the Laboratory has introduced adaptive sampling and analysis techniques. Also under this program, Argonne maintains surveillance on sites (known as Site A and Plot M) in Palos Forest Preserve southwest of Chicago.

For surplus DOE facilities like those at the Weldon Spring and Fernald sites, Argonne is developing alternative strategies and plans for cleanup and assessing potential health risks and environmental impacts. The Laboratory is also supporting development of cleanup approaches for such sites.

Argonne is supporting the Environmental Restoration Office of Northwestern Area Programs in the development and implementation of quality assurance programs, in self-assessment and management evaluations, and in implementation of safety and health programs. The Laboratory also analyzes economic impacts and risks to human health and the environment posed by inactive and surplus DOE facilities and sites in the Northwestern Programs Area. In addition, Argonne is analyzing legislation, regulations, and policies; interpreting DOE policy and guidance for successful implementation of federal environmental laws; and monitoring and providing technical advice on responses to federal and state regulations dealing with residual radioactivity levels in soils and scrap metals.

Environmental restoration at Argonne-East includes remediation of the 800 area landfill, the 317/319/east-northeast area, and numerous other sites. Major D&D activities for unused facilities are also under way at the Illinois site. These facilities include the CP-5 Reactor, the JANUS reactor, the ZPPR, the Argonne Thermal Source Reactor, and other smaller facilities. At completion, the facilities will be available for unrestricted use. Argonne staff also support environmental restoration activities at other DOE sites, such as Brookhaven National Laboratory and the Oak Ridge Reservation. In addition, the Laboratory will be devoting major efforts to upgrading its waste management operations by, for example, rehabilitating the waste management building; upgrading the hazardous, radioactive, and mixed waste storage facility; and minimizing generation of regulated waste.

Argonne assists the DOE Office of Transportation, Emergency Management, and Analytical Services by evaluating safety analysis reports for spent-fuel casks and other radioactive

transportation packaging systems. This project evolved from Argonne's long-established core competency in the development and evaluation of nuclear energy technology, as well as from a more recently developed competency in the assessment of transportation end uses. The Laboratory evaluates packaging designs to ensure that current safety regulations are met, conducts training in quality assurance, and develops public education materials.

6. Defense Programs (DP)

Argonne provides technical and analytical assistance to the Office of Defense Programs in support of federally mandated activities relating to emergency management and preparedness. See Table II.13 for program funding. Argonne assesses emergency preparedness exercises directed toward emergencies involving radiological, chemical, and hazardous materials. The Laboratory also develops and conducts training in the evaluation and control of emergency exercises, in public relations and media relations during emergencies, and in the operation of joint information centers. Other support requires working directly with DOE field elements, assisting in the development of effective emergency management and preparedness programs, and assessing the effectiveness of these programs at selected sites.

Along with other DOE national laboratories, Argonne is a major participant in the congressionally mandated Newly Independent States Industrial Partnership Program. This collaboration with defense institutes of the former Soviet Union is pursuing the development of commercial technologies. Under the auspices of the collaboration and in cooperation with selected partners in U.S. industry and in the newly independent states, Argonne also participates in other technology development projects endorsed by DOE, the U.S. Department of State, and the U.S. Industry Coalition.

Table II.13 Defense Program Funding[a]
($ in millions BA)

Major Program Title (B&R Code)	FY96	FY97	FY98
Weapons Activities (DP)	1.9	0.9	0.7
Other Weapons Activities (GB)	0.0	0.0	0.2
Total	1.9	0.9	0.9

[a]In addition to the new BA funding directly from DOE-Defense Programs described above, Argonne receives funding via transfers from other DOE contractors. In Table II.1, this funding is included in "Work for Other DOE Contractors." In FY 1997, $5.8 million was received; a similar amount is expected in FY 1998.

7. Nonproliferation and National Security

Argonne's multidisciplinary work in the field of arms control verification and nonproliferation is coordinated within a single Laboratory program that is closely integrated with the DOE Office of Nonproliferation and National Security. As superpower tensions diminish, emphasis shifts toward nonproliferation, focusing on four major program areas: arms control and nonproliferation policy and technology, low-enrichment research reactor fuel, export control, and international safeguards. In addition, Argonne's expertise in emergency management is used by the Office of Emergency Management in support of its general oversight and policy-making roles. See Table II.14 for program funding.

Table II.14 Nonproliferation and National Security Program Funding ($ in millions BA)

Major Program Title (B&R Code)	FY96	FY97	FY98
Nonproliferation and Verification R&D (GC)	2.0	1.9	2.1
Nuclear Safeguards and Security (GD)	0.2	0.2	0.2
Arms Control and Nonproliferation (GJ)	8.6	9.9	12.0
Emergency Management (ND)	0.1	0.1	0.1
Intelligence (NT)	0.4	0.3	0.3
Total	11.3	12.4	14.7

a. Nonproliferation and Verification Research and Development (GC)

The Office of Research and Development within the DOE Office of Nonproliferation and National Security supports Argonne's

development of several new technologies to detect potential nuclear proliferation and to monitor compliance with treaties in force or pending. These technologies include using various novel types of tags and seals, as well as satellite tracking, to protect and monitor sensitive materials; a crystal lens for sensitive detection of gamma radiation; millimeter wave detection of chemical effluents from handling of special nuclear material and production of chemicals prohibited under the Chemical Weapons Convention; a miniature time-of-flight mass spectrometer to identify chemical or nuclear effluents; a sealed-tube neutron generator for non-destructive examination of munitions and other sealed containers; biologically engineered proteins for ultrasensitive detection of proliferation signatures; and computer techniques to automate and expedite the handling and interpretation of data from national verification programs.

Argonne is cooperating with the Kurchatov Institute in Moscow and other Russian institutes to develop technical means to intercept sensitive materials such as fissionable materials, explosives, and drugs at control points such as airports, railroad stations, and border crossings. This "Second Line of Defense" aims particularly at intercepting materials that have escaped government custody. The work includes establishing technical requirements, developing special sensors, and preparing a curriculum to train students in the relevant technologies at the Moscow Institute of Physics and Engineering.

In the area of arms control and nonproliferation policy analysis, Argonne is studying various arms control treaties to elucidate legal aspects of their implementation. The Laboratory studies procedures for determining host compliance during inspections under the Chemical Weapons Convention and the Strategic Arms Reduction Treaty. The Laboratory also provides Russian-English translations for meetings in Moscow and for documents related to arms control and nonproliferation.

b. Low-Enrichment Research Reactor Fuel (GJ)

The DOE Office of Arms Control and Nonproliferation supports Argonne's Reduced Enrichment for Research and Test Reactors (RERTR) program. This program has developed new fuel systems that can make research and test reactors throughout the world more resistant to proliferation, primarily by reducing the degree to which the fuel is enriched. To this end, Argonne assists operators of research reactors who wish to convert to low-enrichment fuels and also assists designers of new research reactors by analyzing the safety, performance, and economic characteristics of reactors using such fuels.

Argonne is working with the Research and Development Institute of Power Engineering in Moscow and several other Russian institutes to complete the Russian reduced-enrichment program, which began in 1978 but was halted because of lack of funding in 1988-1989. Under an Argonne contract signed in January 1995, the Russian organizations are developing and testing high-density fuels and will perform whole-core demonstrations of the use of these fuels in two research reactors of Russian design. Successful completion of this five- to six-year program will provide the technical means to convert to low-enrichment fuels more than 20 research reactors in Russia, other republics of the former Soviet Union (FSU), Eastern Europe, Libya, North Korea, and Vietnam.

The cornerstone of the RERTR program has been the application of a technology based on uranium disilicide dispersion fuel that was developed, tested, and demonstrated under the auspices of the program. High uranium densities allow most research and test reactors to use the low-enrichment uranium fuel without significant reductions in performance or increases in cost. In March 1996, DOE funded Argonne to begin developing fuels with even higher uranium density, in order to convert existing reactors not adaptable to the disilicide fuel and to provide a fuel suitable for future advanced research reactors. The basic concept is to replace the uranium disilicide fuel powders with powders of gamma-phase-stabilized uranium alloys, which have much higher density. Screening irradiation tests will begin in the Advanced Test Reactor in August 1997; first results are expected in the middle of FY 1998. Overall, a five-year program is envisioned.

The RERTR program is also working toward the development of low-enrichment uranium targets and processes for production of molybdenum-99. These targets, which support very important medical applications, currently use high-enrichment uranium and require significant exports of that material from the United States to countries around the world. One of the target systems is being tested in cooperation with the National Atomic Energy Agency of Indonesia under a cooperation agreement signed in November 1994. Completion of irradiation and processing for this system is scheduled for February 1998.

c. Nuclear Transfer and Supplier Policy (GJ-08)

For the Nuclear Transfer and Supplier Policy Division of the DOE Office of Nonproliferation and National Security, Argonne conducts several projects in the area of nuclear technology security in support of DOE's statutory responsibilities under the Atomic Energy Act of 1954 (as amended), the Nuclear Nonproliferation Act of 1978, and U.S. treaty obligations emanating from the Treaty on the Nonproliferation of Nuclear Weapons. These projects contribute to controlling dissemination outside the United States of certain unclassified equipment, materials, and scientific and technical information that could contribute to nuclear proliferation. Laboratory technical analyses and expertise support (1) review and evaluation of nuclear and nuclear-related exports; (2) U.S. participation in multilateral export control regimes; (3) identification, definition, and control of sensitive equipment, materials, and technologies; (4) maintenance of a system for tracking foreign requests for information from DOE laboratories; (5) review of technology transfer risks associated with foreign visitors to DOE laboratories and foreign travel by DOE representatives; and (6) sensitizing DOE and DOE contractor personnel to proliferation concerns and to technology security.

Argonne participates in projects supported by DOE or the Department of Defense that assist states of the FSU with establishment of national systems for identifying and controlling equipment and technologies that could be used for the design, production, or testing of weapons of mass destruction. Activities include assisting FSU countries in (1) establishing technical support infrastructures for government policy, licensing, and enforcement authorities; (2) organizing FSU technical experts to develop export technical review processes; and (3) establishing technical collaborations promoting protection of weapons technologies.

d. International Safeguards (GJ-08)

Argonne works for the Russia-Newly Independent States (NIS) Nuclear Material Security Task Force of the DOE Office of Nonproliferation and National Security. The focus is support for U.S. assistance in safeguarding nuclear materials and facilities that are not directly associated with nuclear weapons in the NIS. Under the Cooperative Threat Reduction Act, the Defense Special Weapons Agency provides funding for upgrades of material protection, control, and accountancy (MPC&A) at selected facilities in Ukraine, Kazakhstan, and Belarus. The Task Force also supports assistance to other facilities in those countries and to nuclear facilities in other of the NIS. Argonne coordinates management of technical support through a project involving multiple divisions at Argonne, as well as four other DOE laboratories. Argonne is currently supporting a technical review of the security of the plutonium fuel at the BN-350 reactor in Kazakhstan.

e. Emergency Management (NN)

The DOE Office of Emergency Management has responsibility for general oversight and policy-making for all DOE emergency preparedness activities. Argonne's technical and analytical assistance to the office primarily involves technical review and analyses of plans, procedures, capabilities, and the various threats to effective emergency response. In addition, Argonne develops and conducts training in the evaluation and control of emergency exercises, public information and media relations during emergencies, and operation of joint information centers.

8. Environment, Safety, and Health (HC)

For the Assistant Secretary for Environment, Safety, and Health, Argonne provides technical support in developing data, analyses, guidance, and training that can be used by DOE facilities to ensure their compliance with environmental, safety, and health regulations. The Laboratory also conducts research relevant to the effects on workers of radiation and other toxic and hazardous materials. See Table II.15 for program funding.

Table II.15 Funding from Other DOE Program Offices ($ in millions BA)

DOE Program Office (B&R Code)	FY96	FY97	FY98
Environment, Safety, and Health (HC)	1.8	1.9	1.6
Civilian Radioactive Waste Management (DB)	0.1	0.0	0.0
Policy, Planning, and Program Evaluation (PE)	0.7	0.3	0.4
Economic Impact and Diversity (WA-50)	0.5	0.1	0.2
Fissile Materials Disposition (GA)	0.9	1.5	1.4
Packaging Certifications (HS)	1.2	0.0	0.0
Nuclear Safety (NS)	0.2	0.0	0.0
Federal Energy Regulatory Commission (VR)	0.1	0.0	0.0
Total	5.5	3.8	3.6

Argonne's activities in guidance and compliance are supported by DOE under Environment, Safety, and Health: Overview and Assessment (HA-01). Environmental data assembled, evaluated, and applied by Argonne support sound DOE planning for environmental protection, safety, and emergencies.

Argonne will be assisting the DOE Office of Environment, Safety, and Health in areas related specifically to regulation of its internal facilities. For the Environmental Guidance Office, Argonne is developing data, analyses, and training materials and courses that can be used by DOE facilities to ensure their compliance with state and federal environmental regulations. The Argonne RESRAD model is being further developed for use as a primary tool in determining cleanup requirements and in assessing human health risk for radioactively and chemically contaminated soils and buildings, as well as other materials containing residual radioactivity. Argonne's extensive experience with NEPA requirements is utilized by the DOE NEPA Project Assistance Office in developing guidance and reviewing NEPA documents prepared specifically for DOE.

Argonne recently completed an environmental impact statement for the Western Area Power Administration's (WAPA's) electric power marketing program for the Colorado River Storage Project Customer Service Office. Follow-up activities include technical support to WAPA in the formulation of plans to protect resources affected by dam operations.

For the Office of Information Management, Argonne continues to develop a hypertext information management system that serves as a central repository for oversight documents related to NEPA and to environmental protection, safety, and health, as well as the foundation for a future digital library. The system functions as a management planning and decision-making tool that facilitates analysis; it also encourages technology transfer and the communication of lessons learned across DOE. The system is accessed by DOE program offices, field offices, and the public via the World Wide Web.

For the Office of Human Radiation Experiments, Argonne has developed an innovative information management system that provides on-line public access to reports pertaining to human radiation experiments. (As a part of the Openness Initiative of the Secretary of Energy, DOE has recovered information on experiments dating back to 1945.) Over 250,000 pages of reports are available over the Internet via the World Wide Web, with images and searchable text linked together. Agencies other than DOE are also placing information on human radiation experiments into this system.

Initiative: Assessment and Management of Risk

Argonne continues to develop its initiative in risk assessment and risk management that builds on and consolidates the Laboratory's extensive, diverse expertise in health and safety studies and related studies of system failures. Using a common base of risk evaluation methodologies, the resulting comprehensive program addresses scientific and engineering investigations of hazards and other sources of risk; the pathways and mechanisms by which sensitive humans, ecologies, and other systems become exposed; and the nature and extent of the impacts resulting from exposure. Also included are risk management and related processes of communicating risks to decision makers and affected communities.

This initiative supports Argonne's broader missions in the development and technical evaluation of energy and environmental technologies, in areas such as accident and safety analyses, risk-based maintenance for nuclear power plants and other engineered facilities, and transportation of hazardous materials. Risk assessment is increasingly understood to be an appropriate basis for formulating cost-effective policy decisions on issues ranging from protection of the environment to the allocation of resources for technology development.

Resources required are described in Table II.16. Funding is sought from the Environment, Safety, and Health Program (HC, HD) and also from the Environmental Management programs (EW and EX).

Table II.16 Assessment and Management of Risk
($ in millions BA; personnel in FTE)

	FY97	FY98	FY99	FY00	FY01	FY02	FY03
Costs							
Operating	1.0	1.5	2.5	3.0	3.0	3.0	3.0
Capital Equipment	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	-	-	-	-	-	-	-
Total	1.1	1.6	2.6	3.1	3.1	3.1	3.1
Direct Personnel	5.1	7.1	11.0	12.0	12.0	12.0	12.0

9. Civilian Radioactive Waste Management (DB)

Argonne researchers have been studying interactions between waste package materials and the unsaturated repository environment associated with the proposed site at Yucca Mountain, Nevada. This work includes elucidating processes that affect the release of radionuclides from high-level waste forms (glass and spent fuel) under simulated repository conditions. Also performed are characterizations of the factors that control the corrosion of metals, to assist in the selection of container material, and studies of the effects of radiation on corrosion and leaching. See Table II.15 for program funding.

10. Policy, Planning, and Program Evaluation (PE)

In support of environmental policy-making by DOE, Argonne will be analyzing energy and environmental issues. Studies will address U.S. Environmental Protection Agency regulations that affect energy development and policy questions related to transportation. Argonne provides key support for assessments of atmospheric pollutants, global climatic change, and international trade. Argonne supports the development of models and databases used to assess the environmental implications of U.S. energy plans, policies, and strategies.

Other studies are analyzing nonpetroleum transportation fuels, vehicle technology, supplies of fuels, associated infrastructure needed, and the environmental effects of using compressed natural gas, methanol, ethanol, liquid propane gas, and electricity as transportation fuels. Argonne also supports analyses of transportation energy policies and related issues. See Table II.15 for program funding.

11. Economic Impact and Diversity (WA)

Argonne helps DOE's Office of Economic Impact and Diversity comply with the DOE Organization Act of 1977. The program's three broad tasks are (1) to develop and update a database and model describing energy use by

various population groups, (2) to assess the effects of government energy policies on minorities, and (3) to estimate the effect of key macroeconomic variables on the pattern of U.S. energy demands and expenditures, according to demographic groups. See Table II.15 for program funding.

12. Fissile Materials Disposition (GA)

For the Office of Fissile Materials Disposition, Argonne is performing tests that are critical for the disposition of excess plutonium as a ceramic in a geologic repository. These dissolution tests on the titanate-based ceramic material that has been selected for immobilization of the plutonium will ultimately be used in the application to open the U.S. repository. (Excess plutonium created by arms reduction treaties between the United States and Russia will be disposed by conversion to commercial reactor fuel, as well as by placement in a geologic repository.) See Table II.15 for program funding.

13. Additional DOE Secretarial Offices

In addition to the work for DOE secretarial offices described above, Argonne also conducts typically less extensive work for other secretarial offices. See Table II.15 for program funding.

B. Work for Other DOE Contractors

Argonne performs a variety of R&D activities in cooperation with other national laboratories and as a subcontractor to organizations whose primary source of program funds is DOE. This type of work is undertaken when Argonne has technical expertise needed to support major DOE programs being conducted by other contractors.

For several years, Argonne has conducted extensive research on *in situ* bioremediation of a diesel fuel spill at Sandia National Laboratories, Livermore, California. The Laboratory provides technical assistance in the design, implementation, and long-term monitoring of remediation activities. A remediation strategy designed by Argonne was installed at Sandia at pilot scale.

The Laboratory is performing work for ORNL as part of significant national programs under the Office of Conservation and Renewable Energy, the Office of Industrial Technologies (OIT), and the Office of Transportation Technologies (OTT). Funded by OIT, Argonne is developing nondestructive evaluation methods of flash infrared imaging, elastic optical scattering, and air-coupled ultrasonics for continuous-fiber ceramic-matrix-composite (CFCC) materials; this work for the CFCC program is also to be applied to thermal-barrier coatings for the Advanced Turbine Systems project. Funded by OTT as part of the Heavy Vehicle Technology program, Argonne focuses on development of nondestructive evaluation methods for ceramics for diesel engines. These methods include high-resolution X-ray computed tomographic imaging ("CAT scans") and resonant ultrasound spectroscopy. For ORNL, as part of national programs funded by the Office of Energy Research, Argonne is evaluating whether rapid prototyping technology can be used to fabricate functional ceramics directly.

The Laboratory is providing technical assistance to Pacific Northwest National Laboratory and DOE's Richland Operations Office as a member of the DOE task force supporting activities aimed at potential privatization of the treatment of high-level wastes in tanks at the Hanford Reservation. In further support activities, Argonne is conducting experimental work on the design and synthesis of crown ethers specifically for waste separation.

Argonne is providing technical support to the DOE Idaho Operations Office for the Plutonium Focus Area and the National Spent Nuclear Fuel Program. This support includes experimental work, technical evaluation, and planning.

In support of DOE-Environmental Management, Argonne is collaborating on many projects with the DOE Nevada Operations Office and Sandia National Laboratories.

In collaboration with ORNL, Argonne is working on the design and application of centrifugal contactors and general solvent extraction technology for the removal of fission products (such as cesium, strontium, and

technetium) from tank wastes at the Hanford Site and the Savannah River Site.

C. Work for Sponsors Other than DOE

Part of Argonne's work is supported by sponsors other than DOE. Major sponsors include the Nuclear Regulatory Commission, Department of Defense (DOD), National Institutes of Health, Environmental Protection Agency, Federal Emergency Management Agency, Department of State, National Science Foundation, Department of Agriculture, Department of Transportation, National Aeronautics and Space Administration, Electric Power Research Institute, Gas Research Institute, private firms, and state and local governments. See Table II.17 for program funding.

Table II.17 Program Funding from Sponsors Other than DOE ($ in millions BA)

Sponsor	FY96	FY97	FY98
Total Federal Agencies	50.5	45.4	49.0
Nuclear Regulatory Commission	5.8	6.4	6.0
Department of Defense	24.6	24.0	24.0
Other Federal Agencies	20.1	15.0	19.0
Nonfederal Organizations	20.5	24.8	23.0
Total	71.0	70.2	72.0

Argonne's work for non-DOE sponsors supports accomplishment of its missions (see Chapter II of the 1997 *Institutional Plan*) and development of its initiatives (as described in the 1997 *Institutional Plan*, Chapter IV). From a national perspective, this "work for others" (WFO) allows Argonne's unique facilities and capabilities to be applied to U.S. R&D priorities.

The Laboratory's WFO strengthens resources available for DOE missions and programs and promotes development of specific energy and environmental technologies. It enhances Argonne's research capabilities, helps support the infrastructure at the Laboratory, and ultimately increases opportunities to transfer Argonne technologies to productive applications in the private sector. The Laboratory does not undertake work for non-DOE sponsors if that work can be performed satisfactorily by private organizations.

Argonne plans to expand industry sponsorship of its research. For private organizations, the accessibility and attractiveness of the Laboratory's technical resources have improved significantly in recent years because of the more favorable terms under which intellectual property rights can be made available and also because of easier and quicker processing of contracts. The Laboratory will also continue to apply its special capabilities and facilities to research for DOD.

Areas where Argonne capabilities match the needs of non-DOE sponsors and where the Laboratory plans to strengthen its capabilities in support of DOE missions are neutron irradiation of materials, high-temperature superconductivity, advanced electrochemical technologies, biomedical and environmental research, software for parallel processing, and industrial modeling software.

1. Nuclear Regulatory Commission

Argonne conducts research for the Nuclear Regulatory Commission (NRC) under a legislatively mandated memorandum of understanding between DOE and NRC. The major focus of this research is on materials engineering, thermal hydraulics, and safety analysis. In addition, Argonne provides short-term technical assistance to various NRC offices in many different areas. Both research and technical assistance take advantage of special capabilities that Argonne has developed in areas such as nondestructive testing, numerical simulation, evaluation of fuels and materials, regulatory analysis, and analysis of utility systems.

a. Office of Nuclear Regulatory Research

Most of Argonne's work for the NRC is supported by the Office of Nuclear Regulatory Research. The largest efforts address materials issues, analysis of thermal transients, component reliability, and severe accident behavior.

Materials research focuses on the degradation of structural materials in light-water reactors that is caused by reactor environments, including the effects of water chemistry and neutron irradiation. These studies include measurements of (1) growth rates of stress corrosion cracks and (2) the fatigue life of stainless and ferritic steels used in the reactor core, piping, and pressure vessel. Results from these studies are used by the NRC to ensure the structural integrity of plants as they age. The testing includes specimens from operating commercial reactors. Additional irradiations of stainless steels are performed in Norway's Halden test reactor to provide further systematic data on relationships between material composition and susceptibility to cracking after irradiation.

A comprehensive study of degradation in the steam generator tubing of nuclear power plants is under way. Critical areas being addressed include (1) evaluation of techniques used for in-service inspection of steam generator tubes and recommendations for improving the reliability and accuracy of those inspections, (2) validation and improvement of correlations for evaluating structural integrity and leakage of degraded steam generator tubes, and (3) validation and improvement of correlations and models for predicting degradation in aging tubes during operations. The studies focus on mill-annealed Alloy 600 tubing, but tests will also be performed on replacement materials such as thermally treated Alloy 600 and Alloy 690.

Argonne's work in thermal hydraulics for the NRC emphasizes detailed analyses of the mechanisms governing postaccident cooling of advanced pressurized-water reactor systems. Included are the development of models for liquid-film cooling of containments and comparison of the resulting computer simulations with experimental data provided by vendors. Recently completed revisions and modifications of the Argonne COMMIX code, a three-dimensional, general-purpose thermal-hydraulics computer code originally developed under NRC sponsorship, allow analyses of a variety of postaccident cooling transients for advanced configurations of pressurized-water reactors.

The NRC continues to use Argonne's broad expertise in severe-accident phenomena. An experimental study of the energetics of steam explosions resulting from interactions between water and molten core materials focuses on the possible extent of chemical augmentation of the energetics by metallic constituents in the core melt, particularly zirconium. Results will contribute to evaluation of the structural integrity of reactor vessels and their containments in severe accidents.

Argonne also provides support for NRC's rule making and other regulatory functions by performing regulatory analyses of proposed and final rules and proposed changes to regulatory guides and by analyzing public comments on rule making.

The Laboratory uses simulation models for electric utilities to estimate the cost of replacement energy and other costs when reactors are shut down. Cost estimates developed for both temporary and permanent shutdowns are updated periodically. These estimates aid regulatory policy-making, particularly regarding temporary shutdowns for safety modifications or permanent shutdowns resulting from severe accidents.

b. Office of Nuclear Reactor Regulation

In addition to experimental research work, Argonne provides assistance to the Office of Nuclear Reactor Regulation on a variety of issues related to the performance of materials. This work contributes to the development of a standard review plan for operating reactors that can be used to assess the suitability of renewing the plants' initial 40-year licenses.

Argonne assists the NRC in reviewing the probabilistic risk assessment for the AP-600 advanced-concept pressurized-water reactor design, in the areas of system success criteria and performance reliability of passive-system thermal hydraulics. This work includes (1) identification of parameter uncertainties that significantly affect plant risk, (2) analyses of the sensitivity of system performance to such uncertainties, (3) assessment of margins between predicted system performance and the system-limiting state (the beginning of core damage), and (4) expert judgment and conservative assessments of margins. Internal and external events are considered during both power operation and shutdown. Argonne also advises the

NRC on refining, focusing, and redirecting the approach that has been adopted for resolving issues about the reliability of the passive safety system for the AP-600.

Argonne provides comprehensive reviews of selected technical literature for the NRC. The reviews focus on issues of materials-related degradation and aging that may be relevant to renewal of nuclear plant licenses. The Laboratory also provides other support in the general area of managing the aging of nuclear systems. These activities are vital to Argonne's work in two of its major mission areas: energy technology and technical evaluation.

2. Department of Defense

Argonne is conducting research for several organizations within DOD.

a. Office of Secretary of Defense

For the Defense Modeling and Simulation Office, Argonne is developing a sophisticated software architecture for studying the impact of environmental effects on military and civilian operations. The Laboratory also supports this office in the development of advanced computer architectures for the DOD modeling and simulation community. In addition, Argonne is assisting the Program Analysis and Evaluation Office in the development of a process and tools to support the development of generic terrain maps that can be used for military analysis of potential threats without indicating locations of specific military interest.

b. U.S. Air Force

The U.S. Air Force is sponsoring several programs at Argonne. The Laboratory's experience and expertise in conducting environmental assessments of sites with unique environmental features or potential impacts are being used for several major proposed Air Force activities.

Argonne is studying biodiversity at a number of Air Force installations across the country, focusing on the abundance of federal- and state-listed species and on the existence of exceptional natural communities. The information collected is incorporated into geographic information systems.

Argonne is also studying a number of environmental systems to identify for the Air Force the most cost-effective technical approaches to environmental management. Included are development of innovative approaches to computer-assisted management of large numbers of air pollutant emission sources in complex industrial areas, development of approaches to risk management, and planning for use of natural resources and land near Air Force installations. Innovative approaches to site characterization and remedial technologies for soil and groundwater contamination are being investigated.

For the Air Force Headquarters Air Weather Service, Argonne is studying the development of an effective theater weather-forecasting capability, focusing on the system's architecture and a general proof of concept. In particular, the Laboratory is developing a test bed for an appropriate architecture, where the ultimate design goal is short-term forecasts at resolutions as fine as ten kilometers. To effectively integrate the various component meteorological models needed, Argonne is using its Dynamic Information Architecture System as the software architecture. The basic forecasting model is a version of a mesoscale model originally developed by the National Center for Atmospheric Research and Pennsylvania State University. Argonne's parallel version of the model has been running successfully in a semioperational mode on the high-performance computer network implemented by the Laboratory at Global Weather Central, located at Offutt Air Force Base in Omaha. Argonne's success in developing this test bed has motivated the Air Force to shift to a full-scale development program called the Global Weather Analysis and Prediction System.

Argonne is providing technical support for the Air Force's Hypervelocity Rocket Sled Upgrade Program. This work includes technical reviews, advice, and analyses regarding support and guidance systems that use superconducting magnets and cryogenic systems.

c. The Joint Staff

Argonne supports the J-8 Directorate of the Joint Staff. This work entails developing better planning and simulation models and evaluating new or improved information management technologies. An important aspect of the work involves developing innovative uses of rapidly advancing graphics technologies to manipulate and analyze large databases. These Laboratory efforts take advantage of more than 15 years of experience in designing large engineering and scientific databases; developing new methods of representing data; and building and using knowledge bases, image exploitation, and data visualization. The work for J-8 also benefits from the availability of relevant advanced processors at Argonne's Center for Computational Science and Technology, the Laboratory's extensive and diverse experience in applied decision analysis, and its experience in studying knowledge representation and applying expert systems.

Working with J-8, Argonne has greatly expanded its efforts to develop a modeling system for simulating and displaying environmental effects at the earth's surface. The resulting software system, the Dynamic Environmental Effects Model, supports both static and dynamic investigations of geographic areas. It will have wide applicability, both within and outside J-8 and the DOD. To provide the "synthetic environment" needed by the military for training and analysis, the model must manage and coordinate information based on natural (atmospheric and oceanic) processes and human disturbances (effects of vehicles and weapons). The model uses software objects intensively and is a sophisticated and comprehensive implementation of modern object-oriented theory. Initial development, pioneered by J-8 and Argonne, has already elicited interest and funding from the armed services and other DOD agencies.

Argonne is improving the efficiency of computer models for J-8 in a variety of ways, including their adaptation to advanced processors, and is recommending improved computer system configurations that incorporate advanced multiple-processor computers, high-performance workstations, advanced networking, and greater data storage capacity. In addition, the Laboratory is providing R&D on distributed computing, distributed database management systems, and parallel processing using object-oriented techniques.

Also for J-8, Argonne is pioneering the use of advanced information retrieval techniques in planning and decision support systems. Such systems integrate text management and data management technologies into a single platform for analyzing requirements for new acquisitions. In addition, the Laboratory is applying object-oriented techniques to mission planning. Associating image data with objects greatly enhances the quality of assessments. Argonne is using these tools to support the Joint Community in infrastructure assurance analyses and technical R&D evaluations.

Since 1987 the Joint Staff has sponsored a multifaceted logistics and mobility modeling program at Argonne. The program has two primary goals: (1) to provide decision makers with information management capabilities for planning missions such as military operations, disaster relief, and peacekeeping and (2) to develop advanced computer system prototypes for planning and tracking the movement of personnel, equipment, and supplies throughout the world. The program has grown to include 13 interrelated projects. One representative model simulates detailed logistic movements that begin with arrivals at ports (by sea or air) and includes movements across land (by road, rail, inland water, or air) through various intermediate destinations to a final set of destinations. Movements of people, supplies, and equipment are included. Other Argonne models address the same kinds of movements at different levels of detail. A more aggregated model determines the maximum amount of material that can be pushed through an infrastructure network in a given time period. On the other hand, a highly disaggregated model simulates each process that occurs at a seaport (unloading, handling, and waiting) at a much greater level of detail. Infrastructure components are also modeled.

Argonne is intensely involved in the design and implementation of high-performance networks incorporating the latest switching technologies, to provide classified suites (both garrison and deployable) and unclassified suites with a high

degree of flexibility and cable management capability. Designs provide for multimedia connectivity worldwide via the Internet and the Defense Simulation Internet. Current efforts in this area are being extended to the J-8 Directorate, the Joint Staff, and the U.S.-Republic of Korea Combined Forces Command. Long-range plans provide for phased implementation of higher-performance technologies as they evolve.

d. U.S. Army

For the Army Logistics Integration Agency, Argonne is part of a team developing the Distributed Intelligent Architecture for Logistics (DIAL), which will integrate logistics models into a distributed computing environment by using an architecture capable of expansion. A suite of independent software agents will manage communications and trigger tasks or events among distributed applications. The Laboratory will develop a functional model design and various software agents, implement and integrate a DIAL prototype, and plan and manage the project.

Argonne is assisting the Army's implementation (in conjunction with the Federal Emergency Management Agency) of the Chemical Stockpile Emergency Preparedness Program. The Laboratory supports program development, policy analysis and development of associated guidance, emergency preparedness planning, institutional analysis, development of hazard-specific risk communications and emergency public education mechanisms, and testing and assessment of response capabilities. Argonne assists in technical management. This work involves hazard analysis, modeling of chemical agent dispersion, development of cost estimation and measurement methodologies, and integration for emergency planning. The Laboratory is also conducting independent reviews of the Army's Phase I environmental documents, giving to Congress and the Army comments on the chemical demilitarization environmental process and helping the Army prepare site-specific environmental impact statements.

For the Construction Engineering Research Laboratory of the Army Corps of Engineers, Argonne is conducting research at a series of demonstration sites to develop techniques for environmental rehabilitation of U.S. Army training bases in the continental United States and Europe. The focus is on developing site-specific recommendations for training sites (at Fort Riley, Kansas; Fort Benning, Georgia; and Hohenfels, Germany) that will serve as models for other installations, thereby facilitating integration of training needs with environmental management. Argonne also is creating a knowledge-based air emissions reduction model to improve compliance decision making.

For the Waterways Experiment Station of the Army Corps of Engineers, Argonne has provided advanced visualization software to support field sampling; the Laboratory is currently a partner in the Groundwater Modeling System Program.

Argonne is also helping the Army Corps of Engineers to implement projects under the Superfund and Defense Environmental Restoration Programs through the Baltimore District. The Laboratory is developing specialized approaches to remedial investigations and feasibility studies, particularly for sites with radiological contamination, and is designing and overseeing implementation of remediation technologies for various sites.

Argonne is conducting an integrated program of environmental and engineering research and technical support for the Army Corps of Engineers (Norfolk District) and the Army's Training and Doctrine Command, examining issues such as land restoration, solid waste management, and cleanup of hazardous waste sites.

For the Army Materiel Command, Argonne's expert peer review process is being used to evaluate alternative technologies and regulatory considerations for cleanup activities at the Rocky Mountain Arsenal near Denver, Colorado. Argonne will demonstrate techniques for land reclamation after cleanup at that facility.

For the Army Chemical and Biological Defense Command, Argonne assists in the development and analysis of restrictions regarding the land disposal of chemical agents and their by-products in the environment. Studies are coordinated with multiple environmental agencies within the Army and the state of Utah. In addition, the Laboratory supports the Command's Alternate Technology Program in

the area of environmental compliance for demilitarization of assembled munitions.

For the Edgewood Research, Development, and Engineering Center at Aberdeen Proving Ground, Argonne assists in assessments related to environmental compliance.

Argonne has undertaken studies of the environmental risks posed by active and former test ranges for the Army Test and Evaluation Command. Argonne is now conducting specific environmental restoration and compliance assessment studies at several installations of the Command (Dugway Proving Ground, Yuma Proving Ground, and Aberdeen Proving Ground).

Argonne is providing technical assistance for environmental restoration activities at the Aberdeen Proving Ground, which has a legacy of chemical contamination. The Laboratory is seeking solutions to such problems through a restoration study at the "J Field" site. Work addresses management of environmental information, wetlands issues, and containment of groundwater contamination.

Also at the Aberdeen Proving Ground, Argonne is conducting a sitewide environmental assessment that couples advanced database technology to geographic information systems.

Argonne is also supporting the U.S. Army Environmental Center through R&D on environmental restoration at various Army installations, including several sites that have been placed on the National Priorities List. Specific activities include development of state-of-the-art environmental data management systems to expedite remedial decision making and use of groundwater models to evaluate alternative methods of restoring aquifers. The Laboratory is also supporting compliance and regulatory analyses for the Center. Another project for the Army Environmental Center is demonstrating the use of slurry bioreactors for detoxifying soils contaminated with explosives.

For the U.S. Army Defense Ammunition Center (USADAC), the Laboratory is developing a data system for hazardous waste characterization to support environmental compliance related to the destruction of munitions and explosives at Army installations and to the reuse and recycling of components. In related efforts for the Army Industrial Operations Command, Argonne is developing a demilitarization planning and management system that incorporates the USADAC system and other information to improve the Army's ability to plan for cost-effective and environmentally sound demilitarization.

e. Defense Special Weapons Agency

As part of its arms control program, Argonne is developing verification procedures for the Defense Special Weapons Agency. Currently the Laboratory is studying the overall, long-term information and organizational requirements for treaty verification and compliance as further treaties are implemented. These efforts include analysis of functional requirements; technical evaluation, independent verification, and validation of new automated systems; prototyping for automated training techniques; and assistance in implementation planning. The Laboratory is also performing studies and technical evaluations in support of the Open Skies Treaty.

The Defense Special Weapons Agency's Arms Control Technology Program Office is developing technologies that will aid in the implementation of various arms control treaties. Effective verification of chemical arms control agreements, such as the recently signed Chemical Weapons Convention, requires protection of the health and safety of United Nations inspection teams. To make verification inspections safer, Argonne is developing a novel field-portable monitor for the selective determination of volatile organoarsenical agents at trace levels in ambient air.

The Laboratory is also assisting the Technology Applications Directorate with emergency preparedness reviews at civilian and military facilities.

f. Defense Advanced Research Projects Agency

For the Defense Advanced Research Projects Agency, Argonne is developing efficient algorithms and software for the symmetric and unsymmetric eigenvalue problem. In another project, the Laboratory is developing

oligonucleotide microchip detectors that will detect and identify microbes; genes that code for protein toxins; and specific protein and chemical toxins.

Because of the success of its Logistics and Mobility Modeling Program, Argonne has been selected as lead agency for simulations in the Advanced Logistics Program. The simulation area — a distinctive Argonne competency that includes advanced simulation, visualization tools, and algorithms for parallel computation; automated reasoning; and object-oriented databases — contributes significantly to the Advanced Logistics Program. Of particular interest are several high-fidelity simulations of transportation and logistics processes that Argonne has developed over the last decade. Argonne plans to integrate these simulations into a new type of hybrid modeling system that combines simulation and scheduling technology with real-time data feeds on the locations and status of various items. The result will be a unique view of the past, present, and projected states of readiness in the logistics support infrastructure.

3. Other Federal Agencies

a. Environmental Protection Agency

For the Environmental Protection Agency (EPA), Argonne will continue to assess the economic and environmental effects of regulatory initiatives under the Clean Air Act. Emphasis is on issues related to the regulation of fine particulates, ozone, short-term sulfur dioxide standards, and hazardous air pollutants and on implementation of acid rain controls.

To develop algorithms for use in the EPA's next generation of numerical models of atmospheric pollution, Argonne is studying the dry air-surface exchange of nitrogen oxides, sulfur dioxide, submicron particles, and other substances. The Laboratory also is conducting field studies on surface emissions of nitric oxide and, on the basis of field observations and numerical modeling, is developing parameterizations for several atmospheric substances.

Argonne researchers continue to work with the EPA to develop risk models for health effects attributable to human exposure to criteria pollutants. Recently completed were models relating ozone exposures to the formation of lesions in the human lung, decreased lung function, and symptoms such as coughing and chest pain. When necessary, Argonne uses probability encoding to quantify the judgments of health experts about the occurrence of health effects at subclinical exposure levels — levels at which few scientific data exist. These models allow the EPA to evaluate, for example, alternative standards for criteria pollutants in the face of incomplete, but telling, information. Another current project is developing tools to analyze data on hazardous and toxic substances found at sites designated for cleanup under the Superfund Authorization and Recovery Act. Displaying the data to highlight geographic aspects is a particular interest.

Through the Environmental Technology Initiative, jointly funded by DOE and EPA, Argonne is identifying and evaluating regulatory prototypes for the petroleum refining industry.

Argonne is providing analytical support to the Global Change Division regarding industrial technologies and new policies that may mitigate emission of greenhouse gases. The Laboratory is studying industrial cogeneration and other technology options and analyzing scenarios involving high industrial energy efficiency, by using the National Energy Modeling System and the Argonne Multisector Industry Growth Assessment Model.

The EPA is providing funding for the Pacific Basin Consortium for Hazardous Waste Research and Management, of which Argonne is a founding member. The Consortium's activities currently include conferences and exchange of information on hazardous waste problems.

To allow EPA Region V to achieve its legislatively mandated obligations for reporting and data dissemination, Argonne will evaluate the existing Superfund database management system and apply its knowledge of Superfund activities and procedures to develop an improved system.

Also for EPA, Argonne is parallelizing weather models to be used in studies of general climate models.

For the EPA's Great Lakes National Program Office, the Laboratory is analyzing 12 years of water quality data obtained via annual monitoring of the Great Lakes. Argonne will evaluate the sampling network used in the monitoring program and will interpret the results.

b. Federal Emergency Management Agency

Argonne's support to the Federal Emergency Management Agency involves three major areas relating to radiological and hazardous materials: (1) analysis and evaluation of the capabilities of U.S. industry, nearby communities, and host states to respond to emergencies involving the materials; (2) R&D on guidance for emergency planning, exercises to test emergency plans, and response activities; and (3) the development and conduct of training activities in support of area 2.

c. Department of State and International Atomic Energy Agency

Since 1976 Argonne has been the host institution for U.S. participation in the training activities of the International Atomic Energy Agency (IAEA). Argonne staff serve as instructors for more than 75 courses, covering topics such as radiation protection, environmental monitoring, nuclear safety, and energy and environmental analysis. Training is conducted for 25-28 weeks each year.

The IAEA, along with the State Department, has supported Argonne's development of analysis tools for decision making on energy and the environment. These tools are distributed to the ministries for energy and electric utilities in IAEA member states. In addition, Argonne staff participate in IAEA missions providing technical assistance in the recipient countries. Activities include training local experts to use the decision analysis tools developed at the Laboratory.

d. Health and Human Services

The National Institutes of Health support a broad range of fundamental studies at Argonne. These investigations generally apply techniques developed in DOE-supported programs to studies in biophysics, carcinogenesis, mutagenesis, and physiology.

The majority of these studies emphasize structure-function relationships or mechanisms underlying biological responses. One project focuses on the identification and characterization of genes that are induced in cultured cells following exposure to 60-hertz electromagnetic fields and other stress-inducing agents. The objective is to determine the mechanisms for inducing specific genes. A related project isolates genes induced by ultraviolet light and studies their expression patterns. This research complements DOE studies on target genes and the mechanisms of radiation-induced damage. In another study aimed at identifying new genetic regulatory elements, the Laboratory is using two-dimensional electrophoresis to investigate changes in protein expression resulting from chemical exposures. A database of species-specific protein changes is being created.

Biophysical studies are addressing the properties of human antibody light chains that lead to pathologic deposition in myeloma. Investigations of *in vitro* aggregation of light chains consider their structure and pathologic characteristics. One study is investigating the role of metallothionein in the metabolism and toxicity of heavy metals such as cadmium. Another study is seeking to describe the mechanism by which cadmium causes bone loss. The study includes experiments designed to test the hypothesis that cadmium can act directly on bone cells or on their marrow cell precursors and that these effects are separate from the effects of cadmium on other organs.

The National Institutes of Health have also funded Argonne research to develop area detector technology for protein crystallography. This collaborative research project aims to develop area-sensitive electronic X-ray detectors employing amorphous silicon arrays to record diffraction data for protein crystallography. (The technology is based on the design of a charge-coupled device developed with funding from DOE's Office of Health and Environmental Research.)

e. Department of Transportation

For the Research and Special Projects Administration of the Department of Transportation and in conjunction with the Federal Emergency Management Agency, Argonne continues to support two interconnected nationwide electronic bulletin boards with 30,000 registered users. The purpose of the bulletin boards is to disseminate information on hazardous materials that is needed for emergency planning. Argonne is also preparing emergency planning and response guidance documents, developing and using related computer modeling systems, and creating and maintaining related computer information systems for hazardous materials transportation emergencies.

f. Department of Agriculture

As part of an ongoing program for the Commodity Credit Corporation of the U.S. Department of Agriculture (CCC/USDA), Argonne is supporting remediation of sites having contaminated groundwater and soil by integrating field sampling, groundwater modeling, and engineering cost analyses. The Laboratory is also evaluating sources of contamination in the soil and methods of treating groundwater. New cone penetrometer technologies are being assessed for potential contributions to the CCC/USDA's remediation requirements.

In other work for the USDA, the Laboratory is developing a decision support system to evaluate alternatives to certain pesticides under USDA review.

g. National Science Foundation

Argonne is a member of the Science and Technology Center for High-Temperature Superconductivity with the University of Illinois at Urbana-Champaign, Northwestern University, and the University of Chicago. The Center is sponsored by the National Science Foundation (NSF).

Argonne is the lead laboratory for teacher training supported by NSF, which is conducted at ten DOE national laboratories and involves teachers at the elementary and junior high levels. Teachers interact with scientists in their work environment and experience the research process firsthand, enhancing their understanding of science and their science teaching.

With Rice University and several other universities and national laboratories, Argonne participates as a partner in the NSF-sponsored Science and Technology Center for Research on Parallel Computation.

The Laboratory participates in a joint NSF-NOAA (National Oceanic and Atmospheric Administration) project examining the importance of episodic events for coastal processes in the Great Lakes. Argonne's roles in the five-year program include making *in situ* measurements of physical conditions within one meter of the lake bottom and determining very low concentrations of radioactive tracers in lake sediments.

h. National Aeronautics and Space Administration

For the National Aeronautics and Space Administration, Argonne is investigating the use of automated differentiation techniques to provide reliable, fast derivatives for large-scale FORTRAN programs.

Argonne is collaborating with NOAA's Great Lakes Environmental Research Laboratory and Ohio State University to develop algorithms for interpreting multispectral satellite observations of the Great Lakes. This work involves field studies of the Great Lakes' optical properties and the development of specialized radiative transfer models appropriate for the optically complex waters typical of the Great Lakes.

4. Nonfederal Organizations

a. Electric Power Research Institute

Argonne conducts research for the Electric Power Research Institute (EPRI) on topics related to the risk of a severe accident at a nuclear power plant. Major experiments were conducted to measure the release of fission products in aerosol form when concrete is attacked by molten core

materials. Resulting data are now being analyzed. Argonne's current work on the Melt Attack and Coolability Experiment program is particularly timely. It investigates the ability of water to quench and cool a pool of molten core debris without formation of an insulating crust, thereby terminating an accident and preventing basemat penetration. This work has attracted worldwide attention because of its importance to strategies for managing accidents at existing plants and its great relevance to design decisions for future light-water reactors. These experiments are part of the 15-nation Advanced Containment Experiments program headed by EPRI, which pursues realistic understanding of the consequences of an accident involving core melting.

Complementary Argonne programs have directly measured the thermophysical properties of core debris and concrete and have addressed the ability of melted core materials to spread to a readily coolable configuration on concrete. Argonne programs for EPRI generally have the objective of resolving key safety issues through a combination of analysis and experiments. Recently developed computer codes (MELTSPREAD and CORQUENCH), based on data from these experimental programs, are being used to analyze accident phenomena. The nuclear industry is attempting to close unresolved issues with the U.S. Nuclear Regulatory Commission. The Laboratory's contributions are a key part of the work needed to meet that objective.

b. Gas Research Institute

Argonne is developing several programs with the Gas Research Institute (GRI) that involve the commercial development of a new corrosion probe, advanced techniques for geologic exploration, and research on cleaning up waste-water generated during natural gas production.

Argonne has also assisted GRI with the development of an Internet-based information system to disseminate R&D results.

c. Private Firms

Argonne is conducting research for a number of private firms, making use of its special facilities and technical resources. These firms include the Association of American Railroads, BDM International, Braidwood Nuclear Power Station, the Chicago Manufacturing Center, CMS Rotational Dynamics, Eichrom Industries, Genencor International, General Motors, Kaiser Foundation, the National Center for Manufacturing Sciences, 3M, and Solar Turbines.

For the health care provider Kaiser Permanente, Argonne is developing a system to simulate the company's operations in southern California. Investigation of the effects of changes in health care policies on the company's membership will incorporate analyses of diseases (contraction, progression, treatment, and outcome), health care decisions of individuals, treatment decisions of the medical community, policy decisions of regulatory agencies, and related aspects of health care. The simulation system ultimately will provide information on the combined consequences of clinical, financial, administrative, and policy decisions for the membership's health and the cost and quality of their health care, allowing Kaiser Permanente to make better decisions. The simulation system includes more than 100 models and modules and can be employed at different levels of detail. At the heart of the system is a unique Argonne framework for coordinating new and existing models that originated in DOE-sponsored work and continues to be developed for the Joint Staff of the Department of Defense (see Section II.C.2.c).

Argonne's work for private firms often grows out of industry-laboratory collaborative projects. A good example of a new Argonne facility growing in this direction is the Laser Applications Laboratory, which conducts R&D to support the use of high-power lasers in materials processing for manufacturing. Current work supports a number of CRADAs funded by the Energy Research-Laboratory Technology Research program and the Office of Transportation Technologies. Industrial partners include the Low Emissions Partnership of the U.S. Council on Automotive Research, Spawr Industries, Laser Mechanisms, and U.S. Laser. Processes being pursued include high-power beam shaping and delivery, fiber optics, surface modification, and welding. The Laser Applications Laboratory also does work in support of Argonne's major facilities and programs, such as the Advanced Photon Source, the Intense Pulsed Neutron Source, the

Fusion Power Program, and D&D of reactor systems.

d. State of Alabama

The Laboratory is initiating a series of studies for the Alabama Emergency Management Agency (AEMA) in support of six counties that adjoin a huge U.S. Army chemical stockpile, the Anniston Chemical Activity, which contains over 7% of the nation's unitary chemical-weapons agents. Construction of a high-temperature incinerator to destroy the stockpile is expected to begin soon. With support from the U.S. Army and the Federal Emergency Management Agency, AEMA is administering a program to enhance emergency preparedness against the risk of an accidental chemical release from continuing storage or the planned destruction of these chemical agents. Argonne's contribution will be to gather and analyze data on households in the area (constituting possibly the largest demographic survey ever undertaken in the United States outside the decennial census). AEMA and the six counties will use the information to assess how rapidly the population could evacuate in case of an accident and who might require special assistance. The agency can then develop state-of-the-art emergency plans providing maximum protection to the public.

e. University of Illinois

Argonne is a major participant in the NSF-sponsored Science and Technology Center for High-Temperature Superconductivity, with the University of Illinois at Urbana-Champaign, Northwestern University, and the University of Chicago. Research at the Center focuses on theory, synthesis and structure, bulk properties, and vortex phenomena. All of these areas of research are important to Argonne's work for DOE, which the Center complements extremely well. In the Center's educational activities, Laboratory personnel play key roles in all areas, particularly precollege and minority education. Argonne personnel also play key roles in linking the Center's basic research program to the needs of U.S. industry.

f. World Bank

Argonne is working with the World Bank and countries borrowing from the Bank on energy and environmental analyses addressing issues such as planning least-cost expansions for electrical generating systems, estimating marginal costs of electricity production, and simulating the operation of mixed hydrothermal systems. Argonne typically conducts these studies in close cooperation with system planners in the borrowing counties, who are often trained to use the analytical techniques themselves.

g. North Atlantic Treaty Organization

For the Science Committee of the North Atlantic Treaty Organization, Argonne organized a workshop on problems associated with decommissioning the Russian nuclear submarine fleet. The workshop was held in Moscow in June 1995, and the proceedings were published in 1996. A second workshop is planned for the fall of 1997.

h. Foreign Countries

Argonne scientists pioneered in developing the technology for niobium superconducting radio-frequency accelerating structures (resonators) used in heavy-ion nuclear accelerators. The Laboratory recently developed a new prototype cryogenic resonator for the Nuclear Science Centre in New Delhi, India, and is now fabricating the first group of accelerating structures by following that design.

The Laboratory is collaborating with Egypt's Cairo University to establish there a state-of-the-art Center for Environmental Hazard Mitigation. This five-year project will address Egyptian environmental problems such as urban encroachment onto the fertile lands of the Nile Delta, sea shoreline erosion, seismic hazards, and air and water pollution. Also being evaluated are the environmental impacts of the Salam Canal, the New Valley Project, and the origins of groundwater in the newly reclaimed lands in Egypt's western and eastern deserts.

Argonne works directly with many foreign countries to provide energy and environmental analyses along with training in the use of supporting computer models, including Argonne's ENergy and Power Evaluation Program (ENPEP). Recently negotiated is a project to provide technical assistance and energy and environmental analyses to the Turkish Electricity Generation-Transmission Corporation and the Turkish Ministry of Energy and Natural Resources.

D. Laboratory Directed R&D Program

The Laboratory Directed R&D (LDRD) program at Argonne funds creative and innovative R&D projects that advance science and technology in strategic areas of value to DOE and the nation but are insufficiently mature for support through normal programmatic channels. Selection is the responsibility of the laboratory director. The LDRD program maintains the scientific and technological vitality of the Laboratory and allows rapid response to emerging R&D opportunities. Ultimately, the LDRD program enhances Argonne's ability to pursue its missions.

As Table II.1 suggests, the tasks performed under most Laboratory research programs are determined directly by DOE or by other external sponsors. Except for a small collaborative research program between Argonne and the University of Chicago, the LDRD program is the only source of support that gives the Laboratory discretion to choose research projects to be pursued. This program is funded Laboratory-wide through Argonne's indirect budget.

Argonne's LDRD program has two major branches: (1) strategic initiatives and (2) the Director's Competitive Grants Program, which in FY 1998 consists of the Coordination Council for Science and Technology (CCST) awards and the Director's Individual Investigator Program. The laboratory director, in consultation with the Strategic Planning Council, determines the relative sizes of the categories of LDRD projects. Before the beginning of the fiscal year, the Laboratory proposes the maximum total size of the LDRD program to DOE for approval. Argonne's LDRD request for FY 1998 was $16.8 million, representing 3.5% of an earlier projection of FY 1998 budget authority (BA) for both the operating budget and the capital budget of the Laboratory. The amount actually budgeted was $14.2 million.

Strategic initiatives constitute the larger branch of Argonne's LDRD program. These projects emphasize R&D aligned with the Laboratory's strategic initiatives, as defined by the Strategic Planning Council and described in the *Institutional Plan*. The projects are selected by the laboratory director in close consultation with other members of the Laboratory's Strategic Planning Council. The initiatives for which FY 1998 LDRD proposals were sought are listed in Table II.18. (The laboratory director delegates responsibility for initial proposal review to the associate laboratory directors.)

The objective of the CCST award is to increase the extent to which Argonne's LDRD program includes projects that address the Council's technical goals by integrating both basic

Table II.18 Strategic Initiatives[a]

DOE Mission Area	Argonne Strategic Initiative
Science and Technology	APS Research Initiatives
	APS Beamlines
	Fourth Generation Light Source
	Exotic Beam Facility
	Mechanistic Biology
	Computational Science and Technology
	Linear Accelerator Upgrade
	ATLAS Detector at the LHC
	Fundamental Chemistry of Radioactive Waste
Energy Resources	Transportation Technology
	Nuclear Technology
	Industrial Energy Efficiency
Environmental Quality	Environmental Technology
	D&D Technology
	Atmospheric Observatory
National Security	International Cooperation in Safeguards and Nonproliferation

[a]This list of initiatives differs somewhat from that in Argonne's 1997 *Institutional Plan*, mainly because of the passage of several months from the early spring reporting date for that document.

and applied research capabilities. The CCST has encouraged more proposals for projects of that type. The Council rank-orders proposals received, which then are accepted according to the total funding made available. For FY 1998, the CCST broadened its criteria to include projects having multidisciplinary content that may or may not couple basic and applied components. The CCST is chaired jointly by Argonne's associate laboratory directors for physical research and for energy and environmental science and technology. Directors of several of the Laboratory's science and technology divisions are standing members. In addition, senior scientists and engineers are named to the Council on a rotating basis. For FY 1998, $1.2 million was allocated for eight CCST projects.

Within the LDRD program, the Director's Individual Investigator Program provides a direct avenue for single investigators to propose small, short-duration projects — generally up to $75,000 per year in funding — that otherwise might not compete effectively within the larger, strategically oriented part of the LDRD program. Selection of projects is by peer review through the Director's Review Committee, the chair and vice chair of which are appointed by the laboratory director. Committee members are nominated by the chair and vice chair and by associate laboratory directors. Final selection of members is again the responsibility of the laboratory director. For FY 1998, $1.2 million was allocated for 16 Individual Investigator projects.

All LDRD projects, whether chosen centrally or by decentralized delegation from the laboratory director, are explicitly selected according to the same criteria. Among the selection criteria, the most basic is scientific and technical excellence. Relatedness to Laboratory strategic goals is considered outside the Director's Individual Investigator component of the program. Other selection criteria are innovativeness, expected contributions from the results, and prospects for future support.

Argonne's LDRD program supports promising novel and innovative projects wherever they may appear across the broad spectrum of science and technology relevant to current or prospective Laboratory missions. However, certain scientific and technical areas within those missions tend to be emphasized, to allow the Laboratory to capitalize on the distribution of expertise among its staff. This emphasis also reflects a more focused attempt in recent years to further the Laboratory's long-range strategic plan by targeting particular areas of research where success could more sharply define the Laboratory's mission and strengthen its associated capabilities. The LDRD proposal guidance given to employees in FY 1998 more explicitly reflected this program objective.

The following areas of technical emphasis for Argonne's LDRD program are consistent with the Laboratory's missions and strategic view, as presented in its *Institutional Plan* and in other statements by Argonne management:

- Advanced Accelerator and Detector Technology
- X-Ray Techniques for Research in the Biological and Physical Sciences
- Nuclear Technology
- Materials Science and Technology
- Computational Science and Technology
- Biological Sciences
- Environmental Sciences
- Environmental Control and Waste Management Technology

In addition to the above areas of emphasis, Argonne categorizes some of its LDRD projects into a residual category of "Novel Concepts in Other Areas," a title that emphasizes the fact that the program supports novel research having the greatest scientific and technical merit, regardless of whether the research supports an emphasized area. Individual investigators and small research teams are encouraged to submit high-quality proposals without regard to their degree of relatedness to existing Laboratory programs.

Table II.19 describes FY 1998 LDRD expenditures by technical area of emphasis. Projects recommended by the CCST and projects funded in the Director's Individual Investigator Program cut across the technical areas in the table. Table II.19 also presents a projected distribution for FY 1999. (Ranges of expenditures are given because of intrinsic uncertainty in the selection of LDRD projects.)

Table II.19 Anticipated FY 1998 LDRD Expenditures by Technical Area of Emphasis

Scientific and Technical Area	LDRD Support Range (as percent of total) FY 1997 (Actual)	FY 1998 (Actual)	FY 1999 (Projected)
Advanced Accelerator and Detector Technology	14	23	13-17
X-Ray Techniques for Research in the Biological and Physical Sciences	8	9	6-9
Nuclear Technology	17	13	13-17
Materials Science and Technology	17	25	13-17
Computational Science and Technology	14	12	18-20
Biological Sciences	4	4	6-8
Environmental Sciences	8	5	8-11
Environmental Control and Waste Management Technology	12	6	7-9
Novel Concepts in Other Areas	6	3	2-6

Though the LDRD program is relatively small in terms of funding, it serves the vital roles of (1) supporting the Laboratory's mission and strategic initiatives, as described in the *Institutional Plan*; (2) enriching the Laboratory's technical capabilities; (3) encouraging innovation by technical staff; (4) reinforcing the Laboratory's R&D planning; and (5) exploiting the technical potential of the Laboratory for the benefit of the nation. LDRD projects normally are relatively small (i.e., roughly 0.5-2.0 scientific staff years per year of project activity) and generally fall into one or more of the following functional categories: (1) advanced study of hypotheses, concepts, or innovative approaches to scientific or technical problems; (2) experiments and analyses directed toward "proof of principle" or early determination of the utility of new scientific ideas, technical concepts, or devices; and (3) conception and preliminary technical analyses of experimental facilities or devices.

In addition, the program has the very important benefit of enhancing the morale and vitality of the Laboratory's scientific staff. Researchers' enthusiasm is nurtured by the knowledge that good new ideas, even if they appear tangential to existing programs, will be eligible for the immediate funding they need.

III. Operating Plan for Laboratory Operations

Operations infrastructure and support activities are crucial to the achievement of Argonne's missions. Operations organizations work as partners of the Laboratory's R&D programs, providing cost-effective, customer-focused infrastructure and services that enable the creation of world-class science, technology, and service products. Maintaining and continuously improving this institutional environment and support structure require effective and efficient accomplishment of the following major mission elements:

- Develop and manage programs for the recruitment, development, and support of the Laboratory's human resources
- Develop and manage programs to facilitate and support safety and health in the workplace
- Provide environmental stewardship of the Laboratory site
- Maintain and operate the Laboratory's physical plant; upgrade general plant facilities or construct new facilities as required
- Provide centralized administrative, business, and technical support to the Laboratory's science and technology programs

These institutional programs are the responsibility of Argonne's operations organization, hereafter referred to as OPS. The OPS organization is headed by the chief operations officer (COO), who is part of the Laboratory's senior management team and serves on the Laboratory Management Council and Executive Council. OPS functions through eight organizational units, each with its own executive leadership and staff. These units are, in turn, organized into functional departments or groups that have clearly defined missions and roles in support of Laboratory programs. Overall, the OPS organization currently employs approximately 1,250 FTEs, representing 32% of the Laboratory's total full-time regular workforce.

The general goals and strategies for OPS and for its organizational units form the framework for the "Operations and Infrastructure Strategic Plan" that was reported in Argonne's 1997 *Institutional Plan*. This chapter summarizes the OPS operating plan for FY 1998 that is linked to the Laboratory's strategic plan. It highlights initiatives that have near-term, strategic significance, and it will serve as a partial basis for assessing the progress of OPS toward meeting its strategic objectives in FY 1998.

A. Operations Overview

1. Overall Scope

The eight principal OPS organizational units perform all of the Laboratory's administrative, business, technical support, infrastructure, and operational support functions. The scope of these functions is as follows:

- *Human Resources:* Compensation, benefits, employee relations, employment and placement, performance development, medical services, diversity, temporary services, and security
- *Environment, Safety, and Health:* Health physics, industrial hygiene, safety engineering, fire protection, ES&H training, emergency management, emergency services, and nuclear and accelerator safety support
- *Environmental Management:* Environmental monitoring, environmental restoration projects, waste management, and waste prevention
- *Plant Facilities and Services:* Site and facilities planning and engineering, maintenance and crafts, site services, utility systems, and custodial services

- *Information and Publishing:* Management information systems support, technical communications support, media services, library services, and technical information services
- *Business and Financial Management:* Accounting, budget management, business systems support, travel, property and inventories, and procurement
- *Technical Support:* Electronics engineering, telecommunications services, computing and networking, and central shops
- *Communication and Outreach:* Internal communications, public information, community affairs, special events, and conference services

2. Resource Plan

Operations activities at Argonne are supported through three internal funding mechanisms. Activities that are not specific to particular research programs and have general benefit to the Laboratory are funded as an indirect tax on all programmatic funding that comes into the Laboratory. Approximately 44% of OPS is funded through this mechanism. Costs related to usage of physical space and the costs of health physics and special nuclear materials support are allocated through a second mechanism, direct allocation. In total, approximately 18% of OPS is funded by direct allocation. The remaining roughly 38% of OPS activities operate as service centers and derive their funding by charging for their products and services a unit price that fully recovers their costs. These centers are organized as small business service desks serving the demands of Laboratory research programs and of other support organizations.

Table III.1 describes OPS resource allocations for FY 1997 and FY 1998, which reflect a major budget reduction accomplished in anticipation of FY 1998 budget necessities that are indicated briefly here and discussed from a more global Laboratory perspective in Chapter IV. The overall OPS budget for FY 1998 is $119.1 million, a decrease of 11.1% from the FY 1997 budget. Most of the savings are being accomplished through staffing reductions, the majority made during the latter half of FY 1997, in anticipation of a continuing decline in programmatic revenues and continuing pressures to reduce overhead costs. The overall OPS staff level was reduced by 8.6% during the course of FY 1997, and it will be reduced by an additional 4.1% early in FY 1998.

Table III.1 OPS Resource Summary

	FY 1997	FY 1998	Change (%)
OPS Operating Budget ($ million)			
Indirect Centers	56.5	52.1	-7.8
Direct-Allocation Centers	22.9	21.5	-6.1
Service Centers	54.5	45.5	-16.5
Total	133.9	119.1	-11.1
OPS Budgeted Staff (FTEs)			
Indirect Centers	472	419	-11.2
Direct-Allocation Centers	372	337	-9.4
Service Centers	540	458	-15.2
Total	1,384	1,214	-12.3

The impact of budget and staffing reductions on the quality of OPS services is not expected to be major, although there is general concern about the timeliness and responsiveness of services and about diminished depth in key technical specialties. Impacts will be monitored closely to ascertain whether quality is being maintained at acceptable levels. Outside vendors will be used to complement in-house service centers more frequently and effectively in order to achieve greater cost-effectiveness.

3. Major Initiatives

The overall goal of the Laboratory's operations infrastructure and support functions is to provide, at the lowest possible cost, unique, high-value facilities and technical services to support science and technology programs, along with high-quality administrative, business, and operational services. Pursuit of this goal is guided by requirements established under the contract between DOE and the University of Chicago for management and operation of Argonne. Effective through September 1999, the current contract — hereafter referred to as the *Prime Contract* — is performance based and incorporates important incentives. A special provision of the *Prime*

Contract, Appendix B, provides for systematic measurement of the Laboratory's performance and identifies specific performance measures to be used in this process for each of the OPS functions. Discussions in this chapter identify significant linkages to these performance measures.

In support of the overall goal of the Laboratory's operations infrastructure and support functions, a range of strategies has been developed. During FY 1998 each OPS organizational unit will be working on key initiatives to implement these strategies. The initiatives are described in the eight sections of this chapter, in the context of the strategic goals and operating objectives that are being served. The remainder of this overview highlights selected OPS strategic initiatives for FY 1998.

Attracting, developing, and retaining world-class researchers and support personnel is a primary Laboratory goal. Argonne has launched strategic initiatives to improve performance-based appraisals of employees and associated compensation and benefits programs, to foster the further development of human resources, and to maintain a diverse workforce. The Laboratory is developing a new program to integrate employee performance evaluations with a performance-based compensation system. Employee interactions and feedback are being facilitated through new human resources information systems and a broad-based employee opinion survey that will inform management responses in FY 1998. Argonne's initiatives in human resource development and support are discussed further in Section III.B.

Effective environmental stewardship and safety and health management are overriding priorities for Argonne. The Laboratory is pursuing continuous improvement in these areas through organizational realignment, new policies and procedures, and enhanced training for operating personnel. Current strategies to increase the effectiveness of ES&H management and improve ES&H performance overall involve moving toward regulation of worker safety under the Occupational Safety and Health Administration (OSHA); strengthening implementation of the Integrated Safety Management program as part of the Laboratory's work processes; performing a chemical vulnerability assessment; and conducting a Laboratory-wide environmental management assessment to identify potential vulnerabilities that are not currently being addressed, including enhanced hydrogeologic modeling. Operations initiatives for safety and health support and for environmental management are discussed further in Sections III.C and III.D.

Continuing Laboratory goals are the efficient use and maintenance of an aging physical plant and the provision of efficient new physical structures to accommodate new programs or replace old buildings. Both removal of substandard and temporary buildings from service and modernization and life extension for programmatic buildings will continue. Laboratory utilities will be substantially upgraded. A new Argonne Information Center will begin operation. The Laboratory is developing strategies to purchase energy supplies at lower cost from vendors who are positioning their services to compete in a deregulated environment and is also developing strategies to adopt additional energy conservation measures. Argonne's plant and facilities initiatives are discussed further in Section III.E.

In FY 1998 Argonne will implement cost management and process reengineering initiatives across all its technical and business support service centers in order to improve their efficiency and cost-effectiveness. The travel function will be streamlined, and outside vendors will be used to improve the quality of services while reducing in-house costs. Service desks for small engineering projects and for information services will be established, making greater use of outside vendors where that is cost-effective. Sections III.F, III.G, and III.H discuss, respectively, Argonne's initiatives in (1) information and publishing; (2) business and financial management; and (3) electronics, computing, and central shops.

Argonne is implementing strategies to enhance openness, mutual understanding, and trust among the Laboratory, DOE, and their stakeholders. The Laboratory will implement a variety of initiatives to expand and strengthen existing communications and outreach programs. Greater involvement of neighbors and stakeholders will be achieved through an expanded visitor and tour program, a major open house event, and various programs centered around the new Argonne Information Center. Argonne's community and outreach initiatives are discussed in Section III.I.

B. Human Resources

1. Overall Scope

The quality of technical staff is a primary determinant of the performance of an R&D laboratory. The general goal of the human resource function is to develop and support exemplary programs that attract, develop, compensate, and retain the highest quality staff. Argonne's Human Resources (HR) Division works in partnership with the Laboratory's program and operations organizations to develop an understanding of their needs and to support their strategic objectives. The following ten departments within the HR Division perform the functions implied by their names: Compensation, Benefits, Employee Relations, Employment and Placement, Performance Development, Business Information Systems, the Medical Department, the Diversity Program, the Temporary Services Program, and Security.

2. Resource Plan

Staffing in the HR Division for FY 1998 consists of 44 employees (43.5 FTEs) in the HR core, 15 employees (14.5 FTEs) in the Medical Department, and 12 employees in Security. The FY 1998 budget is $3.8 million for HR core functions, $1.5 million for the Medical Department, and $0.9 million for Security. The staffing reduction in FY 1998 may result in slightly slower response times, elimination of some nonessential activities, and delays in completion of new projects and initiatives. Reductions in budgets for purchased materials and services are being implemented largely through increased efficiencies in document distribution (e.g., electronic versions of the *Policy and Procedure Manual* and the *Employee Handbook*) and decreased reliance on external support for information systems.

Table III.2 Human Resources Operating Budget and Staffing

	FY 1997	FY 1998
Budget ($ million)	6.9	6.2
Staffing (FTEs)	77.5	70.0

3. Major Initiatives

Strategic Goal: To link and integrate HR's goals and objectives with the strategic needs of the Laboratory.

- *Operating Objective:* Provide HR services that are responsive to the needs of divisional management.
  - *Initiative:* Hold an annual meeting of the employment manager, the diversity program manager, and division directors to discuss strategic staffing needs.
  - *Initiative:* At least annually, survey divisional management regarding HR-related issues.
  - *Initiative:* Offer the course for supervisors and managers on "Managing Employee Issues," which was developed late in FY 1997, to more divisions in FY 1998.
- *Operating Objective:* Better match training programs with the needs of individual divisions.
  - *Initiative:* With divisional input, undertake a comprehensive training needs analysis by September 1998.

Strategic Goal: To develop and maintain a competitive total compensation program that will attract, motivate, and retain a highly productive and creative workforce.

- *Operating Objective:* Develop a compensation structure that is competitive in the marketplace.
  - *Initiative:* Further examine the Laboratory's job pricing methodology for potential refinements. Complete by September 1998.
  - *Initiative:* Participate in a benchmarking survey to ascertain the value of Argonne's benefits package relative to those of other R&D organizations. Complete by March 1998.
- *Operating Objective:* Strengthen the pay-for-performance relationship at the Laboratory.

- *Initiative:* Provide linkage between pay and performance through the use of merit increase guide charts.

- *Initiative:* Offer performance management training to supervisors.

- *Initiative:* Measure the effectiveness of the pay-for-performance relationship.

Strategic Goal: To improve the timeliness and effectiveness of HR communications, information flows, and work processes.

• *Operating Objective:* Take advantage of new electronic technologies.

- *Initiative:* Streamline the job posting and job evaluation processes through development of an on-line database of position descriptions (a proposed FY 1998 *Prime Contract* performance measure). Complete by September 1998.

- *Initiative:* Develop an annual employee benefits statement providing individualized information about each employee's benefits and their value. Make available by September 1998.

• *Operating Objective:* Develop more effective means of communicating personnel policies (a proposed FY 1998 *Prime Contract* performance measure resulting from a 1996 survey conducted by the Laboratory's Office of Public Affairs).

- *Initiative:* Undertake a thorough review of current and potential communications media; use the results to adjust the current approach; conduct a follow-up survey in the last quarter of FY 1998 to confirm that targets for improved employee satisfaction have been met.

C. Environment, Safety, and Health

1. Overall Scope

The Environment, Safety, and Health (ESH) Division at Argonne-East supports other divisions, facilities, programs, and personnel in efforts to reduce risk at the work planning stage; to execute work safely; to identify, manage, and control hazards; to respond to emergencies; and to support satisfaction of environmental requirements through sampling and analysis. To minimize disruption of the Laboratory's work by safety, health, or environmental issues or mishaps, the ESH Division employs subject matter experts who are engaged by programmatic and operations personnel as fellow team members. ESH also develops and publishes the Argonne-East *Environment, Safety, and Health Manual.* The ESH Division is organized along the following functional lines: health physics, industrial hygiene, safety engineering, fire protection engineering, ES&H training, emergency management, emergency services (fire department), and nuclear and accelerator safety support.

2. Resource Plan

The ESH Division is funded by both the indirect- and direct-allocation processes. As Table III.3 shows, the division anticipates for FY 1998 a reduction in its authorized staffing level by approximately 17% and a corresponding 10% budget reduction. These reductions in staffing and budget allocation reflect reductions in demand from the division's customers, the stated service preferences of customers, and the identification of areas where it is appropriate to accept a somewhat higher degree of risk.

Table III.3 Environment, Safety, and Health Operating Budget and Staffing

	FY 1997	FY 1998
Budget ($ million)	12.9	11.6
Staffing (FTEs)	146.0	121.0

The division's personnel are a unique resource for Argonne-East, possessing knowledge, skills, experience, and perspectives found nowhere else at the site. ESH staff have the high-quality facilities and equipment needed to perform their technical support role. The division operates a fully equipped and self-contained emergency services (fire department) organization; it possesses, utilizes, and maintains all the equipment necessary for measuring and assessing

radiation exposure and for evaluating nonradiological workplace hazards; it operates analytical chemistry laboratories for measuring workplace and environmental samples; and it has available the equipment necessary for proper testing and repair of fire detection and suppression systems.

3. Major Initiatives

The ESH Division is integrated into Argonne-East operations. It continually evaluates the Laboratory's short-term, intermediate-term, and long-term goals and how it can best contribute to the attainment of those goals. Plans and initiatives for supporting six key strategic goals of the Laboratory are discussed below.

Strategic Goal: To reduce Argonne-East overhead costs.

- *Operating Objective:* Downsize and reengineer the ESH Division in a way that provides the optimal level of ES&H support services to minimize risks faced by programmatic and operations personnel and the general public.

  - *Initiative:* Execute the proposed plan for downsizing and reengineering the ESH Division, taking into account input from Argonne management while simultaneously providing perspective on possible associated risks and cost benefits. This initiative should be essentially completed early in the second quarter of FY 1998. Reorganization will involve some specialized training and retraining for ESH personnel.

Strategic Goal: To execute a smooth transition to external regulation by OSHA.

- *Operating Objective:* Ensure that the Argonne-East site is complying with OSHA regulations.

  - *Initiative:* Extract key information from ESH Division records on the status of Argonne-East facilities and training relative to OSHA requirements. Where regulations are unclear, provide interpretations and propose actions based on these interpretations — balancing risk and cost as appropriate to provide a strong and defensible course of action for Argonne-East. The initial effort will concentrate on life safety needs relevant to fire safety. Completion of a definitive needs assessment for compliance with OSHA life safety requirements is expected by the first quarter of FY 1998. Satisfaction of the needs assessment will begin during the second quarter of FY 1998 and will continue throughout the fiscal year. Signage and emergency exit lighting will be improved, and fire alarm systems will be upgraded. The ESH Division will work cooperatively with all stakeholders in this process to achieve consensus and arrive at a firm basis for action.

  - *Initiative:* During FY 1998, provide divisional ES&H coordinators and other interested personnel with additional training on recognition of OSHA deficiencies. In addition, educate and train personnel and management on the effects of the transition to OSHA regulation.

  - *Initiative:* Implement an enhanced system for recording ES&H needs and tracking corrective actions, tying together several existing specialized systems. The enhanced system will facilitate and improve prioritizations and other decision making by management for implementation of the corrective actions.

Strategic Goal: To approach zero impact on worker health from operations at Argonne-East.

- *Operating Objective:* Reduce risks to employees to levels that are as low as reasonably achievable, always maintaining awareness of the zero-impact ideal.

  - *Initiative:* In concert with the Medical Department, develop and implement a program plan for prevention of chronic beryllium disease, as directed by the Secretary of Energy. Completion of a draft plan is expected by the second quarter of FY 1998.

  - *Initiative:* Support the Chemical Vulnerability Assessment Program by providing assessment guidance and by participating in assessment walkthroughs and evaluations. These activities are

expected to continue through at least the third quarter of FY 1998.

- *Initiative:* Promote the "As Low as Reasonably Achievable" (ALARA) concept as a cornerstone of the Argonne-East radiological protection program, particularly as an active lead contributor to the site's ALARA committee process. Continue to play an active role in the radiological work planning process and in the generation of radiation work permits that are well conceived and effective. Continue to provide and enhance radiological worker training (e.g., "ALARA for Designers") by using alternate strategies when appropriate.

- *Initiative:* Reduce the numbers of accidents and injuries and associated workers compensation claims by (1) providing, in the *ESH Manual*, guidance on avoiding repetitive-stress injuries; (2) targeting the most prevalent of these types of ergonomic injuries, based on historical data; (3) raising employee awareness of the dangers through both broad communications and *in situ* communications; and (4) implementing a proactive workplace evaluation program. This initiative will continue throughout FY 1998 and beyond.

- *Initiative:* Provide electronic access to employee radiological exposure data, in order to facilitate better work planning and to identify potential worker exposure issues. Completion is expected by the end of FY 1998.

- *Initiative:* Provide wider access to worker exposure data by developing and maintaining client-server database systems accessible to Argonne divisions. Implementation of this initiative depends on funding provided through the Administrative Data Processing Oversight (ADPO) Committee process. Completion is expected by the end of CY 1998, with some further refinement during FY 1999.

Strategic Goal: To implement an active and effective ES&H self-assessment process.

• *Operating Objective:* Determine the status of the ES&H program at Argonne-East — both its strengths and weaknesses — through a self-assessment process that draws on internal and external resources as appropriate, thereby providing managers and decision makers with the information necessary to ensure compliance with the *Code of Federal Regulations* and DOE directives.

- *Initiative:* At the beginning of FY 1998, complete a formal self-assessment of integrated safety management at the Laboratory. Through the remainder of the year, improve safety practices where the self-assessment has identified opportunities.

- *Initiative:* Work with health physics customers to establish a process for conducting an assessment of the radiological protection program under *Federal Register* regulation 10 CFR 835. Provide lead assessors and other personnel to serve on assessment teams. Combine the results of this assessment with the results of other assessments of narrower scope to meet the DOE requirement for a triennial assessment. This activity is scheduled for the first three quarters of FY 1998.

- *Initiative:* For Argonne-East as a whole, assist in clarifying the ES&H assessment process and provide simple strategies for successful execution of the process, so that, in addition to satisfying assessment requirements, real program improvements result. This effort will continue throughout FY 1998.

Strategic Goal: To provide ES&H training with minimal disruption of employee work schedules.

• *Operating Objective:* Develop and use more flexible alternatives to classroom training, to provide required ES&H training with the greatest possible convenience and freedom from disruption for employees.

- *Initiative:* Accelerate the development of computer-based (including Web-based) ES&H training, and increase the number of required training and retraining courses available in that format. Distribute new courses to established computer-based training facilities requesting them, and make all such courses available to employees at the facility operated by the

ESH Division training group. This ongoing FY 1998 activity will be supported by an increase in designated funds.

- *Initiative:* Work with Laboratory divisions to improve attendance at regularly scheduled and special training sessions, to counter recent increases in "no shows."

Strategic Goal: To minimize the impact of emergencies at Argonne-East.

• *Operating Objective:* Identify measures to reduce the risk of business interruption, loss of assets, adverse effects on site occupants, damage to the environment, and unfavorable publicity as a consequence of emergencies.

- *Initiative:* Examine past emergencies to identify opportunities for improving Argonne's safety systems and emergency preparedness capabilities. Share lessons learned with emergency managers from other DOE sites and from other organizations. Make recommendations for improvement to management. These activities will continue throughout FY 1998.

D. Environmental Management

1. Overall Scope

Environmental Management Operations (EMO) provides support services to research and operations organizations at Argonne-East, to help ensure that all activities are conducted in accord with environmental regulations and in harmony with the environment. EMO consists of two departments: Environmental Protection (which includes environmental restoration) and Waste Management.

Environmental protection and restoration support services include conducting effluent monitoring and environmental surveillance, supporting environmental compliance, managing projects to improve pollution control facilities, managing voluntary remedial actions, managing the corrective measures program under the Resource Conservation and Recovery Act (RCRA), and supporting outreach stakeholders.

Waste management and related support services include operating and maintaining waste management activities for the site's nuclear facilities; collecting, treating, storing, and disposing of all nonsanitary wastes generated at the site; decontamination and demolition; asbestos abatement, decontamination, and related services; managing improvement projects for waste management facilities; coordinating waste minimization and pollution prevention programs; and managing specific waste minimization and pollution prevention projects.

2. Resource Plan

As Table III.4 shows, the FY 1998 budget for EMO is $15.8 million, and the planned staffing level is 88.5 FTEs. Two sources of funds support EMO. As overhead activities, EMO conducts the Argonne-East effluent monitoring and environmental surveillance program and coordinates and supports the site's environmental compliance program. Direct funding from DOE-Environmental Management and other Argonne-East programmatic divisions supports all other work.

Table III.4 Environmental Management Operations Budget and Staffing

	FY 1997	FY 1998
Overhead Budget and Staffing		
Budget ($ million)	1.5	1.3
Staffing (FTEs)	12.4	9.7
Programmatic Budget and Staffing		
Budget ($ million)	20.0	14.5
Staffing (FTEs)	91.1	78.8

As part of the Laboratory's efforts to reduce the cost of operations, staff assigned to coordinating the Argonne-East environmental compliance program and providing related support services have been reduced from 5.0 FTEs to 4.0. If integrated environmental management is effectively implemented by Laboratory programmatic and operating organizations, this reduction should not damage the Laboratory's ability to

ensure that operations are within regulatory requirements.

In addition, personnel assigned to conducting the site's effluent monitoring and environmental surveillance program have been reduced by 1.7 FTEs. The purpose of the monitoring and surveillance program is to provide analytical evidence that research programs and operations are being conducted within regulatory requirements and in harmony with the environment. Because the Laboratory has accumulated several years of data that document its compliance with regulations, these systematic reductions in monitoring and surveillance efforts should not weaken overall documentation of successful performance.

Reductions in FY 1998 funding from DOE program offices, as reflected in Table III.4, primarily reflect successful completion of upgrades to both pollution control and waste management facilities. As projects are completed, the number of FTEs needed naturally decreases. A portion of the funding reduction, however, results from a decision by DOE-Environmental Management, Office of Environmental Restoration (EM-40), not to support accelerated cleanup activities at Argonne-East.

3. Major Initiatives

Strategic Goal: To elevate existing environmental conditions to modern standards appropriate for the intended use of the land.

- *Operating Objective:* Execute the "Current-Year Work Plan" in the Argonne-East Remedial Actions Project (ERAP), as approved by EM-40.

  - *Initiative:* Prepare a revised project plan (including scope, cost, and schedule) by December 31, 1997.

Strategic Goal: To conduct all programmatic research and operations at Argonne-East in harmony with the environment.

- *Operating Objective:* Reduce environmental impacts to levels that are as low as reasonably achievable within the constraints of available resources, always maintaining an awareness of the zero-impact ideal.

  - *Initiative:* Prepare a proposed "Strategic Plan for Integrated Environmental Management at Argonne-East" by December 31, 1997.

  - *Initiative:* Fully implement the Argonne-East Environmental Compliance Assistance Tracking Tool (ECATT) database application by June 30, 1998.

- *Operating Objective:* Execute the "Current-Year Work Plan for Waste Management and Related Support Services," as approved by DOE-Environmental Management, Office of Waste Management (EM-30).

  - *Initiative:* Dispose of 20 contaminated steel tanks stored in the 317 area.

- *Operating Objective:* Coordinate execution of the "Current-Year Work Plan for Waste Minimization and Pollution Prevention," as approved by DOE-Environmental Management, Office of Site Operations (EM-70).

  - *Initiative:* By August 30, 1998, complete an assessment of four waste generation processes with regard to possible waste minimization alternatives.

Strategic Goal: To implement environmental enhancements beyond the requirements of regulatory compliance and general environmental protection.

- *Operating Objective:* Explore new ideas to improve environmental conditions, waste minimization and pollution prevention performance, and the effectiveness of support services.

  - *Initiative:* By August 30, 1998, prepare a proposal for development of a central database and records retention center for the Argonne-East Environmental Management System.

Strategic Goal: To embrace fully a stakeholder-centered culture.

- *Operating Objective:* Earn the trust of all stakeholders.

  - *Initiative:* Conduct a customer feedback survey.

- *Initiative:* Conduct an internal employee feedback survey.

- *Initiative:* Proactively support the Argonne-East stakeholder outreach program.

- *Initiative:* Continue proactively to develop rapport with contacts at regulatory agencies.

E. Site and Facilities Operations

1. Overall Scope

Argonne's Plant Facilities and Services (PFS) Division manages the following activities: site and facility planning and engineering; maintenance of facilities, roads, and grounds; site utility systems operations and maintenance, including steam generation and distribution, domestic and cooling water service, wastewater collection and treatment, and electrical power distribution; materials shipping and receiving; internal mail services; custodial services; site vehicle management; and management of contracts for operation of the child development center and the cafeteria. The PFS Division provides riggers, drivers, mechanics, craft laborers, and equipment operators in response to internal Laboratory requests and also labor-hour manpower for construction activities.

2. Resource Plan

As Table III.5 shows, the FY 1998 operating budget for the PFS Division represents a 14.9% reduction in FTEs relative to FY 1997 and a 12.6% reduction in funding (not including fixed costs associated with operation of utility systems). This decrease represents a continuation of efforts over the past few years to improve efficiency and reduce costs, through such actions as reorganizing to remove layers of management, improving operational processes and procedures, and outsourcing services to commercial providers when advantageous in terms of quality and cost.

Expected Multiprogram Energy Laboratories — Facilities Support (MEL-FS) funding for FY 1998 represents a 122% increase over FY 1997. General Plant Projects (GPP) and General Purpose Equipment (GPE) funding is expected to remain at FY 1997 levels.

By implementing the initiatives outlined below, the PFS Division expects to reduce its FY 1999 budget by another 5%.

Table III.5 Site and Facilities Operations Budget, Staffing, and Capital Funding

	FY 1997	FY 1998
Operating Budget and Staffing		
Budget ($ million)	39.8	36.0
Staffing (FTEs)	460.0	391.5
Capital Funding[a] ($ million)		
Multiprogram Energy Laboratories — Facilities Support (MEL-FS)	4.9	10.9
General Plant Projects (GPP)	4.8	4.8
General Purpose Equipment (GPE)	2.0	2.0
Total	11.7	17.7

[a]Capital funding for FY 1998 is based on program guidance available in October 1997.

3. Major Initiatives

Strategic Goal: To improve the effectiveness with which existing facilities are utilized.

- *Operating Objective:* Operate and maintain facilities in a reliable, efficient, and safe manner.

  - *Initiative:* Continue facility maintenance programs to ensure that Argonne-East assets are maintained in a reliable, safe, and environmentally benign manner, thereby preventing premature degradation of facilities and associated costs. (This initiative is linked to *Prime Contract* performance measures PF4 and PF6, where Argonne is expected to continue to earn performance ratings of outstanding.)

  - *Initiative:* Continue to assess the effectiveness and efficiency of facility maintenance operations at Argonne-East. Building Maintenance, Custodial Services, Grounds, and Vehicle Maintenance will continue to be benchmarked against outside

organizations, in order to improve service quality or reduce costs. Outsourcing will be emphasized when it is shown to be cost-effective.

- *Initiative:* Complete implementation of the new PFS Facility Information System (FIS), which is expected to improve planning, work control, and reporting and to reduce associated costs. The new FIS is scheduled to come on-line during January 1998 and to become fully operational by the end of August 1998.

• *Operating Objective:* Improve energy efficiency and reduce associated energy costs.

- *Initiative:* Enter into Energy Savings Performance (ESP) contracts for one or more energy conservation projects at Argonne-East. (Under ESP contracting, a recently authorized mechanism for funding energy conservation projects, a project is originally financed through a third party, who is then repaid via a regular stream of payments derived from the resulting energy cost savings.) The target for entering into the first ESP contract is December 1997. (This initiative is linked to *Prime Contract* performance measure PF7, where Argonne is expected to continue to earn a performance rating of outstanding.)

- *Initiative:* Upon approval from the DOE Argonne Group, begin implementation of recommendations from the Laboratory's Utility Options Study, which include negotiating rate reductions, simultaneously initiating a cogeneration implementation process (which may be terminated if sufficiently low rates are negotiated), and planning for opportunities created by deregulation of energy markets. (Federal statutes require that ESP and utility service contracts be held by DOE; however, the Laboratory performs all associated background technical and support work.)

• *Operating Objective:* Maximize the efficient utilization of Argonne-East facilities.

- *Initiative:* While working closely with the occupants of Laboratory space, continue to implement a strategic space consolidation wherein, to the extent practical and cost-effective, higher-quality space will be utilized more intensely. The space made available through this effort (the FY 1998 target is 50,000 square feet) will allow either a reduction in the amount of space leased off-site or demolition or mothballing of on-site space. (This initiative is linked to *Prime Contract* performance measure PF3, where Argonne is expected to continue to earn a performance rating of outstanding.)

Strategic Goal: To update strategic facilities and infrastructure.

• *Operating Objective:* Develop project concepts, plans, and funding requests for required rehabilitation and upgrades of Argonne-East facilities and infrastructure.

- *Initiative:* By August 1998, update the formal Argonne-East Condition Assessment Survey for all facilities not assessed since FY 1995. (Condition assessments are updated approximately every three years on a rotating basis, providing a credible, documented basis for identifying and prioritizing needed rehabilitations and upgrades. This initiative is linked to *Prime Contract* performance measure PF5, where Argonne is expected to continue to earn a performance rating of outstanding.)

- *Initiative:* Prioritize facilities and infrastructure needs for additional line-item capital funding under the MEL-FS program; develop project concepts and prepare conceptual designs and FY 2000 funding requests for consideration by DOE and Congress. The number and types of projects to be included will be based on MEL-FS program guidance and on the set of projects receiving congressional approval for FY 1999 funding. This initiative is scheduled for completion by April 1998.

- *Initiative:* Prioritize facilities and infrastructure needs for additional GPP and GPE capital funding, and prepare FY 2000 funding requests for consideration by DOE. This initiative is scheduled for completion by April 1998.

- *Operating Objective:* Implement facilities and infrastructure upgrades.

  - *Initiative:* Complete the Fire Safety Upgrades - Phase III line-item project and start the Electrical Distribution System Upgrade - Phase III line-item project. Continue implementation of two ongoing line-item projects, the Central Heating Plant Upgrade and the Building Electrical Service Upgrade - Phase I. Complete six of seven currently active GPP projects. Prioritize FY 1998 GPP needs, allocate funding to the highest priorities, and initiate projects. (The major milestones for these projects are documented in the project baselines. This initiative is linked to the *Prime Contract* performance measures PF1 and PF2, where Argonne is expected to continue to earn a performance rating of outstanding.)

  - *Initiative:* To identify GPE needs, solicit input from Argonne-East programmatic and support organizations. Prioritize needs and allocate FY 1998 funding by priority. This initiative is scheduled for completion by January 1998.

Strategic Goal: To eliminate substandard facilities.

- *Operating Objective:* Remove substandard surplus facilities from the inventory.

  - *Initiative:* Through an aggressive space management program, the PFS Division has already vacated some of the site's least efficient space, including older temporary facilities that are costly to maintain. During FY 1998 the division plans to remove approximately 35,000 gross square feet of space from inventory by demolishing eight obsolete buildings.

Strategic Goal: To increase customer satisfaction.

- *Operating Objective:* Improve small project performance.

  - *Initiative:* Establish a Small Projects Office (SPO) in the PFS Division Office to improve customer responsiveness and cost efficiency. Serving as the key customer interface to coordinate all small project work within PFS, this office will be responsible for establishing an agreement with each customer regarding project cost, scope, and schedule and will have the authority to determine project disposition (e.g., make or buy) by using a graded approach. The SPO will also serve as ombudsman for the customer. This initiative will be established in October 1997.

F. Information and Publishing Services

1. Overall Scope

The Information and Publishing Division (IPD) provides diverse services to enhance the value of information at Argonne-East by helping programmatic and support personnel find, use, and communicate information effectively via all media. The division is organized along functional lines. Through cost-recovery service centers, IPD offers its customers management information systems support; specialized writing, editing, and communication planning; and video production, graphic design, printing, photography, and document processing. With indirect funding, IPD operates the Argonne-East library system and the Laboratory's records management and publication clearance programs.

2. Resource Plan

The IPD budget and regular-employee staffing levels for FY 1998 are shown in Table III.6. (Indirect staffing includes the division office, whose costs are distributed between service center and indirect budgets.) The decline in service center staffing reflects actual experience through FY 1997, combined with forecasts of FY 1998 programmatic activity levels. The decline in indirect staffing reflects efficiency improvements and reductions in in-house service capacity.

The expertise of IPD staff encompasses systems analysis and programming, technical writing and editing, marketing communication,

library science, and the various graphic arts disciplines. In addition to these staff skills, the division operates equipment necessary to fulfill its support functions: a wide array of traditional and computer-based technology in the graphic arts disciplines, complemented by a variety of information management technologies. These resources are supplemented by use of commercial service providers when cost-effective.

Table III.6 Information and Publishing Services Operating Budget and Staffing

	FY 1997	FY 1998
Budget ($ million)		
Service Centers	9.1	8.3
Indirect	4.9	4.8
Total	14.0	13.1
Staffing (FTEs)		
Service Centers	105.8	94.6
Indirect	45.6	41.5
Total	151.4	136.1

3. Major Initiatives

The overarching goal of information management at Argonne-East is to maximize the ease and effectiveness with which information is acquired, created, modified, stored, retrieved, and applied, within the Laboratory and also beyond, with the Laboratory's partners in government, academia, and the private sector. The strategic goals, objectives, and initiatives for IPD described below flow from this primary goal. All initiatives listed are intended to be completed in FY 1998.

Strategic Goal: To provide cost-effective support functions that facilitate internal and external information exchange.

- *Operating Objective:* Continually improve work processes to reduce cost and cycle time for IPD products and services and to improve their quality and alignment with Argonne's mission.

  - *Initiative:* In IPD's service centers, implement a more formalized service desk function to (1) maintain a group of commercial providers to handle peak work loads and furnish job-based quotes for benchmarking; (2) direct incoming work to the in-house or commercial provider that can deliver the most appropriate mix of quality, price, and timeliness; and (3) improve internal job cost estimating and tracking.

  - *Initiative:* Benchmark Argonne's library services and costs against those of comparable organizations.

  - *Initiative:* In collaboration with R&D staff and management, evaluate and improve the process used to decide which journals and books to buy for the Argonne-East library system, within the constraints of each year's collection budget.

  - *Initiative:* Formalize software change management to ensure the efficiency of programming done by systems analysts in support of OPS client-server information systems. (This initiative will restore work processes that functioned in the earlier Argonne-East mainframe environment.)

  - *Initiative:* Initiate the collection and analysis of utilization and performance data for the UNIX servers that underlie OPS information systems, to create a baseline for planning efficient server use.

- *Operating Objective:* Develop new services as needed to support programmatic initiatives.

  - *Initiative:* Merge catalog records for Argonne-West library materials into the Laboratory's AIM (Argonne Information Management) System, to facilitate use of both collections by staff at both Argonne sites. Centralize purchasing and cataloging of library holdings at Argonne-East to achieve economies of scale. (Requested special funding for this initiative was not received; as of January 1998, planning is under way to rescope the initiative and locate other resources.)

  - *Initiative:* To improve technology transfer, expand IPD's current network of working relationships with editors of technical trade publications in order to encourage more frequent placement of IPD-authored

articles describing licensable Argonne inventions.

Strategic Goal: To apply emerging technologies to Argonne's information and publishing needs in a cost-effective way.

- *Operating Objective:* Replace paper-based and other traditional media and work processes with digital media and processes.

  - *Initiative:* Implement a Web-based system for electronic review and clearance of R&D publications to replace today's paper-intensive process.

  - *Initiative:* Create a searchable, Web-based inventory of all Laboratory business forms, with pointers to forms embedded in business information systems and with downloadable word processing templates of all other forms, in order to eliminate physical inventories of preprinted forms. (Completion depends on receipt of funding through the ADPO Committee, which was undetermined as of January 1998.)

  - *Initiative:* Increase IPD's use of digital photography technology.

- *Operating Objective:* Introduce new services and products as enabled by technological advances.

  - *Initiative:* For digital library products and services introduced in FY 1997, evaluate usage levels and other measures of customer satisfaction to determine whether continuation or modification is appropriate. (These products and services include the Web-based *Ask a Librarian* service, access to electronic journals, and a directory of Web information resources that supplement the Laboratory's library collection.)

Strategic Goal: To maintain strong core competencies in emerging information technologies.

- *Operating Objective:* Plan and implement training programs to develop and maintain IPD staff expertise.

  - *Initiative:* Formally identify the key software technologies — such as databases, work flow software, Web and GUI (graphical user interface) tools, operating systems, and application packages — likely to be used in OPS information systems through the year 2000, and determine which IPD systems analysts should be expert in which technologies to enable the necessary breadth and depth of support. Use this mapping to implement an improved professional development program for IPD analysts.

  - *Initiative:* For IPD's librarians and publishing staff, provide further training in the technical and communication principles used in developing effective computer-based training programs and Web-based information resources.

Strategic Goal: To upgrade the computer skills of Laboratory employees through education and outreach.

- *Operating Objective:* Teach employees outside IPD how to use the self-service computer-based tools that the division provides.

  - *Initiative:* For new information retrieval tools introduced by the library system, conduct group and individual training to enable R&D staff members to use the tools effectively.

G. Business and Financial Management

1. Overall Scope

The Office of the Chief Financial Officer (OCF) is responsible for determining the Laboratory's financial policies and practices and for ensuring the adequacy and integrity of its financial structure, processes, and records. The chief financial officer is the Laboratory's internal controls officer, responsible for establishing the overall internal control systems necessary for protection and management of all assets (other than the guard force for physical security), and for ensuring acceptable financial performance in accord with the provisions of the *Prime Contract.* OCF supports management decision making by the laboratory director, R&D programs, and support organizations. OCF also supports the

Laboratory's optimization of financial status and performance and provides independent interpretation and advice. In addition, OCF (1) manages the acquisition, disbursement, records, and protection (other than guard force physical security) of the Laboratory's non-real property, special materials, precious metals, and inventory assets; (2) manages the processes for acquisition of all products and services required for the conduct of Laboratory business and the sale of Laboratory services; and (3) executes all necessary business arrangements and commitments attendant to these functions under authority delegated by the University of Chicago. In addition, the responsibilities of OCF include the Laboratory's travel-related services and administrative functions.

All but one of the functional organizations within OCF are indirectly funded: Accounting, Business Systems and Support, Budget Management, Procurement, Property and Inventories Management, Travel, and the chief financial officer's office. The Special Materials organization is funded by direct allocation. The chief financial officer is part of the Laboratory's senior management team, serving on the Laboratory's Management Council, Executive Council, and Strategic Planning Council.

2. Resource Plan

As Table III.7 shows, the overall OCF budget for FY 1998 is 8.2% less than in FY 1997. This balanced reduction is associated with a 7.2% decrease in FTE levels. Budget figures in Table III.7 for indirect centers reflect the anticipated consequences of outsourcing the Travel function, which is currently in the final stages of proposal evaluation. A budget for the "reservations" function within Travel is included as a placeholder, rather than a real estimate. Complete outsourcing of the reservation function in FY 1998 is expected to cost about the same as providing the service internally, but outsourcing will reduce the associated Laboratory staffing level to zero. Anticipated reductions in in-house costs and staffing associated with other aspects of Travel — such as cash advances, expense reports, and audits — also are reflected in Table III.7. However, the cost of purchasing software to implement fully the envisioned outsourcing of Travel is not included in the FY 1998 budget numbers, pending the required procurement process, including final negotiation.

Table III.7 Business and Financial Management Operating Budget and Staffing

	FY 1997	FY 1998
Budget ($ million)		
Indirect Centers	12.3	11.3
Direct-Allocation Centers	0.54	0.49
Total	12.8	11.7
Staffing (FTEs)		
Indirect Centers	146.4	135.4
Direct-Allocation Centers	5.5	5.4
Total	151.9	140.9

The FY 1998 budgets in Table III.7 reflect the substantial work already accomplished in OCF in recent years to streamline, reengineer, automate, delayer, and size the organization to meet core demand levels. Some of the actions planned for FY 1998 must be phased over the fiscal year, so their full effect will not be seen until FY 1999.

3. Major Initiatives

Strategic Goal: To improve business and operational practices.

- *Operating Objective:* Provide Laboratory-wide business systems to accomplish work efficiently.

  - *Initiative:* Implement a new travel system, including authorization, optional electronic reservation and ticketing, and electronic expense reporting and processing. Complete in the third quarter of FY 1998 or according to the time frame required by the travel vendor selected.

  - *Initiative:* Implement a new Procurement and Requisition Integrated System (PARIS; a commercial, off-the-shelf procurement database and operation system). The timetable depends on performance by the vendor selected to provide PARIS, but

implementation is expected in the third quarter of FY 1998.

Strategic Goal: To enhance performance measurement.

- *Operating Objective:* Take the next step in self-assessment for the Laboratory's procurement function, in anticipation of an edict from DOE requiring such self-assessment by all its management and operating contractors.

  - *Initiative:* Incorporate the Balanced Scorecard Concept (BSC) for Argonne's Procurement Department in FY 1998 (as a replacement for the current Argonne Procurement Self-Assessment, which earlier replaced the Contractor Purchasing System Review). Use the Center for Advanced Purchasing Studies, information from the DOE complex, or historical Laboratory data to establish core measures for the primary BSC perspectives regarding the "Financial," "Customer Satisfaction," "Internal Business," and "Learning and Growth" areas. Complete during the first half of FY 1998.

Strategic Goal: To improve the overall quality of Argonne's budget systems and practices.

- *Operating Objective:* Enhance the Fiscal Year Budget System (FYBS) to take into account the specific budget requirements of both the indirect and direct-allocation cost centers, as well as programmatic divisions.

  - *Initiative:* Standardize the way nondirect centers model and submit budget information to OCF. Make a wide variety of new reporting and surveillance options available to Laboratory management and divisions.

Strategic Goal: To improve the quality and reliability of budget data and reduce the redundancy of budget modeling by divisions.

- *Operating Objective:* Enhance FYBS to provide for budget planning at levels of detail below the budget category level.

  - *Initiative:* Enhance FYBS to allow users to "drill down" into current budget category levels and to plan in detail — by cost account, person, group, etc. — a type of planning currently possible in private user systems. (This enhancement will satisfy users' preference to perform budgeting in one system rather than entering data twice.)

Strategic Goal: To make OCF operations as effective and cost-efficient as possible.

- *Operating Objective:* Improve operations and procedures for management of non-real property.

  - *Initiative:* At both Argonne sites, complete the value-based self-assessment of the Property Management function and implement suggested improvements that will result in a function that is more cost-effective, trains its staff better, and is more fully developed. (Recommended improvements include better communication between DOE and Argonne, inventory requirements that are less labor intensive, additional training opportunities, and improved user access to excess property.)

H. Technical Support

1. Overall Scope

High-quality technical support is essential to the effective production of Argonne's research. The Electronics and Computing Technologies (ECT) Division is responsible for the development and operations of Laboratory-wide technical services in the areas of engineering, manufacturing, networking and computing, and telecommunications. Products and services provided include computer networks, computing services, communication systems, electronic engineering and fabrication, specialty welding, and metal fabrication.

2. Resource Plan

The ECT Division is primarily a service organization that is operated and staffed in accordance with the Laboratory's guidelines for full-cost-recovery centers. Operating costs and staffing levels for FY 1998 are shown in Table III.8. The 10% reduction in budgeted costs

and the 13% reduction in staffing relative to FY 1997 reflect a combination of anticipated declines in the demand for services and the containment of costs for purchased materials and services. The impact of these reductions will be monitored closely to ascertain whether the quality and timeliness of technical services and the core competencies of the highly specialized technical workforce are being maintained.

Table III.8 Technical Support Operating Budget and Staffing

	FY 1997	FY 1998[a]
Budget ($ million)	24.5	22.0
Staffing (FTEs)	214.0	187.0

[a]Includes the addition of information resources management and training functions.

3. Major Initiatives

The goals and initiatives outlined below address the overall goal of providing unique, high-value technical services that support science and technology programs at the lowest possible cost.

Strategic Goal: To supply effective support for organizations outside Argonne, in order to stay at the state of the art and exploit the Laboratory's special capabilities more extensively for the benefit of the nation.

- *Operating Objective:* Increase the level of work funded from outside the Laboratory to $1.6 million during FY 1998, by cultivating relationships with potential external customers.

  - *Initiative:* To improve funding prospects, work with government agencies such as DOE and the National Science Foundation and with other national laboratories to identify opportunities to provide services in the areas of computing, electronics, and manufacturing.

  - *Initiative:* At the Advanced Photon Source, work with collaborative access teams and private industry to improve funding prospects. Explore potential collaborations in the areas of computing, electronics, and manufacturing.

Strategic Goal: To provide cost-effective, responsive technical support services for strategic Laboratory missions and programs.

- *Operating Objective:* Improve customer services.

  - *Initiative:* Improve cost efficiencies through standardization, via activities such as creating and maintaining lists of hardware and software recommended by ECT and submitting more recommendations to the Computing and Information Policy Committee for approval and endorsement. A benchmarking study of telecommunications costs will be completed by the end of December 1997.

  - *Initiative:* Improve information to customers by, for example, providing simpler customer access to services and technical staff across the division. ECT is working toward maintaining customer service representatives with broad knowledge of the division's services.

  - *Initiative:* Implement a trouble-ticket system to facilitate the tracking and analysis of problems in Argonne's distributed computing environment. Implementation of a new system is to be completed by October 1998.

  - *Initiative:* Sponsor a total-cost-of-ownership study for the OPS computing environment. Benchmark against peer institutions to identify opportunities for cost containment.

  - *Initiative:* Perform make-or-buy analyses for services including fabrication, telecommunications and networking wiring, and pager systems.

Strategic Goal: To maintain the Laboratory's digital infrastructure at the state of the art.

- *Operating Objective:* Continue the evolution of the Laboratory's computing and communications infrastructure to be best in class among peer research institutions.

  - *Initiative:* Leverage the Laboratory's expertise in applications and in integration

with its commercial service and equipment provider. Continue to aggressively pilot test advanced technologies — including gigabit Ethernet, Ipv6, virtual networks, zero-administration desktops, and network computers — to assess their potential for improving the Laboratory's computing and communications infrastructure.

I. Communication and Outreach

1. Overall Scope

Argonne's Office of Public Affairs (OPA) manages the Laboratory's communications and outreach to the local and national news media, to local political and community leaders, to neighboring homeowners, to Argonne employees and families, and to the general public. Other OPA activities include a wide variety of internal communications programs, including employee newsletters, sitewide electronic mail broadcasts, an "Argonne Topics" seminar series, a telephone information line, and employee-oriented World Wide Web pages. An annual highlight is the "State of the Laboratory" address by the laboratory director. External communications and outreach programs include news media relations, Web pages, the publication and distribution of public information documents, community affairs events and activities, operation of a public information center, site tours and open houses, other special events, presentations to external audiences, and conference planning and management. OPA's strategic operating plan, designed to enhance both internal and external communications in FY 1998, is outlined below.

2. Resource Plan

As Table III.9 shows, OPA's FY 1998 operating budget is essentially the same as that for FY 1997. A reduction of 1.0 FTE will be achieved by moving the office's budgeting and administrative functions to the Office of the Chief Operations Officer. Funding of the conference services function is being shifted from an indirect account to full cost recovery, implying a potential saving of $156,000 from the Laboratory's indirect budget. Other OPA resources include volunteer docents who are currently being recruited to help staff the Argonne Information Center.

Table III.9 Communications and Outreach Operating Budget and Staffing

	FY 1997	FY 1998
Budget ($ million)	$1.71	$1.71
Staffing (FTEs)	18.5	17.5

3. Major Initiatives

Strategic Goal: To enhance public, government, and industry perceptions of the Laboratory's value. The Laboratory will expand and strengthen its communications and outreach programs in FY 1998 to significantly increase knowledge and appreciation of Argonne's strengths and value among its key constituencies.

- *Operating Objective:* Secure greater coverage of Argonne's research initiatives, findings, and accomplishments in the national, regional, and local news media.

  - *Initiative:* Increase the production and placement of news releases and articles highlighting Argonne's scientific research strengths and accomplishments, particularly in the national and general science news media. The goal in FY 1998 is issuance of at least 80 news releases during the reporting period (a *Prime Contract* performance measure) and placement of at least 12 significant articles about Argonne in the national (general and science-oriented) news media. As always, OPA will work to ensure that reporters are aware of DOE's role in funding Laboratory activities.

- *Operating Objective:* Enhance Argonne's visibility and reputation through strengthening and promotion of the Laboratory's organizational image.

  - *Initiative:* Design and prepare an "Argonne Organizational Image and Identification Plan" to raise public

appreciation of the Argonne name. A draft plan, modeled on industry standards, will be submitted to Laboratory management by January 1998. It will specify the form and manner in which the Argonne name and logo are to be used by all Laboratory program offices.

Strategic Goal: To constructively involve Argonne's neighboring constituents and stakeholders in the work of the Laboratory and DOE. In conjunction with DOE's Chicago Operations Office and the Argonne Group, continue to work closely with interested groups and individuals to build and maintain trust and promote local stakeholder involvement.

- *Operating Objective:* Continue participation by top management in the Community Leaders Round Table (a *Prime Contract* performance measure) and other community outreach efforts. (The Round Table, established by Argonne and DOE in FY 1997, provides a forum for informing community leaders about Argonne-East activities and their expected impacts on surrounding communities, as well as for eliciting informal comment and advice from community representatives.)

  - *Initiative:* By December 1997, develop, for discussion between DOE and Laboratory management, a proposal for a community involvement action plan to promote information exchange and public participation in the work of the Laboratory (a *Prime Contract* performance measure).

- *Operating Objective:* Provide additional avenues and opportunities for Argonne's neighbors to learn about the Laboratory's programs and activities.

  - *Initiative:* Open the Argonne Information Center to the public in October 1997, and widely publicize the Center throughout FY 1998 to encourage visits by teachers, students, businesses, interest groups, and members of the public (a *Prime Contract* performance measure).

  - *Initiative:* Beginning in November 1998, expand the Laboratory's visitor and tour program to include targeted constituent and interest groups who could visit the Laboratory for half-day briefings, demonstrations, and tours (a *Prime Contract* performance measure).

  - *Initiative:* Hold an open house at Argonne-East in May 1998 (a *Prime Contract* performance measure) and annually thereafter.

Strategic Goal: To align Argonne management goals and employee attitudes and behavior to further employee empowerment and productivity. To keep Argonne's mission, goals, and values in alignment with those of the Laboratory's employees, OPA will increase its efforts to inform both management and employees about activities and forces that affect them.

- *Operating Objective:* Improve Argonne's internal communications by enhancing employees' knowledge of the mission, goals, and activities of DOE and the Laboratory and by providing opportunities for employees to comment, make suggestions, and generally participate in the success and growth of the Laboratory.

  - *Initiative:* By November 1997, develop and begin to implement an action plan to improve Argonne's internal communications, based on needs identified in the 1996 internal communications survey and the 1997 all-employee survey (a *Prime Contract* performance measure).

  - *Initiative:* Develop an Argonne intranet and make it available to employees by December 1997. This new "ArgonNet" will better integrate Web pages of particular interest to employees and will enhance existing Web sites to provide easier access to information and services that employees need to do their jobs.

IV. Financial Operating Plan

This concluding chapter analyzes Argonne's overall funding situation, aggregating over all of the Laboratory sponsors and programs described in Chapter II. The focus of attention is on a recent imbalance between budget authorization (BA) and budget obligation (BO) that has emerged as DOE's national laboratories have experienced a period of shrinking total resources. Argonne is moving aggressively to meet this challenge by pursuing strategies that recognize the central role of the Laboratory's scientists and engineers and ultimately serve the sponsors of their research.

As indicated in Table IV.1, Argonne's BA funding from DOE declined steadily during FY 1995-FY 1997, from $389 million to $351 million. In response to guidance from DOE, the Laboratory supplemented this BA funding by drawing down its carryover reserve. This strategy moderated declines in actual expenditures (BO). However, the Laboratory's carryover reserve has now declined to a point where planned actual expenditures in the Laboratory's operating budget for FY 1998 must be brought more in line with the BA funding that the Laboratory expects to receive for the year.

Argonne's plan for meeting this budgetary challenge has three major elements:

- Optimize the Laboratory's BA funding in FY 1998, with the minimum goal of halting the recent downward trend.
- Stabilize the Laboratory's direct programmatic workforce — that is, the people who directly perform scientific and technical work for the Laboratory's sponsors (a workforce that declined annually by about 6% in FY 1994-FY 1996).
- Balance the Laboratory's operating budget with its new BA funding through reduction of expenditures in areas other than the direct programmatic workforce — namely, expenditures on materials and services and on all support centers, including administration and operations overhead.

The foundation of this strategy for meeting Argonne's budgetary challenge is recognition that the Laboratory must maintain a strong, capable scientific and technical workforce in order to remain a world-class provider of high-quality science, technology, engineering, and technical services in its mission areas.

The remainder of this overview of Argonne's FY 1998 financial operating plan explains key elements in the implementation of the above strategy, particularly actions based on a detailed examination of outsourcing options that the Laboratory is undertaking. At the beginning of the fiscal year, prospects are good for success in all three components of the strategy. (All analysis in this chapter is in terms of the Laboratory as a whole; see Chapter II, "Operating Plan for Scientific and Technical Programs," for detailed projections of the FY 1998 BA funding that Argonne expects to receive from various DOE programs and other major sponsors, along with historical FY 1996-FY 1997 data for perspective.)

A. Implementation

The forecasts in Table IV.1 predict that Argonne's total BA funding in FY 1998 will be stabilized at approximately $457 million, essentially equal to the actual FY 1997 BA level. In addition to reflecting positively on the ability of the Laboratory's scientific and technical programs to maintain their income, this stabilization of BA funding accomplishes about half of the Laboratory's challenge to stabilize its carryover funds. The rest of the solution is reflected in Table IV.2. The FY 1998 budgets for both (1) overhead for administration and operations and (2) expenditures by service centers are being reduced by about 10%. As discussed in Chapter III, support divisions were asked to submit plans for reducing their budgets for the year by 12%. In addition, programmatic divisions are significantly reducing their purchases of materials and services and their divisional overhead expenses.

Table IV.1 Laboratory Funding: Budget Authorization and Obligation
(BA and BO, $ million)

	Actual						Estimate (at beginning of fiscal year)			
	FY 1995		FY 1996		FY 1997		FY 1997		FY 1998	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
DOE	389	405	368	387	351	357	351	374	353	361
Non-DOE Sponsors	90	88	96	89	106	103	96	97	104	107
Total	479	493	464	476	457	460	447	471	457	468

Table IV.2 Strategic FY 1998 BO Financial Plan Summary ($ million)

	FY 1996 (Actual)	FY 1997 (Estimate)	FY 1997 (Actual)	FY 1998 (Estimate)	Change (%) from FY 1997 Estimate
Programmatic Workforce Total	173.9	182.6	177.6	188.7	3.3
Programmatic Materials and Services	127.5	113.3	116.6	121.7	4.4
Total Program Expense	301.4	295.9	294.2	310.4	4.9
Total Support Expense	174.8	174.1	165.9	157.8	-9.4
Total BO Expense	476.2	470.0	460.1	468.2	-0.4

Budget plans for Argonne's divisions — both programmatic divisions and support divisions — are being reviewed by a newly established Overhead Budget Review Committee chaired by the laboratory director. Other members of the committee are the chief operations officer, the chief financial officer, the associate laboratory director for physical research, the director of plant facilities and services, and the director of reactor program services. The Committee's goal has been to budget significant reductions in support expenses without adversely affecting support capabilities.

B. Outsourcing

Argonne's financial strategy includes continual evaluation of the Laboratory's support services to see whether greater efficiency can be achieved by using outside contractors to provide more or different services. The Laboratory's general make-or-buy policy is to provide support services that meet or exceed customer expectations and to do so as efficiently as possible by optimizing the balance between internal and external providers. A key strategy for implementing this policy is the development for each support service of a central service desk that serves as a transparent point of contact for all customers and determines for each job whether an in-house or commercial provider is most cost-effective.

For FY 1998, attention has focused on eight support service areas. Seven are at Argonne-East: Travel, Emergency Services, Analytical Chemistry Laboratory, Central Shops, Media Services, Technical Communication Services, and Vehicle

Maintenance. At Argonne-West, custodial services are being studied. The core objective of these studies is to determine the best mix of support services to be performed in-house and to be purchased from outside, recognizing the need to cope with peak demand periods and to maintain favorable cost and quality of services at normal demand levels. Argonne's FY 1998 operating budget, as summarized in Table IV.2, reflects at least preliminary recommendations received by the Overhead Budget Review Committee. However, in many cases further analysis and decision making will continue into the fiscal year.

C. Employment

As suggested by Table IV.1 — allowing for cost escalation, which continues at a moderate pace — the number of regular Argonne employees (measured in full-time equivalents) declined by approximately 6.5% in both FY 1995 and FY 1996, corresponding to a loss of roughly 300 positions each year. In FY 1997, the decline was about 4.5% or 180 positions. A substantially smaller reduction in regular employment is expected during FY 1998: approximately 2% or 100 positions. (This reduction encompasses all causes, including retirements, resignations, and involuntary terminations.)