II. Mission, Roles, and Strategic Goals

Argonne National Laboratory is a major multiprogram laboratory managed and operated for the U.S. Department of Energy (DOE) by the University of Chicago under a performance-based contract.

A. Mission

Argonne's mission is to serve DOE and national security by advancing the frontiers of knowledge, by creating and operating forefront scientific user facilities, and by providing innovative and effective approaches and solutions to energy, environmental, and security challenges to national and global well-being, in the near and long term, as a contributing member of the DOE laboratory system.

We contribute significantly to DOE's mission in science, energy resources, environmental stewardship, and national security, with lead roles in the areas of science, operation of scientific facilities, and energy. In accomplishing our mission, we partner with DOE, other federal laboratories and agencies, the academic community, and the private sector.

B. Vision

Argonne ensures U.S. scientific and technological leadership by creating — in the national interest — new knowledge and technologies that enhance energy security, national security, economic productivity, and quality of life. The Laboratory is a full participant in the implementation of administration priorities set forth by the President's science advisor. In all its programs, Argonne is committed to managing its resources to maximize benefit to the taxpayer, with DOE's critical performance measures as its guide.

Argonne's leadership inspires cooperation to integrate the resources of other laboratories, agencies, and universities to solve the nation's most challenging problems. The Laboratory's scientific research supports every major DOE program. Our management approach is to focus the Laboratory's attention on research that has the greatest promise and highest potential impact for the coming decade. To maximize benefit to the nation, we create alliances with industry that expedite application of new discoveries and technological innovations.

Argonne is pursuing ten visionary *strategic goals* to deliver extraordinary science and technology with significant value to the nation:

1. Develop the technologies and infrastructure needed to produce, store, and distribute hydrogen fuel.

2. Close the nuclear fuel cycle, reducing the cost of nuclear waste disposal by billions of dollars and disposing of weapons-grade plutonium and actinides.

3. Develop advanced nuclear power technologies that are safe, economical, proliferation-resistant, and environmentally sustainable.

4. Plan, design, construct, and operate the Rare Isotope Accelerator (RIA) and make fundamental discoveries in nuclear physics and astrophysics.

5. Construct and operate the Center for Nanoscale Materials and create innovative materials with valuable commercial properties.

6. Lead the Genomes to Life team that focuses on protein production and related proteomics; implement computational biology to build fundamental understanding of living systems.

7. Realize the full potential of scientific simulation to solve mission-related problems, through leading-edge research on systems architecture and software, parallel programming and numerical tools, distributed computing, and computational science applications.

8. Establish a new associate laboratory directorate in national security to deliver technologies and analyses for the Department of Homeland Security, the Department of Defense, and the U.S. intelligence community.

9. Make major contributions to environmental research, taking full advantage of our state-of-the-art facilities and tools.

10. Optimize the operation of our national user facilities to perform research in fundamental science and other areas.

These strategic goals, explained more fully below, are consistent with priorities established in DOE's FY 2004 budget request.

Goal 1: Hydrogen Research and Development

Argonne will help develop the technologies and infrastructure needed to produce, store, and distribute hydrogen fuel for use in fuel cells, vehicles, and electricity generation. The Laboratory will continue to participate in the FreedomCar partnership, in order to accelerate the development of practical, affordable hydrogen cell vehicles. We will perform the engineering and reactor physics required to develop a nuclear plant that co-generates hydrogen and electricity. Argonne materials scientists are leading the national effort to develop breakthrough technologies for new hydrogen fuel cells and for hydrogen production, transport, and storage.

Goal 2: Advanced Nuclear Fuel Cycle

Argonne will develop advanced technologies to treat and transmute spent nuclear fuel. We will design and demonstrate a fast-burner reactor to close the nuclear fuel cycle. This approach will reduce the cost of nuclear waste disposal by billions of dollars, contribute to U.S. energy independence by recycling spent commercial nuclear fuel, and dispose of weapons-grade plutonium and actinides.

Goal 3: Nuclear Energy

Argonne will help develop advanced nuclear power technologies that are safe, economical, proliferation-resistant, and environmentally sustainable. We will help design and test the Next-Generation Nuclear Plant being contemplated by DOE. We will continue to support the fusion energy sciences with research in plasma and reactor physics and engineering.

Goal 4: Nuclear Physics and the Rare Isotope Accelerator

Argonne will build and operate RIA as a forefront user facility, thereby opening new frontiers for research in nuclear physics and astrophysics and extending the Laboratory's tradition of innovation, scientific leadership, and service to facility users. RIA will allow us to obtain critical scientific information about how heavy elements are created and how nuclear properties influence the stars; the properties of short-lived atomic nuclei near their limits of stability; and the nature of nuclear decay, reactions, and structure.

Goal 5: Nanoscience and Nanotechnology

Argonne will enable the rapid characterization of new materials required for the nanoscale revolution by co-locating multiple research disciplines and nanoscience instrumentation at two of its national user facilities: the Advanced Photon Source (APS) and the Intense Pulsed Neutron Source (IPNS). DOE has approved the mission need ("critical decision 0") and the preliminary baseline range ("critical decision 1") for Argonne's Center for Nanoscale Materials. Construction of this state-of-the-art user facility adjacent to the APS begins in 2003. The state of Illinois is funding the building, and DOE is funding the scientific equipment, including a world-class nanoprobe beamline at the APS.

Goal 6: Bioscience

Argonne will develop a proteomics user facility adjoining the APS, which serves as a world-class user facility for forefront research in structural biology and many other areas. We are planning for significant growth in research for DOE's Genomes to Life program. Argonne is the preferred site for a regional biocontainment laboratory that will conduct microbiology research to combat emerging infectious diseases and

reduce the threat from bioterrorism. This facility is being proposed to the National Institutes of Health by a consortium led by the University of Chicago.

Goal 7: Advanced Scientific Computing

Argonne will provide the high-performance computational and networking tools that are indispensable for scientific discovery. The Laboratory has had international impact through its leadership in the areas of Grid computing, scalable numerical tools, parallel computing, and advanced visualization. We are a major partner in the development of architectures, applications, software systems, and test beds for petaflops-scale computing. We will continue to support the Scientific Discovery through Advanced Computing program — a multidisciplinary effort involving teams of mathematicians, computer scientists, and application area scientists in the development of a new set of scientific simulation codes that can fully exploit our rapidly expanding computing resources — and will actively participate in the state-of-the-art computing initiatives now being planned by DOE. Moreover, Argonne is strengthening its work on computational science applications, especially in the areas of nanoscience and biology.

Goal 8: National Security

Argonne will help enhance national security by delivering new technologies and threat analyses for the Department of Homeland Security, the Department of Defense, and the U.S. intelligence community. Many Laboratory discoveries and inventions developed in pursuit of our mission are now helping to increase homeland security. Notable technologies include portable systems for detection and field identification of concealed nuclear materials, pathogenic microorganisms, and airborne poisonous chemicals; models to guide infrastructure assurance; and the PROTECT system, which combines detection, communication, and quick-response strategies to protect subways and other enclosed public spaces against chemical and, eventually, biological attacks. Argonne is also exploring the sociological dimensions of terrorist threats by partnering with leading social scientists at the University of Chicago.

Goal 9: Environmental Research

Argonne will provide leadership in key areas of environmental research by integrating fundamental research with reliable impact assessments and innovative technological solutions. We will make major contributions in such areas as the cycling and sequestration of carbon, the causes and consequences of global climate change, atomic-level controls for contaminant sequestration, and potential environmental impacts of a hydrogen fuel economy. This research will take full advantage of the APS and other state-of-the-art facilities and tools available at the Laboratory.

Goal 10: National User Facilities

Argonne is committed to maximizing the scientific and technical productivity of its existing user facilities, especially its three leading national user facilities: the APS and IPNS (discussed above) and the Argonne Tandem-Linac Accelerator System (ATLAS, which would become part of RIA). Meeting this goal involves maintaining the facilities' high reliability and availability while increasing their performance and experimental capabilities. At the APS, for example, we plan upgrades over the next two decades that will increase the productivity of users by roughly 10,000-fold. The benefit will be much more information, obtained much more quickly, to support important scientific activities such as imaging nanoscale devices and solving the atomic structures of the huge biological molecules crucial to understanding diseases. Argonne will remain an international leader in accelerator-based user facilities, through the APS, RIA, connections with high-energy and nuclear physics, and involvement in development of the next generation of x-ray sources after the APS.

C. Scientific and Technical Core Competencies

To achieve our vision, we cultivate distinctive, world-class scientific and technical

capabilities and integrate them into a dynamic portfolio of core competencies that serve and anticipate current and emerging national R&D needs in our mission areas. Our current competency portfolio includes the following:

- A complete set of engineering and scientific expertise supporting the design, development, and evaluation of current and advanced nuclear energy systems and proliferation-resistant nuclear fuel cycle technologies, including pyroprocessing.
- Design, construction, and operation of accelerator-based user facilities, along with diverse state-of-the-art capabilities related to acceleration, particle detection, synchrotron radiation techniques, spallation neutron scattering techniques, and the control and manipulation of particle beams and photon beams.
- Fundamental science and engineering expertise in, and at the interfaces between,
  - Materials sciences, chemical sciences, biological sciences, and atomic physics;
  - High energy and nuclear physics;
  - Multidisciplinary nanoscience and nanotechnology;
  - Structural biology, functional genomics, and bioinformatics;
  - Environmental science and technology;
  - Applied mathematics and computer science, including collaborative and virtual environments; and
  - Computational science, including modeling, simulation, systems analysis, and complex adaptive systems.

Our goal in managing our portfolio of core competencies is to be best in the world in selected areas, to be among the leaders in other areas, and to have sufficient breadth and balance to both support users of the facilities we steward and tackle complex multidisciplinary challenges in our mission areas — typically in collaboration or partnership with others.

D. Roles in Accomplishing DOE Missions

Argonne has a contractual responsibility to serve DOE's mission areas, especially its overarching national security mission. In *science* and in *energy*, we have a principal role. Our role in *environmental quality* is as a major contributor. Developments after September 11, 2001, demonstrated how fundamentally our knowledge, technologies, and facilities — even those originally developed for other purposes — serve as a major resource for *national security*.

1. National Security

The recent evolution of threats to U.S. national security has amplified and focused our involvement in DOE's national security mission. Our contributions draw particularly on substantial Laboratory expertise in the nuclear fuel cycle, in chemistry and biology, and in systems analysis and modeling, along with the diverse enabling technologies and sciences underpinning those areas. We also have specialized R&D capabilities contributing to the development of new technologies for detection and attribution, such as highly sensitive instruments and verification technologies to detect radiation and chemical threats or provide biological clues to possible weapons proliferation or actual attacks. Our skills in modeling and decision science are contributing to the security of critical infrastructure at local, regional, national, and global scales. In addition to this scientific and technical expertise, we have experience with other nations in cooperative R&D that will be valuable in supporting DOE goals relating to nonproliferation cooperation, export controls, and materials protection.

Scientific, engineering, and operational capabilities that we have developed over many years for other purposes are more recently yielding results that help to counter the threats of terrorism. In the future, our expertise, facilities, and technologies promise to address a broader range of important goals in national security and homeland defense, across the full spectrum of concerns about threat anticipation, threat mitigation, response, and recovery.

2. Science

For DOE's science mission, we operate major scientific user facilities and have significant experimental and theoretical research programs in nuclear and high-energy physics; in applied mathematics; and in materials, chemical, computer, computational, biological, environmental, and fusion science. In several key fields and subfields important to DOE, our research is among the most cited, and our scientists are international leaders. We take pride in effective collaborations with other DOE laboratories, strong interactions with the academic community, productive R&D partnerships with private industry, and high-quality research experiences provided for hundreds of undergraduate and graduate students each year.

The APS, IPNS, and ATLAS are among DOE's most successful major national scientific user facilities. The APS, the nation's premier hard x-ray synchrotron radiation facility, now serves nearly 5,000 users from universities, corporations, and national laboratories throughout the country, and it routinely reports newsworthy new science. The IPNS continues to provide extraordinarily reliable neutron beams and user support for approximately 400 experiments, while continuing its tradition of leadership in the development of spallation targets, neutron moderators, and neutron scattering instruments. In addition to operating the APS and IPNS, we educate the next generation of users by hosting the National School for Neutron and X-ray Scattering. At ATLAS, unique low-energy heavy-ion beams enable over 100 scientists each year to conduct forefront research in nuclear, atomic, and applied physics. The RIA initiative — recently identified by the nuclear physics community as its highest priority among major new construction projects — derives considerable scientific motivation and much of its technology base from ATLAS.

For several years we have made significant contributions to major subprojects associated with user facilities or detectors located elsewhere. The most visible current example is our participation in the Spallation Neutron Source (SNS). We have leading responsibility for SNS spectrometer systems, and we provide substantial technical support for SNS target systems. Other examples include contributions to the ATLAS detector for the Large Hadron Collider, participation in the Linac Coherent Light Source, and detector fabrication for the MINOS neutrino experiment.

Science at Argonne benefits from access to major facilities and from the Laboratory's integrated approach to complex problems. The grand challenges in modern science, such as nanoscale materials or fundamental understanding of biological processes at the molecular scale, are beyond the reach of isolated experiments. Success requires not only forefront capability but also a suite of experimental and theoretical approaches. Our strength comes from diverse scientific teams that examine a problem from many complementary perspectives. This synergy of many approaches working together generates remarkable scientific power and often leads to the creation of pathbreaking new research facilities. The APS, IPNS, and ATLAS all had their origins in Argonne science.

Four of the major Laboratory initiatives featured in Chapter III of this *Institutional Plan* build on Argonne strengths that serve DOE's science mission, both through performance of forefront research and through service to users. Those four initiatives are the Center for Nanoscale Materials, the Rare Isotope Accelerator, Functional Genomics, and Petaflops Computing and Computational Science. In addition, major components of the initiative Hydrogen Research and Development fall under DOE's science mission.

3. Energy

For its energy mission, Argonne serves with the Idaho National Engineering and Environmental Laboratory as co-lead laboratory for nuclear reactor technology. In addition, we have substantial programs and facilities serving DOE's mission to develop innovative, energy-efficient, cost-effective, and environmentally friendly technologies for electric power, transportation, and industry. Since the 1970s we have cultivated capabilities and programs — and have produced results — that are well aligned with recommendations of the administration's energy policy, as described in the May 2001 *Report of the*

National Energy Policy Development (NEPD) Group. We operate numerous unique energy R&D facilities that are used by researchers from universities and industry.

We have noteworthy expertise and facilities in nuclear reactors, non-reactor nuclear facilities, and nuclear fuel cycle technologies. Over the years, we have developed safe and reliable fast-reactor technologies and have demonstrated the technical basis for a proliferation-resistant closed nuclear fuel cycle, based on pyroprocessing, that can consume weapons-grade plutonium and spent fuel from the nation's current fleet of power reactors. We are ready to contribute solutions that will allow nuclear energy to be a significant component of the nation's energy supply portfolio in both the near and long term — safe, environmentally acceptable, proliferation-resistant, sustainable, and economical. The major Laboratory initiative Advanced Nuclear Fuel Cycle envisions a closed, environmentally sound nuclear fuel cycle that generates electricity — and possibly hydrogen — while reducing inventories of plutonium and the long-term toxicity of the waste generated. We played the key technical role in DOE's development of an R&D road map for "Generation IV" nuclear reactors, and we are now conducting the R&D. We have the capability to contribute importantly to Generation IV technologies, including reactors designed for some combination of electricity generation, waste management, and hydrogen production.

Our broader energy R&D portfolio is built on expertise in superconductivity, fuel cells, fossil fuels and carbon management, renewable energy technologies, energy testing and analysis, and other key technologies. Transportation technology R&D relies on many of these competencies and on unique Laboratory facilities to support DOE's quest to increase the efficiency and productivity of vehicular energy use while limiting environmental impacts.

The breadth of our R&D portfolio in both energy technology and supporting basic science is reflected in the range of contributions that we propose to make in support of the nation's new national hydrogen economy initiative. Our major Laboratory initiative in Hydrogen Research and Development encompasses extensive work on the materials science and chemistry of high-performance structural materials and catalysts, bolstered by use of the APS, IPNS, and other major research facilities; investigation of the production of hydrogen from nuclear power, taking advantage of our extensive expertise in nuclear reactor technology; and exploration of effective systems for utilizing hydrogen in both transportation and stationary applications, capitalizing on experience and facilities developed in earlier partnerships with industrial firms.

4. Environmental Quality

In support of DOE's environmental quality mission, we develop innovative characterization and remediation tools and technologies, create advanced technologies that intrinsically produce little or no pollution and minimize waste generation, clean up land and facilities on the Argonne sites, and conduct thorough and objective environmental analyses. The focus of this work is shifting from effluent control technologies and associated regulation toward resource and waste management, site remediation, long-term stewardship, and global environmental issues. Our strength is our combination of capabilities in bioprocessing, ecology, modeling and measurement of environmental pathways, atmospheric physics and chemistry, environmental assessment, and decision models.

Our work in the environmental quality areas ranges widely. We are responsible for operating all three Cloud and Radiation Testbed facilities of DOE's Atmospheric Radiation Measurement Program. In other work, we are using the APS to pioneer synchrotron-based environmental tools that will deepen microscale understanding of environmental processes. The Laboratory also belongs to the EnviroCAT partnership, which will develop state-of-the-art APS beamlines designed to tackle a broad range of environmental science problems. Elsewhere, the U.S. Department of the Interior has tapped Argonne to develop the environmental impact statement for the Alaska Pipeline.

5. Enabling the Mission through Excellence in Operations

Built into all Argonne programs and support activities is a commitment to operational excellence, to exemplary relations with the public (especially neighbors near the Illinois and Idaho sites), and to development of the diverse science and engineering workforce needed to accomplish DOE missions and assure U.S. prosperity, security, and leadership into the future. In the operations area, our contractual goal is to conduct all work and operate all facilities cost-effectively and with distinction, in a manner that integrates with and supports our missions in science, technology, energy, and environment, while fully protecting workers, facility users, the public, the environment, and national interests.

For most of the past half century, the University of Chicago has, as a public service, managed and operated Argonne under contract to the federal government. As a result, the Laboratory's research environment and performance have maintained a high standard of intellectual excellence and integrity, and the site — despite its age — is among the best maintained in the DOE complex. Currently, the University and the Laboratory are strengthening ties at all levels, from student research to joint appointments, collaborations between individual investigators, and strategic alliances.

E. Strategic Context and Planning Assumptions

Argonne is one of DOE's nine major multiprogram national laboratories, and it is one of ten facilities affiliated with DOE's Office of Science. Like most DOE R&D sites, Argonne is managed and operated by a contractor. We serve all four of DOE's mission areas, and we are internationally recognized for our science, scientific user facilities, and energy R&D. Our track record of performance, our human resources, and our R&D facilities are the assets upon which the Laboratory's strategic plan for the future is built.

Our planning is based on five key assumptions:

- DOE's national laboratories must act increasingly as a synergistic system, with the laboratories managing their collective competencies, increasing their overall cost-effectiveness, and partnering on major initiatives among themselves and with the private and academic sectors.
- Sponsors, regulators, and the public will continue to require that we demonstrate responsible corporate citizenship. This imperative includes being a good and trustworthy neighbor, conducting operations cost-effectively and responsibly, and meeting or exceeding regulatory requirements.
- Argonne must compete on its merits for federal funding, for the "best and brightest" employees, and for the modern infrastructure needed for future success. Important factors in this competition will be scientific and technological excellence, cost-effectiveness, mission contributions, record of performance, and a working environment that enables high performance from a diverse and talented workforce.
- Robust links with universities, industry, federal laboratories, and the general scientific and technical community (within the United States and abroad) are essential if we are to maintain our leadership and fully exploit advances made throughout the world.
- Computing, computational science, and communications and information technology will advance rapidly, will become seamlessly intertwined with experimental science, and will thereby revolutionize many fields of research and applications that are central to the missions of DOE and Argonne.

F. Strategic Objectives

Objective 1. We will continue to perform outstanding science and technology consistent with our mission and will provide results and value to the nation. This objective includes operating world-class scientific user facilities and providing other science- and technology-based tools in a way that maximizes service to users and research productivity, as well as other public

benefits. Outstanding science and technology are Argonne's *raison d'être.* The Laboratory's history of accomplishment is the basis on which it becomes the performer of choice in its mission areas. In support of this objective, we expand the frontiers of knowledge, develop and test new technologies, and create new areas of inquiry that keep us at the forefront. Thousands of scientists and students from universities, industry, and other laboratories around the country and the world use our unique facilities to conduct their research. Reliable facility operation, meeting or exceeding performance specifications, and high-quality user support are critical. In addition to the APS, IPNS, and ATLAS, we operate or provide other important special research tools, such as major nuclear research facilities, environmental research sites, mathematical libraries, software packages, and decision tools.

We have an obligation to the taxpayer to provide the highest possible mission value with the resources we receive. Under constrained or declining budgets, this goal can only be achieved by nurturing the best, most important programs and phasing out the least important. Only by making such choices can we ensure that the research we undertake achieves the required quality and stature. In the near term, we will emphasize expanding and strengthening the computational components of our R&D, operating user facilities effectively, operating and improving reactors and other nuclear facilities, expanding capabilities for research on nuclear fuel cycle technology, applying diverse expertise to homeland security, exploring promising areas at the interfaces between traditional disciplines, solving problems of national importance, and catalyzing the expeditious transfer of our technologies into beneficial use. Chapter IV provides updated plans for each of our major science and technology areas.

Objective 2. We will develop important new R&D initiatives and scientific facilities that serve emerging national needs consistent with our mission and will implement them cost-effectively and expeditiously to the benefit of DOE and the nation. New initiatives are an engine for change. They attract bright research staff and facility users, and they help direct our programmatic focus onto current and future needs. Each year we feature a few major Laboratory initiatives that promise extraordinary, broad benefits and that build naturally on our mission areas and strengths. This year's portfolio includes the Center for Nanoscale Materials, the Rare Isotope Accelerator, Functional Genomics, Petaflops Computing and Computational Science, Advanced Nuclear Fuel Cycle, and Hydrogen Research and Development. Chapter III summarizes these major Laboratory initiatives.

Objective 3. Argonne and the University of Chicago will strengthen and fully exploit partnerships and alliances to maximize the Laboratory's value and impact — nationally, regionally, and locally. A strong intellectual alliance between the University of Chicago — one of the nation's premier research universities — and Argonne — one of DOE's major multiprogram science laboratories — promises benefits to DOE and to the broadly ranging impacts of both institutions. Argonne and the University are increasingly taking advantage of each other's complementary expertise in areas such as nanoscience, computing and computational science, bioscience, environmental science and impacts, homeland security, and economic modeling of energy systems. The two institutions plan to increase joint recruiting, joint proposals, joint appointments, joint projects, and sharing of facilities and other resources.

Objective 4. The University of Chicago and Argonne will continuously improve the cost-effectiveness, management, and operations of the Laboratory. The University of Chicago is working with DOE to continuously improve and streamline Argonne's administration and operation. Major challenges include recruiting and developing a diverse workforce, modernizing the physical infrastructure, and fully exploiting partnerships. The changes undertaken in this quest will build on best practices gleaned from the private, academic, and public sectors. The result will be an integrated, creative, and high-performing laboratory whose performance significantly exceeds the sum of its parts, because it engages — productively, cost-effectively, safely, securely, and environmentally responsibly — as a contributing member of the DOE laboratory system and as a partner and leader in addressing national needs in science and technology. Chapter V and Supplement 3 in this *Institutional Plan* describe our status and plans in operations areas.