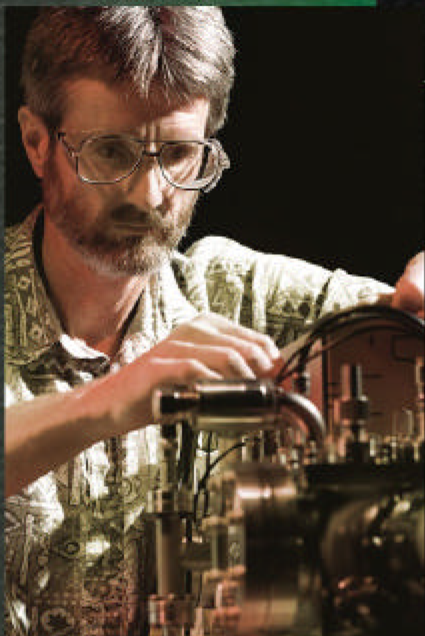
Idaho National Engineering and Environmental Laboratory

Institutional Plan



FY 2002-2006

INEEL

Home of Science and Engineering Solutions

Cover Photographs

Upper Left:

INEEL researchers are advancing the state of the art in mass spectrometry instrumentation and its application, exploring the underlying chemistry and physics of the processes involved in thermal ionization and particle-induced desorption and relating the ion production to the chemistry of the processes.

Left Center:

This scanning electron micrograph shows spherical or oblong calcite particles formed by Bacillus pasteurii urea hydrolosis activity, shown here adhered to the particles. INEEL scientists are studying the feasibility of using urea hydrolosis in the subsurface to stimulate the calcite formation, which may immobilize strontium, a heavy metal.

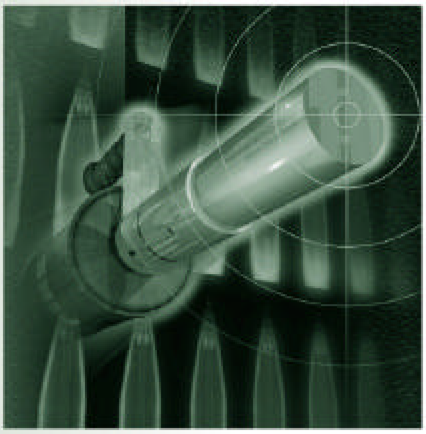
Center:

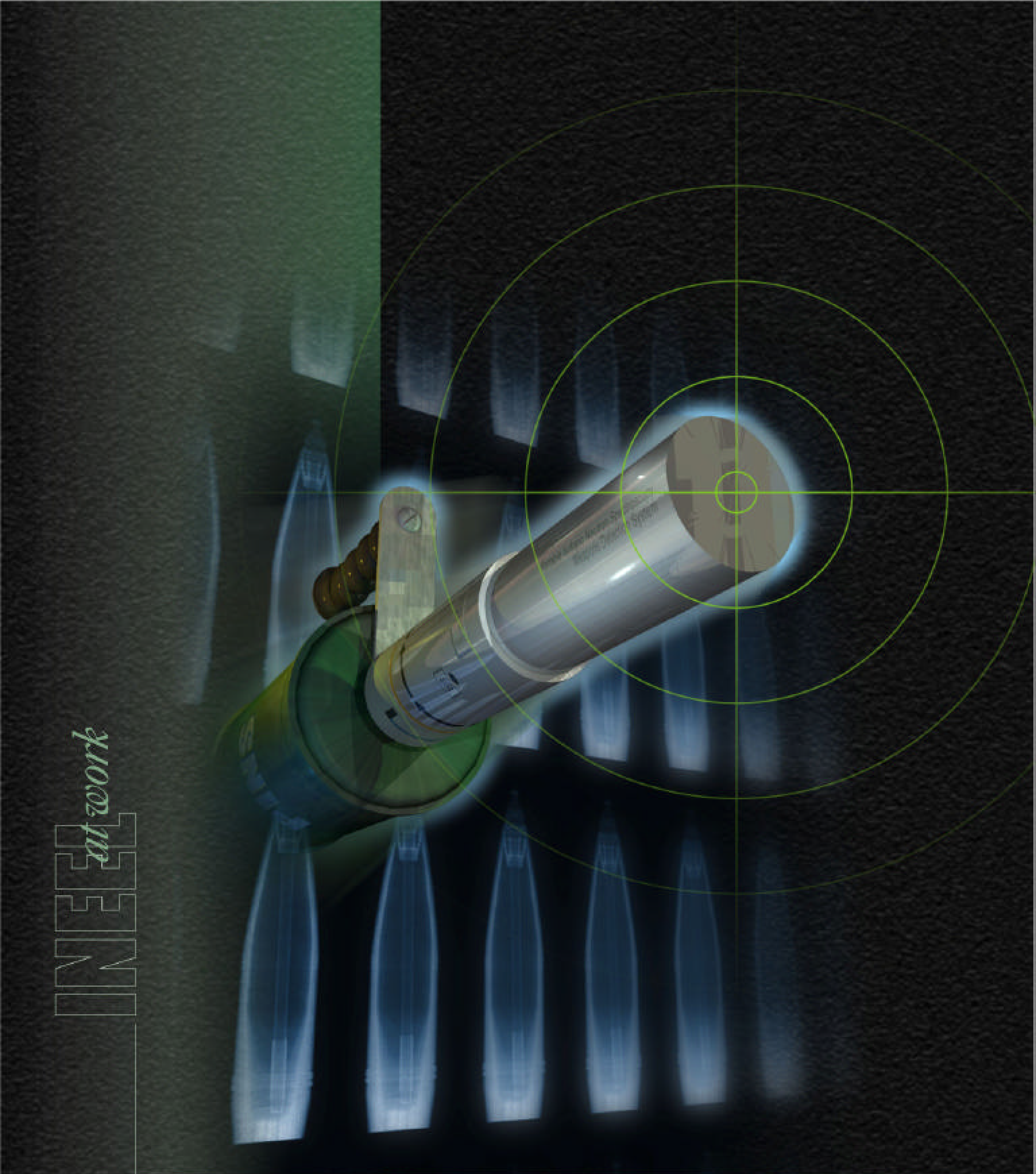
After more than 50 years as a restricted-access federal reservation, the INEEL is in a unique position to safeguard its more than 40,000 cultural resource sites. An archaeological survey of this cave is being conducted to accurately record the only known pictographs on the INEEL and to search for other artifacts. Before it undertakes any ground-disturbing activities, the INEEL conducts archaeological surveys and develops mitigation plans to ensure that historical resources remain intact.

INEEL Institutional Plan
FY 2002–2006

CONTENTS

Introduction





National Security

DOE's goal of enhancing national security and reducing the global threat of weapons of mass destruction is being realized through the efforts of numerous INEEL-developed technologies, such as its award-winning Portable Isotopic Neutron Spectroscopy system. The instrument uses neutrons to identify unknown chemicals in about 30 seconds.

I. INTRODUCTION

A. Laboratory Director's Statement

Two years ago we began a journey toward the realization of a 50-year vision—to be an enduring national resource that delivers science and engineered solutions to the world's environmental, energy, and security challenges. In the past year, we have made significant progress toward this goal. Accomplishments included:

- Completing the safe transfer of Three Mile Island spent nuclear fuel and core debris from wet to dry storage 6 weeks ahead of the schedule established in the Idaho Settlement Agreement. Moving this fuel to dry storage reduces the risks associated with liquid storage and saves an estimated $4 million annually in maintenance costs.

- Fulfilling our ongoing commitment to remove waste from the State of Idaho by safely shipping 680 m^3 of transuranic waste to the Waste Isolation Pilot Plant (WIPP) in New Mexico.

- Reducing the volume of liquid radioactive waste in underground storage tanks to the lowest level in 43 years.

- Removing 9 tons of volatile organic compounds from the subsurface, helping control and reduce contaminated groundwater plumes.

- Obtaining Department of Energy (DOE) approval for the Subsurface Geosciences Laboratory (SGL) and obtaining funding for the initial conceptual design.

- Setting a record for the longest period of uninterrupted operation of the Advanced Test Reactor in its 36-year history.

- Starting the DOE Office of Environmental Management (EM) Core Laboratories network, the Environmental Stewardship Initiative, and the Generation IV Nuclear Energy Systems Initiative.

- Becoming the first national and EM laboratory to attain Star status in DOE's Voluntary Protection Program (VPP).

- Increasing laboratory research and development (R&D) sales by 18% in Fiscal Year (FY) 2001. Securing this financial support for our scientific expertise is a validation of the superior R&D skills found at the laboratory.

- Improving our environmental compliance record by lowering the number and severity of citations, thus demonstrating the ability of the Idaho National Engineering and Environmental Laboratory (INEEL) to operate in an environmentally responsible manner.

We continue to face three fundamental challenges: accelerating environmental cleanup, revitalizing the laboratory, and enhancing facility operations. We will work closely with EM and other DOE and non-DOE customers to address critical needs in these areas.

Shortly before finalizing this plan, we received the EM Top-to-Bottom Review Team report. In the coming months, we will be working to define a path forward for the INEEL environmental cleanup program that reflects the contents of this report. A discussion of our implementation approach will be included in subsequent institutional plans, as appropriate.

The expectation of the community, the state, and DOE is that we will complete environmental cleanup in a safe and cost-effective manner. The INEEL has recently restructured its work force to align its skills and headcount with projected work. A productivity team has also identified significant opportunities for improved efficiency throughout the organization. Results achieved by this restructuring and improved efficiency will create a streamlined organization positioned to complete environmental cleanup as planned. We will use our full intellectual capability to responsibly carry out our environmental cleanup obligations within the funding framework provided by DOE. These activities are discussed in Sections III and V of this plan.

In addition to implementing the necessary changes to accelerate environmental cleanup, we are committed to aligning our R&D programs to the Secretary of Energy's mission and priorities released in October of last year. Along those lines, we will continue initiatives in subsurface science, nuclear energy systems, advanced waste management solutions, environmental stewardship, and advanced computing and collaboration.

Ongoing concern over energy supplies and pollutant emissions is prompting renewed interest in nuclear energy. In partnership with Argonne National Laboratory (ANL), the INEEL will proceed with research into the Generation IV nuclear reactor, helping DOE's Office of Nuclear Energy, Science, and Technology (NE) define a role for nuclear energy in a new U.S. energy policy.

We will continue to serve DOE in areas of national security and energy. Through a balanced R&D portfolio made up of work for various DOE and other customers, we will capitalize on our reputation for solving scientific and technological problems. The laboratory's current R&D portfolio meshes well with both stated missions and homeland security needs. We aim to enhance the perception that the INEEL focuses on what it does best and conducts business in a safe and cost-effective manner.

To ensure that comprehensive resources are available for effective R&D, we will continue our ties with academia, government agencies, and private industry, maximizing opportunities for partnerships. Our Advanced Computing and Collaboration Initiative will position us to take full advantage of strategic relationships.

Environmental cleanup and R&D must be conducted within the context of operational excellence. This means continuing responsible operations at the Advanced Test Reactor, Special Manufacturing Capability (SMC), and other INEEL facilities. We are, of course, committed to maintaining a safe work environment. Principles of the Integrated Safety Management System/Voluntary Protection Program (ISMS/VPP) and the Environmental Management System will be embedded in day-to-day activities.

The years ahead will surely bring an acceleration in science and technology, leading to enhanced U.S. economic competitiveness, environmental protection, and national security. The INEEL will contribute to this acceleration, working closely with DOE, the State of Idaho, and the community to fulfill shared objectives.

B. Executive Summary

The *INEEL Institutional Plan* is the principal strategic document setting the laboratory's direction for the next 5 years. The plan summarizes laboratory objectives, strategies, and proposed initiatives in keeping with ongoing interactions between INEEL and DOE officials.

1. Plan Structure

The *Institutional Plan* consists of six sections and seven appendixes:

- Section I contains the "Laboratory Director's Statement," "Contents," and "Executive Summary"
- Section II outlines the INEEL's mission, roles, critical outcomes, core competencies, and competency-strengthening activities
- Sections III and IV describe the laboratory's scientific and technical strategic plan and proposed laboratory initiatives
- Section V covers plans and strategies for support functions and infrastructure
- Section VI contains resource projections for FY 2001-2006
- Appendixes contain supplemental program descriptions and supporting information.

2. Content Overview

Section II lays the foundation for the laboratory's vision and strategic objectives, discussing performance outcomes that are the core performance elements around which the *INEEL Performance Evaluation Management Plan* is structured.

Section II also details the laboratory's assigned roles, particularly its lead laboratory roles for EM and NE. After more than 50 years of multidisciplinary science and engineering, the INEEL has developed a broad set of scientific and technical capabilities, which have been integrated into notable core competencies described in this section. Also outlined is a suite of competency-strengthening activities that enhance the laboratory's ability to fulfill current and future missions.

Section III contains the Laboratory Scientific and Technical Vision and Strategic Plan. Planning assumptions and framework discussed early in this section form the basis for developing the strategic objectives and strategies that follow.

The laboratory's R&D efforts will emphasize subsurface geoscience, nuclear reactor technology, advanced waste management solutions, environmental stewardship, and advanced computing and collaboration. It is expected that, as environmental cleanup is completed, funding levels for environmental cleanup operations will decline and R&D, including EM R&D, will grow by 5% annually, plus escalation (inflation). Section III outlines strategic issues related to completing environmental cleanup as well as needed investment in human resources, infrastructure, and information technology.

In support of its strategic objectives and strategies, the INEEL proposes five laboratory initiatives (discussed in detail in Section IV):

- **Subsurface Science**

  This initiative is a multidisciplinary, multi-institutional research program whose aim is to enhance the scientific and engineering underpinnings of DOE's environmental programs and to provide better options for cleanup, monitoring, and stewardship of contaminated sites. The initiative focuses on research in the vadose (unsaturated) zone, since a large portion of cleanup and closure costs will be for vadose-zone contamination, and since the vadose zone is much more poorly understood than the saturated zone below. The initiative's research program addresses cleanup and stewardship problems at DOE field sites and has short-range as well as long-range objectives. Laboratory-scale, pilot-scale and field-scale applied research projects are being undertaken, with an increasing emphasis on pilot-scale (mesoscale[a]) experiments that mimic field conditions.

- **Generation IV Nuclear Energy Systems**

  In collaboration with ANL, this initiative will—over time—fulfill DOE's Energy mission of delivering a new reactor design that not only minimizes waste but also reduces operational costs, proliferation potential, and safety concerns.

- **Advanced Waste Management Solutions**

  This initiative uses program integration and R&D expertise to complete the treatment and disposition of INEEL legacy waste such as spent nuclear fuel, high-level waste, and transuranic waste. Collaborating with other national laboratories and DOE, the INEEL will apply its skills in waste characterization, treatment, packaging, and transportation across the DOE complex.

- **Environmental Stewardship**

  This initiative focuses on (a) developing science and technology that will improve the reliability of engineered systems and reduce the science and technology uncertainty surrounding long-term stewardship methods; (b) assisting DOE in the development and execution of a national Long-Term Stewardship Program; and (c) applying the laboratory's long-term stewardship expertise to similar challenges faced by other federal agencies and foreign countries.

- **Advanced Computing and Collaboration**

  This initiative is the focal point for (a) developing INEEL capabilities in advanced computing and collaboration, (b) applying advanced computing and collaboration to achieve objectives of other laboratory initiatives, and (c) coordinating program development in these areas.

Division initiatives, which may in the future evolve into laboratory initiatives, are also proposed and described at the end of each mission-area discussion in Section III.

a. A large-scale laboratory experiment that mimics field processes.

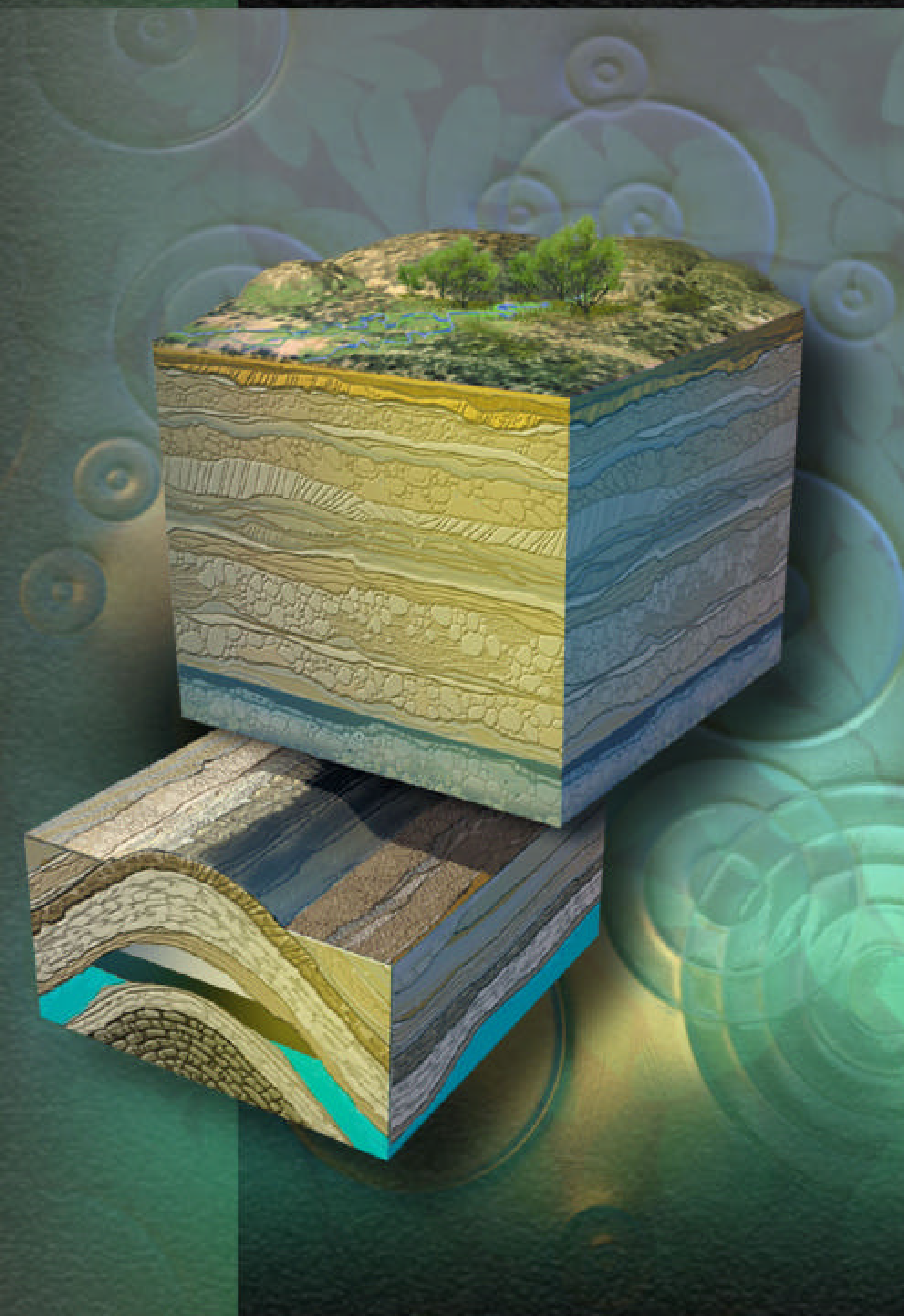
INEEL infrastructure and support functions described in Section V improve business processes, reduce costs, and ensure safe and compliant facilities and services. Infrastructure management will focus on mission-critical facility needs and on reducing the overall scope and cost of laboratory infrastructure.

Resource projection tables contained in Section VI summarize funding and personnel levels based on planning assumptions discussed in Section III.

Due to the timing of this plan, full implementation of the accelerated INEEL EM program and recommendations of DOE's Top-to-Bottom Review are not included but will be incorporated into future institutional plans.

Laboratory Mission and Roles

INEEL at work



Subsurface Science

DOE's daunting responsibilities to advance the basic research and instruments of science and clean up the environmental legacy of nuclear weapons and civilian nuclear research are among the many reasons why the INEEL is so aggressively pursuing its multidisciplinary Subsurface Science Initiative.

II. LABORATORY MISSION AND ROLES

A. Laboratory Mission and Critical Outcomes

1. Mission Statement

The mission of the INEEL is to:

- Deliver science-based, engineered solutions to the challenges facing DOE offices, other federal agencies, and industrial clients consistent with DOE missions
- Accelerate environmental cleanup responsibly, using innovative science and engineering capabilities
- Provide leadership and support to optimize the value of EM investments and strategic partnerships throughout the DOE complex
- Enhance scientific and technical talent, facilities, and equipment to best serve national and regional interests.

2. Performance Outcomes

Performance outcomes contained in the *INEEL Performance Evaluation Management Plan* define success in terms of results that must be accomplished over the next 5 years. Objectives and performance measures are identified for each performance outcome and are aligned to the vision and strategic objectives contained in this *Institutional Plan*. These performance outcomes, objectives, and performance measures focus the INEEL on short-term as well as long-term goals. This performance evaluation and reporting system helps ensure that performance expectations are similar throughout the various INEEL organizations. It also provides a method by which performance issues can be promptly identified, addressed, and resolved. The INEEL's four performance outcomes are:

- Deliver science-based, engineered solutions
- Complete accelerated environmental cleanup responsibly
- Provide leadership and support to optimize investments
- Enhance scientific and technical talent, facilities, and equipment.

B. Laboratory Roles

The INEEL uses science, technology, and engineering to conduct program operations, research, development, demonstration, and deployment for a variety of DOE and other customers. The laboratory brings together R&D and operations responsibilities within one integrated organization. Within an integrated laboratory system, the INEEL collaborates with other DOE laboratories to cost-effectively support DOE-wide missions. See Appendix A for a summary of INEEL collaborations.

As a multiprogram national laboratory, the INEEL provides R&D support to the four DOE mission areas: Environment, Energy, National Defense, and Science.

The laboratory also has a large operations role to fill, serving DOE and the U.S. Army. INEEL operations are centered on environmental cleanup, the Advanced Test Reactor, and the Specific

Manufacturing Capability. Environmental cleanup operations include ongoing remediation activities, decontamination and decommissioning of surplus facilities, and the treatment, storage, and disposal of radioactive, hazardous, and industrial wastes and spent nuclear fuel. INEEL environmental activities are focused on development and implementation of accelerated environmental cleanup in line with recently released EM Top-to-Bottom Review report recommendations. See Appendix B for a description of current INEEL programs.

Several facilities are maintained and operated in conjunction with these operations. These facilities are the Radioactive Waste Management Complex (RWMC), the Waste Reduction Operations Complex (WROC), several dry and wet spent nuclear fuel storage facilities located at Test Area North (TAN), and the Idaho Nuclear Technology and Engineering Center (INTEC). The INEEL also operates and maintains the Advanced Test Reactor (ATR), the world's largest nuclear test reactor, which delivers high-thermal neutron flux and large test volumes for performing irradiation services. The primary sponsor of ATR is the DOE Naval Nuclear Propulsion Program. However, additional R&D is conducted for international sponsors. The Specific Manufacturing Capability is a tank armor manufacturing facility operated by the laboratory for the U.S. Army.

In line with these roles, the INEEL is designated as:

- EM's lead laboratory
- The lead laboratory for Long-Term Stewardship Science and Technology
- The lead nuclear energy R&D laboratory in partnership with ANL.

1. EM Lead Laboratory Role

As EM's lead laboratory, the INEEL is committed to:

- Reducing the risk, cost, and time required for cleanup by actively encouraging and facilitating the use of innovative technologies
- Enhancing integration across the DOE complex
- Providing unbiased, open, and expert technical assistance on key issues
- Improving the defensibility and implementability of program decision-making
- Enhancing the integration and alignment of EM Office of Science and Technology activities with the overall EM program.

One example of the INEEL's efforts to improve integration across the DOE complex is the formation of a virtual laboratory network referred to as the EM Core Laboratories. The eight-member network[b] is working together to ensure that the best solutions are achieved and that capabilities are utilized from the individual laboratories in a focused, national collaboration. The EM Core Laboratories will provide integrated science and technology capabilities for EM cleanup and stewardship. The INEEL, in its role as EM lead laboratory, is leading and facilitating the EM Core Laboratories Network.

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b. Members are the Environmental Management Laboratory (EML), INEEL, Los Alamos National Laboratory (LANL), National Energy Technology Laboratory (NETL), Oak Ridge National Laboratory (ORNL), Pacific Northwest National Laboratory (PNNL), Radiological and Environmental Sciences Laboratory (RESL), and Savannah River Technology Center (SRTC).

During FY 2000, DOE designated the INEEL as the lead laboratory for long-term stewardship science and technology and the lead field site for long-term stewardship implementation. DOE long-term stewardship science and technology efforts are directed toward:

- Obtaining knowledge of fate and transport mechanisms and predictive capabilities such as those identified in the National Vadose Zone Science and Technology Roadmap that defines science and technology needs
- Developing cost-effective methods for long-term monitoring, surveillance, and end-state planning
- Improving hazard communications via increasing the ability to detect failures early
- Reducing the likelihood that individual containment systems and barriers will fail.

The laboratory will take a lead role in addressing DOE's long-term stewardship science and technology needs and will also support development and implementation of DOE's national long-term stewardship program. The INEEL will lead by example and establish the laboratory as a "model" long-term stewardship program by integrating the best science and engineering into its long-term stewardship operations. Finally, the laboratory will apply its expertise to long-term stewardship challenges nationally and internationally.

The Environmental Programs portion of Section III, "Laboratory Scientific and Technical Vision and Strategic Plan," and the Environmental Stewardship and Subsurface Geoscience Initiatives discussed in Section IV, "Laboratory Initiatives," describe in greater detail the laboratory's contributions to DOE's long-term stewardship mission.

2. NE Lead Laboratory Role

In partnership with ANL as DOE's lead nuclear energy R&D laboratories, the INEEL will:

- Maintain world-class staff and key facilities to pursue advanced nuclear reactor technology R&D and lead out in future nuclear reactor programs
- Maintain a knowledge base to understand, evaluate, and apply results of advanced nuclear reactor studies
- Evaluate, integrate, and build upon research results to meet DOE's long-term goals, and serve as a technical resource to support NE decision-making for R&D efforts
- Follow nuclear energy-related R&D in the U.S. and abroad, becoming a state-of-the-art national resource
- At NE's request, organize and host national and international forums to address key nuclear issues in the national interest.

The nuclear energy portion of Section III, "Laboratory Scientific and Technical Vision and Strategic Plan," and the Generation IV initiative described in Section IV, "Laboratory Initiatives," detail the laboratory's efforts in this area.

3. Multiprogram Laboratory Role

The INEEL fulfills its National Defense role by delivering to DOE, to other government agencies, and to industrial partners science-based, integrated engineering systems for national security and intelligence. R&D efforts focus on threat mitigation and advanced technology systems for nonproliferation and intelligence.

As part of its Energy role, the INEEL also conducts focused research in fossil and renewable energy. Research areas include geothermal, hydropower, advanced power technologies, petroleum, chemical and fuel cell technologies, clean coal technologies, methane hydrates, bioenergy technology, and alternative transportation fuels.

The laboratory also participates in the DOE Science mission. Areas of science research include surface chemistry, subsurface sources of contamination, nucleation and growth of nanostructures, and engineering.

Numerous activities being performed at the INEEL are aligned with the Secretary of Energy's recently published missions and priorities. A brief discussion of the INEEL's R&D contributions to DOE's mission and priorities can be found in the situational analysis for each mission area in Section III.

C. Laboratory Core Competencies

The INEEL has identified four core competencies (Figure 1).

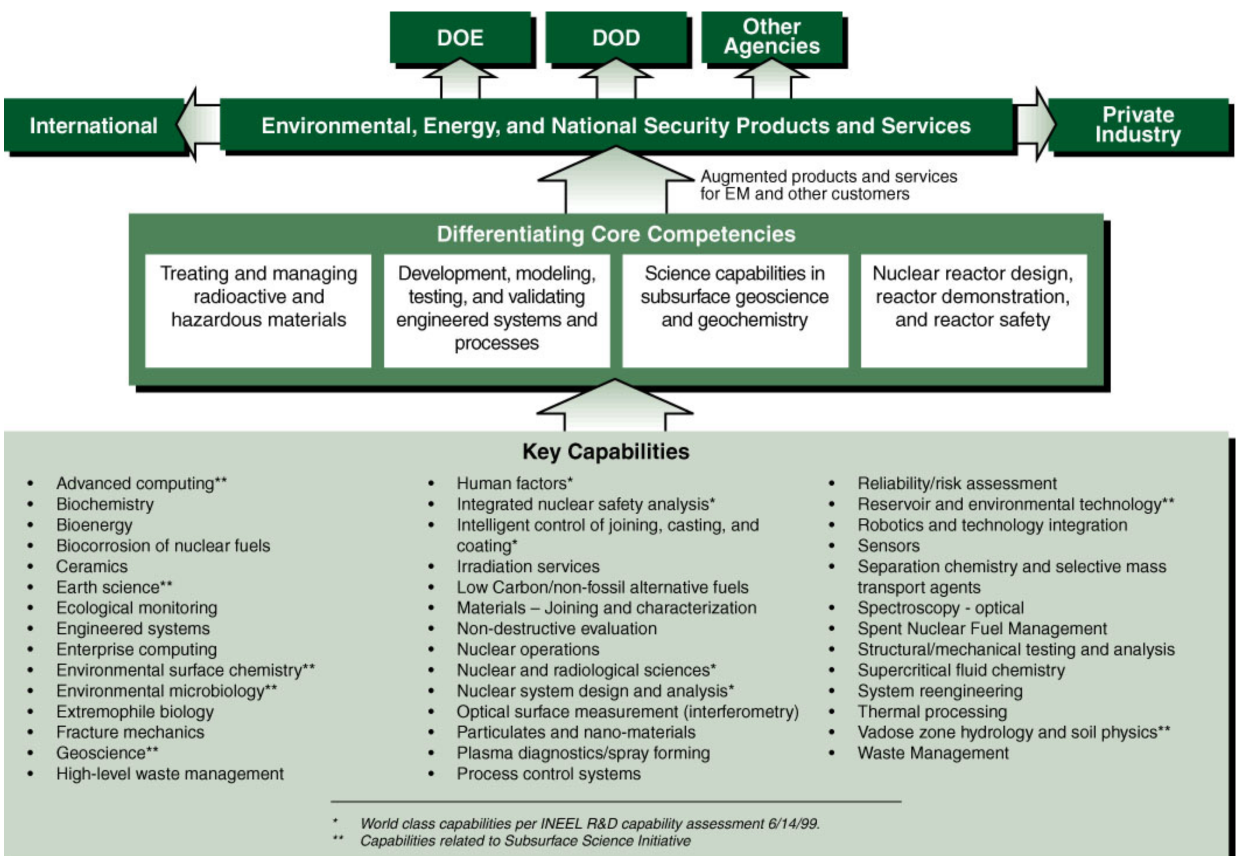


Figure 1. INEEL core competencies and key capabilities.

1. Treating and Managing Radioactive and Hazardous Wastes

The INEEL operates a wide diversity of nuclear facilities used to treat and manage radioactive and hazardous wastes in a safe and environmentally compliant manner. From its experience as a major processor of DOE and U.S. Navy spent nuclear fuels, the laboratory has expertise in processing, handling, using, transporting, storing, and disposing of radioactive and hazardous wastes. These activities resulted in expertise in intelligent automation of remote systems, chemistry, radiochemistry, and radiochemical processing. The laboratory has a trained and disciplined nuclear operations work force that functions in strict compliance with regulations to protect employees, the public, and the environment. It anticipates potential environmental impacts and develops preventive actions such as waste avoidance, reduction, and disposition management to forestall the need for remediation.

2. Developing, Modeling, Testing, Demonstrating, and Validating Engineered Systems and Processes

The INEEL has an experienced engineering and technical work force to develop, model, test, and demonstrate a variety of engineered systems and processes to solve specific DOE and other federal agency problems. Examples of INEEL engineered systems include:

Low-level waste and mixed low-level waste treatment technologies

High-level waste management and treatment technologies

Liquefied Natural Gas and Hydrogen Vehicle Conversion Program

CO_2 sequestration and methane hydrates

Severe Fuel Damage Test Program

Spent Nuclear Fuel Rod Consolidation Demonstration Project

Transuranic waste-handling and characterization technologies

Electric Vehicle Program

Optimal Path Planner for Autonomous Vehicles

Light-Duty Utility Arms

Spent Nuclear Storage Cask Testing Program

Mobile Munitions Assessment System

Air Support Operations Center

The laboratory also develops modeling tools such as the Severe Core Damage Analysis Package (SCDAP), the Reactor Excursion and Leak Analysis Program, Version 5 (RELAP5), and the Systems Analysis Programs for Hands-on Integrated Reliability Evaluation (SAPHIRE) codes used worldwide for assessing nuclear safety and risks.

Backed by its sensing and diagnostic capabilities as well as its biotechnology, geoscience, and environmental engineering, the INEEL provides innovative solutions to complex environmental challenges, developing advanced environmental analysis tools and management methods to address identified needs.

The INEEL also has a long history in design, construction, operation, and decommissioning of nuclear reactors, hazardous materials and waste processing plants, and large-scale energy systems.

3. Science Capabilities in Subsurface Geosciences, Geochemistry, and Microbiology

The INEEL integrates its biological, chemical, and geoscience capabilities through its subsurface geoscience investigations. Subsurface geoscience directly supports DOE's cleanup and long-term stewardship needs by providing the scientific underpinnings necessary to:

- Characterize the subsurface and identify and quantify subsurface contamination
- Contain and stabilize leaks and buried waste, removing buried waste that poses unacceptable risk
- Remediate or destroy mobile contaminants
- Formulate and test computational models of the subsurface fate and transport of contaminants
- Validate and verify system performance for regulators and stakeholders.

The laboratory's extensive geothermal work, long-standing seismic program, and large-scale infiltration test experience further strengthen this competency.

4. Nuclear Reactor Design, Reactor Demonstration, and Reactor Safety

Having designed, constructed, and operated 52 nuclear reactors during its 50-year existence, the INEEL understands reactor operations and safety and is recognized internationally for its expertise in nuclear energy. Specific capabilities include nuclear system design and analysis, nuclear safety analysis, risk assessment, fuels and materials analysis, advanced computing, fuel-cycle analysis and management, irradiation services, and nuclear and radiological sciences (see Figure 1). The laboratory employs facilities such as the Advanced Test Reactor for studying naval propulsion and other nuclear fuels, materials testing, and isotope production. These capabilities enable comprehensive analysis of nuclear components in an effort to lengthen their operating lifetime. In addition, the INEEL conducts spent nuclear fuel management, nuclear plant-life extension, high-burnup fuels development, advanced reactor design, and medical therapy technology development.

D. Competency-Strengthening Activities

Several activities designed to sustain and strengthen laboratory core competencies are being pursued. These activities are described below.

1. Multidisciplinary Research and Education Programs

The INEEL will seek solutions to improve the educational profile of the current INEEL staff through education models that identify and encourage researchers to seek advanced degrees. In addition, the Inland Northwest Research Alliance (INRA), a managing partner of the INEEL, will supplement laboratory staff with faculty to strengthen research teams. Virtual departments will be developed to support major mission agendas, particularly in subsurface research, nuclear activities, and bioenergy. An example is the current effort to develop a virtual subsurface science curriculum to produce new Ph.D.s from the existing staff at the INEEL. Postdoctoral and graduate students from INRA universities (University of Idaho, Idaho State University, University of Alaska, Fairbanks, Boise State University, Montana State University, University of Montana, Washington State University, and Utah State University) are also assisting laboratory researchers in subsurface science research, which is a key component of DOE's long-term environmental management strategy.

INRA, which plays a strategic role in education and research decisions at the laboratory, furthers the INEEL's goals of (a) building successful, multidisciplinary research and education programs; (b) collaboratively competing for new research funding; and (c) facilitating the development of associated programs at INRA institutions.

2. Math and Science Education Investments

It is imperative that the INEEL build a work force of the future to support DOE objectives, a task made more difficult by the fact that fewer young people are choosing math and science careers. According to the Department of Labor, the U.S. needs to fill approximately 432,000 new engineering positions between 2000 and 2010. This underscores the challenge facing the laboratory in ensuring a properly trained work force.

The laboratory is strategically investing in improving math and science education, and in providing industry experience for young people, faculty members at school districts and universities, and current employees. The laboratory's participation in the Governor's Education Committee and the industry Science and Technology Roundtable are highlighted below. Other student and faculty programs, as well as various INEEL employee education programs, are helping the laboratory meet its ongoing need for technically skilled personnel.

(a) Governor's Education Initiative

The INEEL's involvement in the Governor's Education Initiative is an example of how the laboratory is working to improve science and math opportunities within Idaho. The goal of the initiative is to encourage young people to choose a career in these fields. The laboratory participates in an education committee made up of representatives from large employers throughout the state.

Idaho Industry Science and Technology Roundtable

The laboratory has also taken a leadership role in the Industry Science and Technology Roundtable made up of chief executive officers from Idaho's largest employers (INEEL, Micron Technologies, Hewlett-Packard, Washington Group [formerly Morrison Knudsen], Qwest [formerly USWest], and Key Bank). The roundtable targeted six areas for improving science and math education. A subcommittee led by the INEEL made 12 recommendations for sustainable strategies to meet objectives in the six areas.

The INEEL's contribution to the roundtable's recommendations is JASON, a national science curriculum for grades 5-9, which is currently being implemented across Idaho. DOE's Office of Naval Research and Bechtel Corporation are major sponsors of JASON funding. JASON is currently implemented in 35 counties and 40 school districts in Idaho. Approximately 5,000 students participated in the 2000 JASON live interactive broadcast, and 232 teachers serving over 10,000 students use the curriculum during the school year.

Student and Faculty Programs

Postdoctoral fellowships provide essential knowledge as well as a valuable recruiting opportunity for high-demand researchers. The postdoctoral fellowship program is a 12-month fellowship either at the INEEL or a university campus that can be renewed for up to 2 years. The focus is on supporting key INEEL missions.

To engage the future work force, the INEEL provides precollege undergraduate and graduate students with fellowship opportunities for the summer or a semester. These opportunities offer students a research experience with the aim of promoting careers in science, engineering, and technology. The program was expanded in 1998 with the addition of Computer Science Power Internships. These internships provide qualified undergraduate students at selected INRA universities majoring in computer science with a scholarship and summer internship at the INEEL. In addition, in order to promote a diverse work force, the laboratory offers summer fellowships to students of Hispanic-serving institutions and Native American tribal colleges.

Critical research is also stimulated via faculty fellowship programs. The laboratory offers qualified faculty a 3- to 12-month fellowship renewable for up to 2 years. The focus is on collaboration with INEEL researchers and provides INEEL staff with valuable new perspectives.

Outstanding middle and high school teachers of science, mathematics, and technology can immerse themselves in the summer Teaming Teachers with the INEEL program. The primary goal of this program is to facilitate the transfer of experience gained by the teacher in middle and high school classrooms throughout Idaho and to aid the instructor in integrating academic and vocational education.

Appendix C shows the number of participants in various INEEL university and science education programs from FY 1999 through FY 2001 and provides targets for 2005. Participation in several programs is changing as laboratory priorities shift to graduate and postdoctoral programs.

(b) INEEL Doctoral Programs

The laboratory is aggressively seeking to increase the number of mission-appropriate Ph.D.s to strengthen its science and research capabilities. Several programs of note have been developed to assist current employees who wish to complete their doctoral studies. The All But Dissertation Program and the INEEL Education Degree Program are described below.

The INEEL is currently funding a program to allow laboratory employees who are Ph.D. students to integrate their professional research responsibilities with the research requirements of the doctoral degree. Ten students have been selected from a pool of INEEL applicants to participate in this program.

Professional development funds are available for current employees pursuing doctoral degrees in strategic discipline areas. The All But Dissertation Program provides funds for labor hours of employees who have successfully completed all doctoral course work, preliminary exams, and research, and are preparing their dissertations.

Regular, full-time employees are eligible to apply for the INEEL's Education Degree Program if they have at least 3 years of recognized laboratory service immediately preceding the application date and approval of their immediate manager and of Academic and Education Relations. Employees who are eligible for this program are able, if all university requirements are met, to work toward a degree in a number of disciplines important to INEEL missions.

3. Laboratory Partnerships

The INEEL is committed to cooperate with other laboratories in furthering the integration of the DOE complex. Collaboration between the INEEL, other DOE laboratories, universities, and private industry provides significantly enhanced capabilities to support DOE objectives. Appendix A contains examples of the INEEL's more notable collaborations with other DOE laboratories, universities, and private industry and how that collaboration supports DOE missions.

4. State and Regional Collaboration

As the third-largest employer in the State of Idaho, the INEEL is actively pursuing its role as a good corporate citizen within the state and region. As explained earlier, the laboratory continues to make significant contributions through a full spectrum of education programs. Moreover, the laboratory contributes to state and regional advancement as described below.

(a) Governor's Science and Technology Council

The laboratory director is chair of the Governor's Science and Technology Advisory Council. Created by the governor to develop a science and technology plan for the State of Idaho, this council is made up of representatives from academic institutions, technology companies, and entrepreneurial ventures throughout Idaho. The council has completed and delivered to the governor a strategic plan for science and technology designed to foster a technology-based economy in the state. Strategies and actions detailed in the plan were well received by the governor.

(b) Southeastern Idaho Technology Corridor

Idaho is experiencing a decline in its natural resource-based industries of mining, agriculture, and forestry. New methods to ensure economic growth and prosperity in the state must be implemented. One way to achieve the desired level of economic growth is for communities and counties to work together in developing centers of economic interest. The INEEL is committed to developing the Southeastern Idaho Technology Corridor, defined as the area surrounding Interstate 15 from Pocatello to Ashton. The Southeastern Idaho Technology Corridor provides a construct where local governments, economic development agencies, businesses, schools, and universities can work together to further software development, environmental science, environmental science and technology, and advanced materials and material processing.

Committees have been organized to assess Eastern Idaho's work force, infrastructure, real estate, education, funding sources, and marketing strategies.

(c) Economic Development

Since 1994, INEEL managing contractors have invested corporate profits in Idaho's economy. In 1999, the managing contractor committed to spend $1.4 million per year of its corporate profits to promote economic growth throughout the state. In the past 2 years, this investment has helped to create 2,400 jobs, far surpassing the laboratory's original commitment. The laboratory has pledged to create another 600 jobs between now and FY 2005. Additional ongoing economic development activities include grants to economic development agencies across the state, training for economic development professionals, conference sponsorship, assistance with community planning, and mentoring for startup and existing businesses.

(d) Western Connections

The laboratory presently is designing a new avenue of regional support called *Western Connections* to benefit states and communities whose prosperity is being constrained by complex energy and environmental problems. Under this program, the INEEL will focus its expertise to help Idaho and surrounding states resolve their science and technology challenges and, in the process, the INEEL will contribute significantly to restoring the region's economic vitality.

Among the issues on which the INEEL will focus is the contamination of ground and surface waters from past industrial, mining, and agricultural practices. For example, many mountain communities no longer receive the economic benefit of extractive industries, but they still must cope with cleaning up hazardous substances from closed or abandoned mines. Rural communities throughout the region are experiencing rapid suburban growth or are dealing with higher concentrations of dairies and livestock feeding operations, all of which could impact the quality of drinking water. Wyoming, Utah, Montana, and Alaska are witnessing a resurgence of fossil fuel exploration, including drilling for coal bed methane gas that will require new methods of managing low-quality groundwater brought to the surface in the production process. Meanwhile, all western states are facing environmental challenges in upgrading their energy infrastructure for more reliable production and secure transmission of electricity.

To address these challenges, state and local agencies are requesting improved tools, methods and support for conducting environmental assessments, engineering system analyses, advanced remediation and treatment technologies, and low-cost monitoring techniques. Many of these have already been developed by the INEEL. Coordinated through Western Connections, the INEEL will share its tools and expertise with agencies in need and apply the laboratory's core competencies in applied research focused on resolving the region's most complex, intractable problems.

5. Investing in Breakthrough Science and Engineering

The INEEL's Executive Council, chaired by the deputy laboratory director, is chartered with stewarding integrated strategy development, planning, and implementation across the INEEL. In support of this objective, the deputy laboratory director and associate laboratory directors identify and make recommendations to the Executive Council regarding strategic objectives, strategic issues, and *Institutional Plan* priorities. In addition, the council acts as the laboratory's strategic initiative development, laboratory-directed research and development (LDRD), and strategic capital investment decision body.

The two programs designed to encourage breakthrough science and engineering are LDRD and Environmental Systems Research and Analysis.

(a) LDRD Program

As DOE's EM lead laboratory, the INEEL continues to focus research on projects that will help DOE achieve its environmental goals. Environmental cleanup and stewardship are integrated throughout the LDRD program. The laboratory's LDRD program benefits DOE by:

- Reducing risk (e.g., human-machine interface)
- Reducing cost (e.g., natural attenuation as a cleanup method)
- Addressing technology needs and gaps
- Strengthening science capabilities.

The laboratory research portfolio supports multiple R&D needs. Scientists at the INEEL have already developed subsurface monitoring instrumentation tools that have led to national awards, applied large-scale multiphase flow and transport models for predicting the behavior of contaminants in the subsurface, and developed concepts related to characterizing and remediating organically contaminated sites. These projects directly support the technology development needs identified by INEEL EM programs, as well as DOE complex efforts such as understanding fate and transport of subsurface contaminants and long-term environmental stewardship. INEEL LDRD funds will be used to advance research in key areas of DOE missions.

The quality of LDRD-supported research is validated by a significant number of related national awards, technical publications, presentations, and patents. Research sponsored by the INEEL LDRD program laid the groundwork or tested ideas that led to Bright Light and Energy @ 23 awards. These awards honor research that demonstrates DOE's commitment to save taxpayer dollars and improve the quality of life for consumers.

In the period 1995-2000, 12 of the R&D 100 Awards for the most innovative research across the nation went to INEEL projects with origins in LDRD. Almost one third of the patents granted to the INEEL were derived from LDRD projects. In this same period, INEEL principal investigators published 321 articles in peer-reviewed journals, chaired or organized 74 symposia, and presented 327 technical papers.

LDRD continues to be a crucial investment that enables the laboratory to attract and maintain top scientists and engineers. Many of the researchers hired by the INEEL in the last decade have been attracted to the laboratory after collaborating with INEEL scientists on LDRD-sponsored projects, often during yearlong fellowships at the laboratory.

The laboratory LDRD portfolio is designed to explore high-risk breakthrough science and engineering to address both short- and long-term needs, and spans the development spectrum from fundamental to applied research. Associate laboratory directors, operations managers, and other strategic and technical personnel are responsible to continually provide leadership that strengthens operations and R&D integration and shapes the total research portfolio. Approximately 64% of INEEL LDRD supports environmental management missions. The remaining 36% addresses the focused research needs of DOE's other mission areas. Most LDRD projects support more than one DOE mission area. By involving environmental operations managers in the LDRD process, the INEEL improves the integration and deployment of research results into cleanup and stewardship activities.

The LDRD process imposes accountability and high technical standards in the selection, execution, and documentation of all projects. The result is a research portfolio that advances DOE and INEEL Environmental Programs goals and supports the laboratory's role in meeting DOE mission objectives with a presence at the laboratory.

(b) Environmental Systems Research and Analysis Program

The Environmental Systems Research and Analysis Program, funded by the EM Office of Science and Technology, is an applied research program blending core and problem-driven research that best utilizes laboratory expertise and key capabilities to support the INEEL and DOE Environmental Programs mission. Problem-driven research is based on the technology needs and gaps that have been defined by the various operations programs throughout the DOE complex (e.g., High-Level Waste, Spent Nuclear Fuel, Environmental Restoration, and Waste Management), and validated by the Site Technology Coordination Groups. Core research identifies and develops the tools and capabilities that will be necessary to address the outyear issues and needs of INEEL and DOE Environmental Programs activities. Accordingly, projects of the Environmental Systems Research and Analysis Program:

- Develop focused research programs targeted at high-priority INEEL and DOE EM needs and technology gaps

- Develop integrated, multidisciplinary technical research teams focused on environmentally related research and technology development and deployment
- Implement technical approaches that will lead to cost savings and accelerated cleanup actions, facilitating application of the DOE investment to other DOE missions.

6. Corporate-Funded R&D

As another means of revitalizing the laboratory, Bechtel BWXT Idaho, LLC is reinvesting a significant portion of its fee in R&D at the INEEL. This fee reinvestment is termed *corporate-funded R&D*. The minimum amount per year is $1.5 million. The maximum amount is over $8 million annually. As Bechtel BWXT Idaho earns higher percentages of the available fee, it gives proportionally much higher amounts back to the INEEL in corporate-funded R&D.

Corporate-funded R&D projects must be of mutual benefit to the INEEL and the sponsoring parent institution. They support or enhance INEEL key capabilities necessary to further DOE missions (or help commercialize an INEEL technology), and they serve an advanced technical need of the sponsoring parent.

A project that supports the laboratory cleanup mission involves the conceptual design and cost analysis of a *smart barrier* system. This system could improve containment of waste that will remain in place over the long term and improve the monitoring of this waste to ensure that no contaminants are migrating. If the studies are favorable, follow-on work will demonstrate the system at the INEEL.

Corporate-funded R&D is also supporting long-term stewardship of natural resources. One project combines INEEL and Bechtel models to help assess major infrastructure alternatives to reduce congestion and pollution in the Greater Yellowstone and Teton Parks.

Some projects use the laboratory's world-class expertise in nuclear energy systems. For example, INEEL engineers are applying Monte Carlo analysis to help design mausoleums to shield old steam generators stored onsite at nuclear power plants. The robust model being prepared will save costs and design time for nuclear power plants that must replace obsolete steam generators.

Corporate-funded R&D is strengthening the INEEL's energy programs by funding the development of advanced fuel concepts and revolutionary fueling stations that will allow practical use of alternative fuels for transportation and power production.

INRA applies its corporate-funded R&D to enhance regional scientific and engineering capability, addressing the INEEL's technical needs and providing a *pipeline* of graduates who will join the INEEL. For example, INRA will be funding a number of fellowships among its member universities that will participate in the INEEL's Subsurface Science Initiative.

Through the first 24 months of the corporate-funded R&D program, BBWI corporate members have committed almost $9.5 million to fund more than 40 R&D projects. Funded projects have supported all INEEL mission areas (including direct support to operations activities):

- Environmental—$3.2 million
- Energy—$3.9 million
- Science and Technology—$1.4 million
- National Security—$1 million

Projects have included those supporting subsurface science, environmental stewardship, decontamination and decommissioning (D&D), energy production (including advanced nuclear systems), and other areas.

7. INEEL Peer-Review Process

The INEEL has implemented an external peer-review process to enhance the quality and relevance of laboratory science. The peer-review administrator, working under the direction of the associate laboratory director for strategic management and chief scientist, is responsible for ensuring that a robust, effective, and efficient external peer-review process is in place.

Two levels of standing peer review are envisioned. Four division-level review committees relating to the four associate laboratory directorates are currently functioning. A Laboratory Advisory Council is presently being organized. The Laboratory Advisory Council will advise the President's Office on overall laboratory health and direction as well as regional and national trends. In FY 2002 in the absence of a fully organized Laboratory Advisory Council, the four division-level review committee chairs will convene as the Laboratory Advisory Council.

The Division Review Committees advise the associate laboratory directors with regard to each division's:

- Quality of science and engineering
- Relevance to national needs and agency missions
- Performance in the technical development and operation of major research facilities
- Programmatic performance and planning
- Specific review criteria.

Division reviews are intended to be both technical and strategic. Given this intent, members are selected with an appropriate mix of backgrounds. Some are highly technical and respected in division areas and some have broad understanding of programmatic organization, industry needs, and market forces.

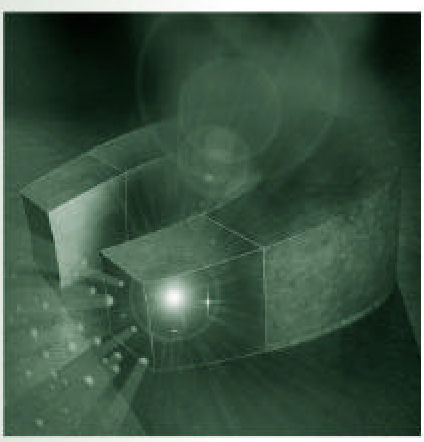
Each Division Review Committee meets at least once per year. The division reviews completed in FY 2001 and those planned for FY 2002 are listed in Table 1 below.

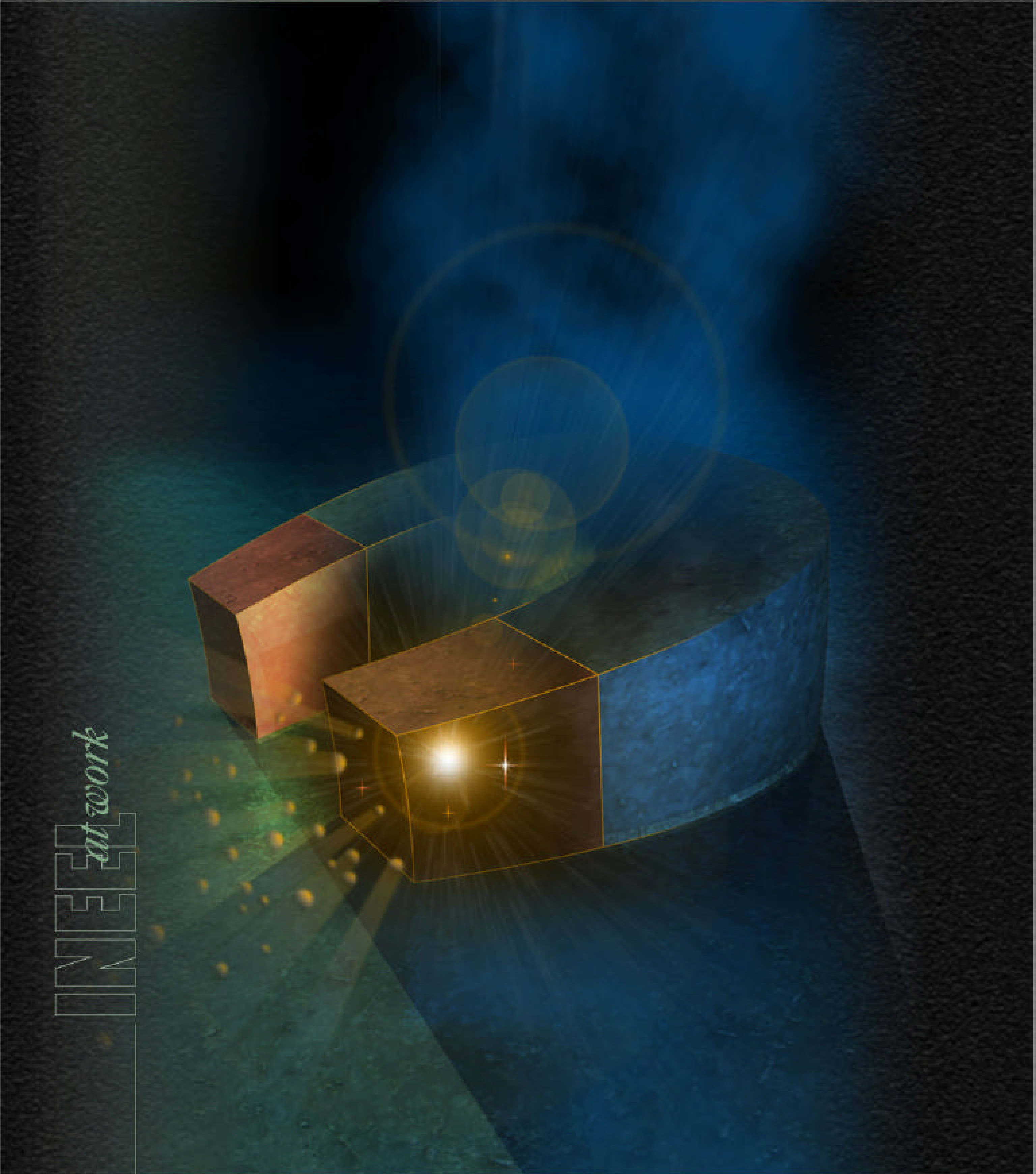
Ad Hoc Review Committees are chartered to review specific programs or projects, or to meet special needs. In 2001, *Ad Hoc* committees will review the methane hydrates program and the EM technical baseline.

Table 1. Division Review Committee meetings.

Division	FY-01 Completed	FY-02 Planned
Environmental Technology and Engineering	February 21-22, 2001	February 12-14, 2002
Nuclear and Energy Systems	October 29-31, 2001	May 20-21, 2002
Environmental and Energy Sciences	May 2-3, 2001	January 21-22, 2002
National Security	May 15-16, 2001	

Laboratory Scientific and Technical Vision and Strategic Plan





Nanomaterials

DOE's objective of understanding matter at its most fundamental level is supported at the INEEL through establishment of a focused research program in nanomaterials. Efforts in this area have already produced remarkably strong mini-magnets and super-hard steel, recently recognized with an R&D 100 Award.

III. LABORATORY SCIENTIFIC AND TECHNICAL VISION AND STRATEGIC PLAN

This section contains the INEEL's Scientific and Technology Vision and Strategic Plan that outlines a path for the INEEL to achieve its vision in the context of DOE's mission areas. Basic elements of the plan are the situation analysis, strategic goals, objectives, and strategies. A discussion of laboratory strategic issues facing the INEEL is also included. Division initiatives that focus on an individual mission area are included at the end of each mission area discussion. Laboratory initiatives that are broader in scope and applicability are included in Section IV.

A. Key Planning Assumptions

Planning assumptions for outyear planning/forecasts are as follows:

- EM remains the INEEL's primary customer through FY 2012
- The INEEL EM funding profile indicates flat funding through 2012
- R&D program planned funding and spending growth is 5% per year over escalation.
- In the next 10 years, the INEEL's focus shifts from environmental cleanup to predominantly R&D
- The INEEL will remain a multiprogram national laboratory beyond completion of its environmental cleanup mission
- Key INEEL plans, including the *Detailed Work Plan*—with all associated cost estimates and schedules—must be reconciled with and rolled up to the *INEEL Institutional Plan*
- The INEEL will complete the Subsurface Geosciences Laboratory (SGL) in FY 2007
- Integrated Safety Management/Voluntary Protection Program/International Environmental Standard 14001 are long-term priorities for the laboratory.

1. INEEL Planning Hierarchy

The *INEEL Institutional Plan* is part of the DOE planning framework comprising the DOE Strategic Plan, DOE Mission Strategic Plans, Mission R&D Portfolios, and program roadmaps. The *Institutional Plan* is the laboratory's principal planning document, driving the preparation of all other laboratory plans. Figure 2 shows the INEEL planning hierarchy and the plan's place in the overall DOE planning scheme.

The Secretary of Energy recently announced his mission priorities for the department. This plan shows the laboratory's alignment with these contemporary and refined mission priorities. Tables and figures previously appearing in this section indicating INEEL program ties to the DOE Strategic Plan and R&D Portfolios have been replaced by new tables that show the tie between laboratory programs and DOE priorities as outlined by the secretary on October 24, 2001.

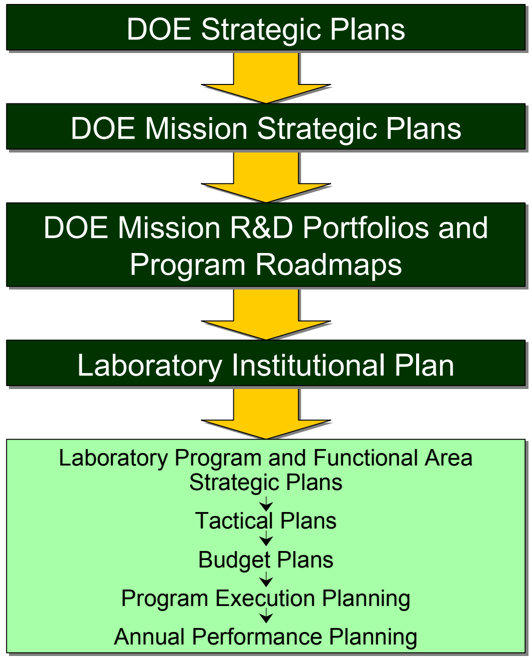


Figure 2. DOE/INEEL planning hierarchy.

B. Laboratory Strategic Vision

The INEEL has a 50-year history of outstanding contributions in furthering U.S. science and technology development. In order to realize its 50-year vision—

> *To be an enduring national resource that delivers science and engineered solutions to meet the world's environmental, energy, and security challenges.*

the INEEL must accelerate environmental cleanup and grow its reputation as an R&D laboratory.

The future path for the INEEL's environmental cleanup and its work with EM is contained in the Environmental mission area discussion in this section and the Advanced Waste Management Solutions Initiative discussed in Section IV. The expectation of the community and the state is that the laboratory will overcome all obstacles and meet its cleanup obligations in a safe, cost-effective manner in reasonable time.

In the years ahead, two-thirds of the INEEL's work will shift from environmental cleanup to R&D. A significant amount of this shift is expected in the next 10 years. Funding levels for environmental cleanup will likely decrease over time and R&D activities will grow 5%, plus escalation, each year as a result of the quality and relevance of science and technology produced at the INEEL. Current plans call for significant subcontracting of EM cleanup operations beginning in FY 2002/2003.

As the INEEL positions itself for the next 50 years, it will build on its legacy of environmental and nuclear science and engineering. The laboratory will function as lead laboratory for both EM and NE, providing excellent management and technological expertise in several areas.

The INEEL will undertake a leadership role in developing and executing EM's long-term stewardship mission. Some of the hazards at DOE sites will remain and require management strategies beyond the capability of current technologies. Current methods for providing long-term stewardship are neither cost-effective nor reliable. Advances in science and technology are required to eliminate or otherwise reduce the hazards associated with long-lived substances. In 2000, the INEEL was named the lead field site for long-term stewardship and the lead for long-term stewardship science and technology. The INEEL will also assist DOE in the development and establishment of a national long-term stewardship program. The laboratory's Environmental Stewardship and Subsurface Science initiatives (described in Section IV) form the basis for future laboratory activities.

R&D work done under the Subsurface Science Initiative (SSI) will enhance understanding of the behavior of subsurface contaminants associated with residual risk at the INEEL and elsewhere in the DOE complex. Understanding the fate and transport of such contaminants will provide a direct link to engineered solutions and systems to protect the public health, including the regional aquifers, in a timely and cost-effective way. Critical mesoscale experiments that link traditional laboratory experiments with field-scale observations will be conducted at the proposed SGL. These experiments will lead to decreased costs, enhanced worker and public safety, and reduced collateral ecological damage.

The capabilities developed for SSI will also be relevant to other DOE missions. The SSI supports understanding of subsurface processes that pertain to the exploration for and production of fossil fuels, more effective use of geothermal energy, strategies for subsurface carbon sequestration, elucidation of the subsurface fate of energy by-products, and development of such energy resources as gas methane hydrates.

The INEEL will facilitate the activities of the EM Core Laboratories. The magnitude and complexity of the EM cleanup-stewardship mission requires the optimal utilization of the laboratory and cleanup site resources. The Core Laboratories will work together as a virtual network to ensure that the best solutions are achieved and that laboratory capabilities are utilized in a focused national collaboration.

Leveraging its nuclear heritage, the INEEL will fulfill its role as lead laboratory for nuclear energy R&D. Secure energy supplies are critical to the U.S. economy and national security. In partnership with ANL, the laboratory will lead national and international R&D efforts to develop, build, and test the Generation IV nuclear reactor. The Generation IV initiative (see Section IV) frames INEEL activities in this regard.

A balanced portfolio is necessary that fully uses the laboratory's capabilities as applicable in DOE's mission areas of Environmental Programs, Energy, National Defense, and Science. To achieve this balanced portfolio, the INEEL will build upon existing relationships with DOE offices: FE, EE, SC, National Nuclear Security Agency, and Office of Intelligence (IN). Full engagement of INRA universities in both research and instructional programs and collaborations with other DOE laboratories, other universities, and private industry is essential to the laboratory's continued ability to provide solutions to customers. The Advanced Computing and Collaboration Initiative outlined in Section IV will ensure that the INEEL has the capabilities necessary to take advantage of key collaborations.

As the laboratory changes, so must its work force. As cleanup is completed, mission focus and program emphasis will also change. Some further work-force restructuring may be necessary to ensure the appropriate employee skill mix to accomplish the changing mission focus. The laboratory will also make use of staff augmentation to effectively manage fluctuations in short-term staffing needs. The INEEL must also enhance the skills of its employees to competently engage in the future responsibilities and programs of the laboratory. The INEEL will need more employees with advanced degrees, more publications, more winning proposals, and better facilities.

C. Laboratory Strategic Issues

The INEEL will need to overcome several significant laboratory challenges in order to continue providing solutions and services to its customers. The challenges represent major managerial, operational, or programmatic issues that the laboratory wishes to have considered by DOE senior management.

1. Accelerate Environmental Cleanup

The overarching challenge faced by the INEEL is accelerating its environmental cleanup schedule within current budget assumptions. The INEEL believes that realigning projects and implementing alternative solutions to those currently in the EM baseline will result in progress toward reaching accelerated cleanup goals. The INEEL will implement recommended Six Sigma Process Improvements in an effort to streamline processes for more efficient operations. The laboratory will also assess alternatives and realignment opportunities. Assessment results will be incorporated in the FY 2003-2007 Institutional Plan.

2. INEEL Revitalization

(a) Investing in Human Resources

The shift in INEEL focus discussed in Section III.B, "Laboratory Strategic Vision," will mean a similar shift in skill mix needs for the laboratory. The INEEL must ensure that it has the appropriate skill mix of senior, mid-level, and entry-level technical experts to complete critical mission assignments. Stiff competition in recruiting talented scientists and engineers make it difficult for all national laboratories to maintain the required expertise in key disciplines. To ensure that the laboratory aligns its skills and headcount with the scope of future work supported by current funding projections, a Human Resources multiyear strategic plan is being implemented.

Improving INEEL science culture is also a key element of INEEL revitalization. Improving the science culture involves increasing the number of peer reviews, encouraging publication in professional journals, and participating in scientific and engineering professional organizations. More rigorous scientific investigation, participation, and leadership by staff in scientific and professional organizations will improve the quality of INEEL research and give more value to the customer. The INEEL is actively working to address these issues.

(b) Investing in INEEL Infrastructure

As described in the discussion of INEEL infrastructure contained in Section V, many laboratory facilities at the INEEL are aging and/or require upgrading. This problem is shared by all DOE national laboratories. Deficiencies reside in the systems-intensive facilities most integral to the INEEL cleanup mission, nuclear operations, laboratory, and processing work. The INEEL is addressing this need by aggressively working to reduce the overall cost of infrastructure so that existing funds can be used for these real needs. However, there are a few mission requirements that cannot be met by cost reduction alone. An example of such an infrastructure requirement is the proposed SGL discussed later in this section and also in Sections IV and V of this plan. Capital investment in the SGL will fundamentally improve the laboratory's ability to predict the fate and transport of contaminants in the vadose zone and will support DOE's long-term stewardship, environmental restoration, and high-level waste programs. The capabilities of the SGL will also be relevant to other DOE missions, including fossil and geothermal energy, carbon sequestration, and methane hydrates. The INEEL expects to be able to take advantage of its partnership with INRA and the proximity of facilities currently operated and planned by both Idaho State University and the University of Idaho. By sharing or leasing facilities in Idaho Falls, such as the proposed university-owned Center for Science and Technology, subsurface science research facility requirements can, in part, be supported until the SGL is available. An *Infrastructure Long-Range Plan* issued in February 2001 discusses in detail INEEL infrastructure requirements and investment needs.

(c) Upgrading Information Technology

High-performance computing has revolutionized the process of scientific inquiry by allowing models of complex processes to be examined in greater detail and to be compared with experimental data much more rapidly and thoroughly than in the past. DOE has recognized that advanced computing and collaboration are critical tools for advancing scientific inquiry within all DOE mission areas. Likewise, the major laboratory initiatives of the INEEL require substantial computing capability and connectivity to achieve their goals. Through the Advanced Computing and Collaboration Initiative (see Section IV), the laboratory is proposing to upgrade its information network to improve connectivity to mainframe supercomputers at other national laboratories and elsewhere. This connectivity will enhance the INEEL's simulation and modeling capability and directly support all other laboratory initiatives and DOE customer requirements. The laboratory will also aggressively develop partnerships with DOE, other federal agencies, INRA, and additional university computing programs.

D. Laboratory Objectives and Strategies—Environmental Program

(a) Situation Analysis

The INEEL, as DOE's lead EM laboratory, is unique in its approach toward and responsibility for achieving the DOE Environmental mission. With responsibilities from science through engineering to deployment, the INEEL is positioned to make outstanding contributions to the Environmental mission. INEEL operations will identify the needs and opportunities, and INEEL scientists and engineers will supply the science and technologies to meet the needs.

The INEEL's share of the Cold War legacy of materials and wastes that must be analyzed, treated, sorted, and dispositioned is 250 metric tonnes of spent nuclear fuel; 9,300 m^3 of high-level and sodium-bearing waste; 65,000 m^3 of stored transuranic waste; 2,300 m^3 of mixed low-level waste; <1,000 m^3 of low-level waste; and 420,000 m^3 of various environmental remediation wastes. (The latest INEEL inventory is available at http://environmental.inel.gov/tsd/cfm#wastes.). Regulations and Idaho-specific agreements (e.g., Idaho Settlement Agreement, Federal Facility Agreement and Consent Order) as supported by public participation processes (e.g., environmental impact assessments) establish the mandatory milestones and the next tier of direction for INEEL institutional planning.

The INEEL has established a vision for completing high-priority cleanup work, which states "by 2012, the INEEL will have completed its high-priority cleanup actions: placed material in safe storage pending repository availability; tank waste and transuranic waste shipped and disposed; and the Site transferred to a new lead program secretarial office. Ongoing activities will include Resource Conservation and Recovery Act (RCRA) closures, D&D, and long-term stewardship."

Accomplishing cleanup work on an accelerated schedule is a key challenge facing the INEEL EM Program. Assuming $444 million per year flat funding, the INEEL must manage under the current baseline, a funding shortfall of $11.5 billion ($13.8 billion including safeguards and security) extending from FY 2001 through FY 2035. However, the INEEL believes that progress toward reaching closure status is possible with a realignment of projects and through implementing alternate solutions to those currently in the baseline.

The INEEL conducted several Six Sigma Process Improvement Projects in FY 2001 focused on applying standard statistical techniques and methods for streamlining INEEL processes such as waste sampling, materials analysis, pollution prevention, waste minimization, and chemical management.

Improvements include expediting the work control processes through a graded approach in sampling low-risk waste and materials; implementing improved waste minimization systems including waste generator financial responsibility, chemical exchange, and improved waste minimization assessments; and better use of excess chemicals at the INEEL to reduce procurement and waste disposition costs. Recommendations from these initiatives will be implemented in FY 2002.

The INEEL is also assessing alternatives and realignment possibilities in line with the Secretary of Energy's complexwide top-to-bottom review of EM. The INEEL is performing an internal assessment of the potential opportunities to accelerate cleanup work in preparation for eventually closing the EM Program at the INEEL. The results of these assessments will be available to incorporate into the FY 2003-2007 Institutional Plan.

The INEEL is following the strategy of using operational needs to drive investments in solution-oriented science and technology. It has developed an integrated, prioritized list of EM needs and opportunities. These needs identify specific site problems within planned project activities. The specific operational requirements defined by these needs thereby drive the required R&D and subsequent technology deployment activities to address and ultimately solve INEEL and national environmental needs. A matrix of the relationship between the INEEL's most significant needs and the associated research efforts under way to resolve these challenges is presented in Table 2.

The INEEL has been named the lead laboratory for long-term stewardship science and technology as well as lead field site for long-term stewardship implementation. Given its climate, geology, land size, diversity of missions, and test-bed opportunities, the INEEL is ideally suited to fill its role to help DOE establish a robust R&D program to address Environmental Programs objectives, including long-term stewardship.

Additional scientific understanding is needed to reduce uncertainties in many critical areas associated with DOE's Environmental Programs mission and long-term stewardship responsibilities. The INEEL, through its various leadership roles for the EM program, works to better understand needs as well as the potential environmental solutions. For example, the INEEL Vadose Zone Science and Technology Roadmap helps to identify the technology needs at the INEEL related to understanding the underground movement of contaminants. The information presented in this roadmap will feed the broader DOE National Vadose Zone Science and Technology Roadmap as well as the EM Long-Term Stewardship Program. As a leader in integrating these research efforts, the laboratory will continue to identify collaborative opportunities for multisite research and environmental management integration. Complementary efforts between the INEEL, Pacific Northwest National Laboratory, Savannah River Technology Center, and other national laboratories will focus the necessary R&D of the EM program.

INEEL Environmental Program activities, both operations and R&D, support the Secretary of Energy's recently released missions and priorities for the department. Table 3 links INEEL programs to these priorities.

In assessing the adequacy of the EQ R&D portfolio, 10 technical categories supported by 42 program elements were evaluated. Four areas were identified as having a significant need for improving the investments made in those areas:

- Environmental Restoration
- High-Level Waste
- Deactivation/Decommissioning

Table 2. Examples of R&D supporting INEEL needs.

Environmental Cleanup Challenges	Supporting R&D
Waste Form Development for High-Level Waste.	• INTEC Specific Projects • Tank Focus Area • EM Science Program • Environmental Systems Research and Analysis • Savannah River Site and Pacific Northwest National Laboratory Collaborations • Laboratory-Directed Research and Development
Robotic Applications for Deactivation, Decontamination, and Dismantlement.	• Decontamination and Decommissioning Focus Area • Robotics Crosscutting Program • Environmental Systems Research and Analysis • Oak Ridge National Laboratory Collaborations
Characterization and Monitoring in Environmental Restoration.	• Subsurface Contaminants Focus Area • Fernald Site Collaborations • INEEL Environmental Restoration Program • Environmental Systems Research and Analysis
Understanding Contaminant Fate and Transport in the Subsurface.	• INEEL Subsurface Science Initiative • INEEL Environmental Restoration Program • Subsurface Contaminants Focus Area • EM Science Program • Environmental Systems Research and Analysis • Long-Term Stewardship Program
Nondestructive Examination of Spent Nuclear Fuel.	• INEEL Spent Nuclear Fuel Program • National Spent Nuclear Fuel Program • Transuranic and Mixed Waste Focus Area • University Collaborations
Characterization and Transportation of Transuranic Waste.	• INEEL Waste Management Program • Transuranic and Mixed Waste Focus Area • Environmental Systems Research and Analysis • Carlsbad Field Office Collaboration

Table 3. INEEL EM program contributions to DOE missions and priorities, 10/24/01.

DOE Environmental Priorities	INEEL Environmental Programs
1. Complete the top-to-bottom review and accelerate cleanup and closure sites where there is no longer a National Security mission	Waste Management Program Environmental Restoration Program Voluntary Consent Order Program Spent Nuclear Fuel Program High-Level Waste Program National Vadose Zone Roadmap Environmental Stewardship Initiative Subsurface Science Initiative Advanced Waste Management Solutions Initiative EM Science Program Environmental Science Research and Analysis Program National Transportation Program National Spent Nuclear Fuel Program
2. Complete the process of determining the suitability of the Yucca Mountain site for permanent storage of spent nuclear fuel	National Spent Nuclear Fuel Program INEEL Environmental Technology and Engineering Laboratory

- Long-Term Stewardship.

The INEEL is allocating a significant portion of its LDRD, Environmental Systems Research and Analysis Program, and program-specific R&D investments in support of these four areas. As an example, a major focus at the INEEL is in the area of subsurface science and the fate and transport of contaminants, research that supports many of the program elements in the four priority areas.

(b) Strategic Objectives

The INEEL is focusing on four strategic objectives that directly support the DOE Environmental Programs priorities. These objectives are discussed briefly below.

Initiate or Complete all Environmental Program Solutions for the INEEL by 2012

Laboratory cleanup commitments will be completed as follows:

- All INEEL environmental remediation activities, except long-term pump and treat, will be complete at Waste Area Group (WAG) 1, 2, 4, and 5 (see "INEEL WAGs," Appendix D) by 2010
- WAG 7 (RWMC), and WAG 3 (INTEC) remediation will be under way
- Ceased use of the five high-level waste pillar and panel vaults by 2003 and closure of INTEC tanks by 2012
- Treatment of sodium-bearing waste will be completed
- Disposition of calcine will be determined
- Ship all transuranic waste to WIPP
- By 2010, the INEEL will be using DOE sites and private sector facilities for treatment and disposal of wastes generated at the INEEL
- All Three-Mile Island fuel will be in dry storage
- Transfer of Spent Nuclear Fuel from wet to existing dry storage
- The INEEL will continue to receive domestic spent fuel shipments
- Nonvitrification of sodium-bearing waste
- Consolidate INEEL operations and inactivate approximately 200 buildings.

Along with these cleanup program objectives, the INEEL plans to transfer to a new lead program secretarial office during this timeframe.

To achieve this cleanup objective, science and technology will play a critical role. Figure 3 depicts one of the processes used to ensure that R&D activities are integrated with the cleanup program. In this case, Waste Management Technologies personnel work directly with the EM programs to ensure that development efforts are fully supporting high-priority EM cleanup efforts.

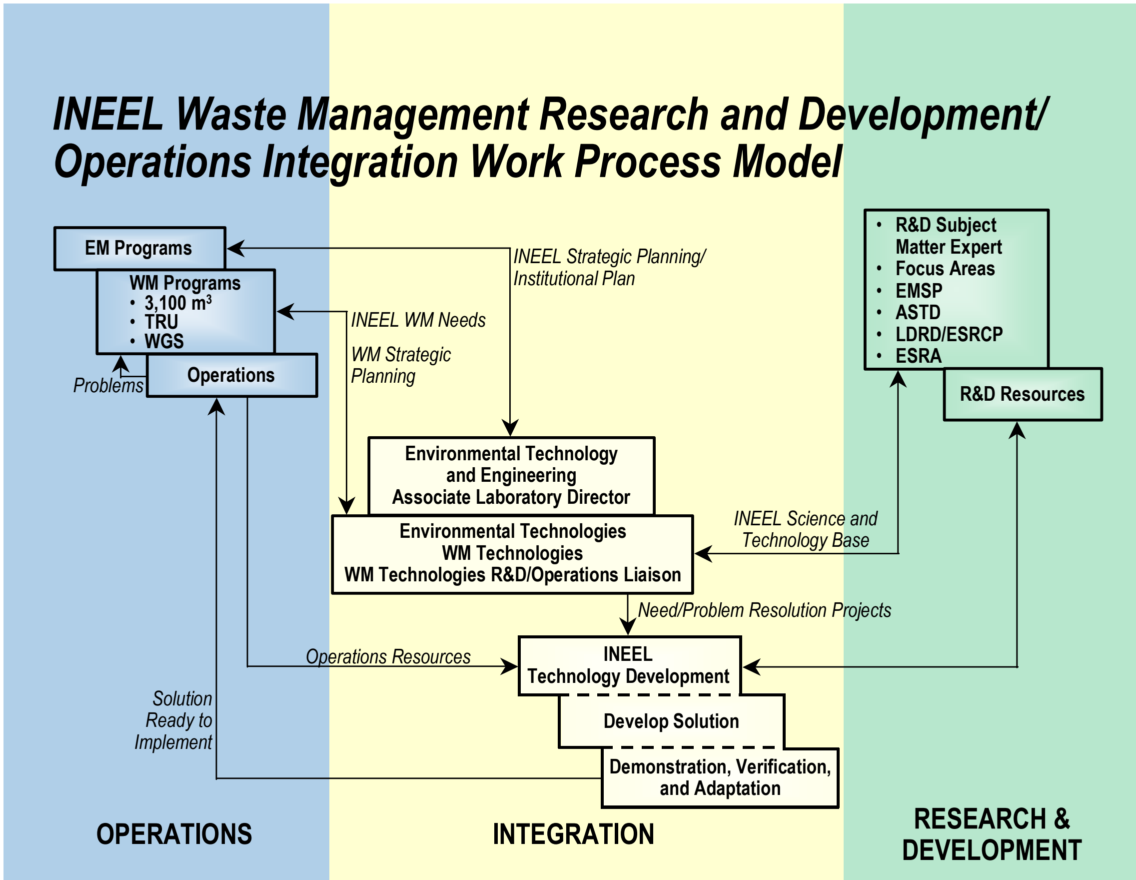


Figure 3. INEEL Waste Management R&D/Operations Integration work process model.

Apply Science and Technology to Reduce the Cost, Risk, and Schedule of the INEEL's EM Program

The INEEL will use its expertise to define sustainable designs and achieve preferable end states for DOE's energy and environmental problems. The laboratory has generated an operations-based focus for science and technology solutions. The science and technology needs and opportunities previously described have been prioritized for the environmental restoration, waste management, high-level waste, spent nuclear fuel, and nuclear material programs. These needs are being addressed by specific R&D efforts at the INEEL and beyond. For example, the INEEL has formed partnerships with INRA universities, private industry, and other national laboratories to advance science solutions to address cleanup needs.

Enhance DOE's Ability to Make Technically Defensible Decisions

The challenge for DOE is to ensure that a systematic approach, including both sound science and stakeholder involvement, forms the basis for decisions. Making enduring technical decisions has proven to be a challenge for DOE's cleanup program. In many cases, decisions that have been made could not be implemented in a timely manner or were reversed because of pressure from the public, state agencies, or local or federal government. The INEEL will take a lead role in helping to identify new paradigms of decision-making that will be implementable by taking advantage of state-of-the-art advances in social sciences. Recognition that a scientifically defensible basis is necessary but not sufficient is critical to the future success of our environmental management programs. The INEEL will continue to perform R&D,

technology development, demonstration, and deployment, and systems analysis and integration. These activities will fully engage the public and other stakeholders, including other DOE laboratories, to ensure that sound science underlies decision-making, as well as to ensure ultimate acceptance of such decisions. In addition, the INEEL will develop new mechanisms of involving the public in its decisions based on social-behavioral sciences and aimed at the development of true partnerships to solve the nation's environmental problems. Through its leadership role in such programs as the EM National Vadose Zone Science and Technology Roadmap and the DOE EM Long-Term Stewardship Program, the INEEL will continue to integrate resources across the DOE complex to address the broad set of environmental challenges at hand and to ensure that science and technology advance in a timely manner to support compliance agreements. This leadership will be broadened from a traditional science and stakeholder approach to one that embraces learning and partnership.

As cleanup progresses, emerging issues surrounding the long-term stewardship of DOE sites are garnering greater attention from DOE and other federal agencies, tribal nations, state and local governments, the Environmental Protection Agency (EPA) and other regulators, and the public. Figure 4 depicts the EM cleanup long-term stewardship process. Long-term stewardship activities are already under way at more than 40 DOE sites. More than 100 sites are eventually expected to require long-term stewardship by DOE. The cost of long-term stewardship will be high. Further investments by DOE in understanding the underlying science and technology of the environmental problems as well as in understanding the public's perceptions, beliefs, and desires are necessary to make acceptable and effective decisions surrounding the cleanup mission and resultant long-term stewardship requirements for these sites.

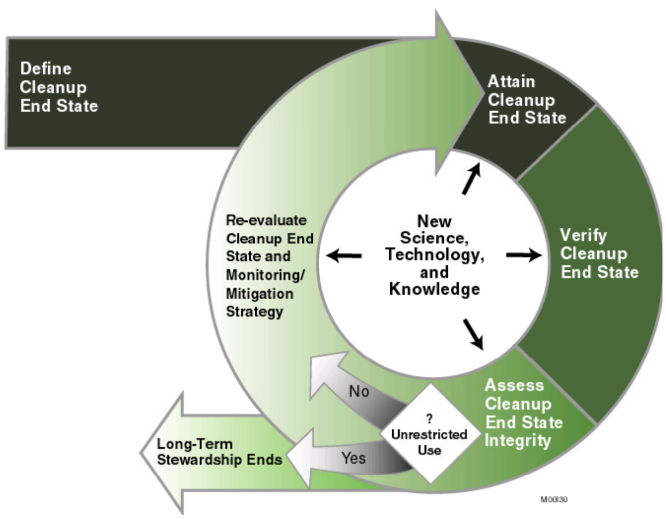


Figure 4. EM cleanup/long-term stewardship process.

Serve the Nation as an Environmental Science and Engineering Solution Provider to DOE's Cleanup and Long-Term Stewardship Missions

The INEEL's mission will continue beyond 2006 as a DOE multiprogram national laboratory. The laboratory's EM program will change over time from active cleanup to implementation of long-term stewardship activities such as monitoring, surveillance and maintenance, D&D of surplus facilities, and facility closures. By successfully managing its own Environmental Programs mission during its 50-year history, the laboratory is positioned to serve the nation as a science and engineering provider for the DOE and world's environmental challenges. DOE and the INEEL will focus on providing solutions that ensure timely and cost-effective mitigation of those challenges. To fulfill the role as the lead laboratory for long-term stewardship science and technology, an initiative has been established that focuses on integrating the necessary science and engineering activities required to improve long-term stewardship decisions and implementation. A detailed discussion of this initiative can be found in Section IV of this plan.

A critical aspect of long-term stewardship involves an enhanced understanding of the physical, geochemical, and microbial processes occurring in the subsurface. Therefore, the INEEL is coordinating a field-oriented interdisciplinary research program (i.e., Subsurface Science Initiative) to develop an improved understanding of processes occurring within the earth's subsurface and to use this improved understanding to accurately predict and monitor the movements and transformations of contaminants. This initiative directly supports DOE's environmental missions by improving understanding of subsurface processes. Reducing uncertainty will provide a sound technical basis for cost-effective cleanup solutions and improved long-term stewardship of DOE assets.

(c) Strategies

The following strategies will allow the INEEL to achieve its Environmental Programs objectives.

Integrate Operations and R&D

R&D activities at the laboratory are focused on DOE's operational cleanup mission. This integration of R&D and cleanup operations is being accomplished to enhance the INEEL EM cleanup mission while leveraging the INEEL's capabilities in support of other DOE mission areas. Interfaces and work processes between operational and R&D organizations have improved coordination across the INEEL. A data model has been developed that will ensure that R&D researcher qualifications and research project results are available to the end user and that end-user needs are available to R&D personnel. The planning and execution of cleanup projects involve R&D personnel, while all environmental R&D projects reflect end-user involvement. Three laboratory initiatives are specifically focused on the cleanup program. The Advanced Waste Management Solutions, Environmental Stewardship and Subsurface Science initiatives are discussed in detail in Section IV of this plan.

This successful management approach has resulted in significant improvements to the operation of the INEEL. During FY-01, 45 deployments were made across the EM program, addressing 14 different Project Baseline Summaries. Of these, 24 were first-time deployments and nine were considered as high-impact deployments. The life-cycle cost avoidance for the 24 first-time deployments is estimated at over $70 million. Technology deployments are continually evaluated and entered into the Integrated Planning, Accountability, and Budgeting System per DOE Headquarters (DOE-HQ) guidance.

Realign/Reduce INEEL Infrastructure Liability

As the laboratory moves toward completion of much of its cleanup mission, a stronger emphasis will be placed on long-term stewardship issues. This change of priorities presents an opportunity to realign and reduce INEEL infrastructure. While this realignment will lead to a requirement for different personnel skills and facilities, the INEEL will also have the opportunity to optimize existing resources, personnel, and infrastructure. Section V, "Infrastructure and Support Services," discusses this topic in more detail.

For example, the INEEL infrastructure realignment, such as the potential early closure of non-SMC activities at TAN, will allow the laboratory to reduce its overall surveillance and maintenance costs, facilitate technology insertion by using more facilities as test beds, and reuse or release large areas for industrial use.

Reduce R&D Time for New Solutions

The INEEL has been a leader in establishing a prioritized problem-driven program baseline. Operational needs and requirements form the basis for science and technology activities. A driving requirement for R&D is to reduce the development time to ensure solution availability in time to meet the operational requirements. Strong project management supports the development and implementation of these creative solutions within operational baselines to satisfy compliance milestones. An example of this is an enhanced bioremediation and natural attenuation technique developed by the INEEL that has been successful in remediating the trichloroethylene solvents in TAN groundwater.

A methodology being used at the INEEL to ensure the R&D solutions are available in a timely manner is the use of science and technology roadmapping. Roadmapping is a highly effective way to forecast critical new technology development requirements and a valuable planning tool for decision making. The roadmapping process clarifies critical missions, applies collaborative realism to solve complex problems, and builds consensus to address near- and long-term science and technology needs. This methodology has been successfully used for several key INEEL projects, including the INEEL vadose zone, sodium-bearing waste, and calcine treatment alternatives projects.

Lay Technical Groundwork for Long-Term Monitoring and Surveillance

The INEEL's Environmental Stewardship Initiative discussed in Section IV will focus investments in science and technology that result in significant reductions in risk and cost. At the same time, the laboratory will continue to protect human health and the environment from hazards/risks remaining at DOE sites after cleanup is complete. A significant thrust of the Environmental Stewardship Initiative is to establish the INEEL as a model program and to leverage the knowledge developed here to the rest of the DOE complex.

The INEEL will lay the technical groundwork for long-term monitoring and surveillance by evaluating the impacts and effectiveness of the remedial actions during the design phase. The impacts of operations on the animal and plant life will be evaluated long-term and will be considered during the design of the monitoring and surveillance networks. As a result, both the remedial actions and monitoring and surveillance networks will be technically defensible and accepted by interested parties.

Develop EM Core Laboratory Collaborations to Generate and Utilize the Best Science and Engineering

The magnitude and complexity of the EM cleanup-stewardship mission requires the optimal utilization of DOE laboratory and site cleanup resources. Under the INEEL's EM lead laboratory charter, a major collaborative effort has been established with the Radiological and Environmental Sciences Laboratory (RESL), Savannah River Technology Center (SRTC), Environmental Management Laboratory (EML), Pacific Northwest National Laboratory (PNNL), Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory (LANL), and National Energy Technology Laboratory (NETL). The directors of these laboratories signed a Memorandum of Understanding to collectively operate as the EM Core Laboratories to ensure that the best solutions are achieved and that their respective capabilities are utilized in a focused, national collaboration. This is the first time the laboratories have agreed to integrate their efforts on such a large scale. They are focusing on providing the science and technology necessary for an accelerated cleanup and risk reduction.

The EM Core Laboratories alliance has begun working several major issues and has developed white papers outlining the paths forward. The alliance is currently focused on three key areas:

1. Need to improve understanding of fate and transport of subsurface contaminants. A set of recommendations have been made to DOE-HQ to establish an initiative to increase the investments in this area to ensure that an adequate basis is developed to support cost-effective decisions regarding cleanup.

2. Providing support to develop the technical rationale for an improved regulatory framework for DOE's WIPP. The focus is to ensure that the appropriate regulatory drivers are in place for cost-effective final disposal of transuranic waste.

3. Development of an improved technical basis for credible and enduring decisions that support alternatives for a more effective cleanup program, i.e., significant reductions in life-cycle costs and schedules.

National and international collaborations will continue to be established to generate and utilize the best science and engineering. Current Environmental Programs collaborative efforts include the Subsurface Science Initiative, National Vadose Zone Science and Technology Roadmap, Spent Nuclear Fuel Program, High-Level Waste Program, EM Long-Term Stewardship, Transuranic and Mixed Waste Focus Area.

The INEEL has formed a collaborative team with Sandia National Laboratories to further develop, research, and model requirement sets related to alternative transport systems for transuranic waste destined for the Waste Isolation Pilot Plant (WIPP) in New Mexico.

Transfer Successful Environmental Solutions to Other Sites and Selected Industries

The laboratory is positioned to share innovative technology-based solutions across the DOE complex and with commercial service providers. Ongoing collaborations are enabling transfer of environmental solutions, acceleration of cleanup schedules, reduction of programmatic and environmental risk, and improvements in operational excellence. Examples of collaborations with other DOE sites include a recently signed memorandum that provides INEEL technologies and services to the Mound Environmental Management Project, and transfer of an INEEL-developed expert system for validation of transuranic waste characterization data to the Los Alamos National Laboratory.

In response to the report of the Secretary of Energy Advisory Board's Panel on Emerging Technological Alternatives to Incineration, the Transuranic and Mixed Waste Focus Area, jointly managed by the INEEL and the Carlsbad Field Office, has developed a Preliminary Research, Development, Demonstration, and Deployment Plan, with the intention of deploying new mixed-waste treatment technologies by 2007. Implementation of this plan will provide facilities and infrastructure required for commercial service providers to validate technologies suitable for treating mixed transuranic wastes stored at the INEEL's RWMC.

E. Laboratory Objectives and Strategies—Other Strategic and Supporting Programs

1. Nuclear Energy

(a) Situation Analysis

Nuclear energy is a vital and strategic resource in the world's energy mix, supplying 20% of U.S. and 17% of global electricity. Nuclear-powered generating plants do not emit carbon dioxide or other greenhouse gases—yielding a significant benefit to air quality in the U.S. and the world. To produce the amount of electricity contributed by nuclear-powered generating plants in the U.S. alone would require fossil-fuel-powered generating plants in the U.S. alone to add more than 186 million tons of carbon emissions per year to the atmosphere.

Despite these benefits, the future viability of nuclear power faces challenges. The President's Committee of Advisors on Science and Technology and recent reports compiled by DOE national laboratories conclude that the U.S. nuclear power industry must:

- Improve nuclear plant economics
- Provide sustainable energy development that improves resource utilization and long-term waste management
- Continuously improve safety performance and enhance public confidence.

The U.S. needs significant new electric-generation capacity over the next 20 years. Present domestic nuclear power plants have demonstrated their reliability and a high degree of safety and cost-effectiveness. However, the decision to build new nuclear plants in the U.S. still faces considerable economic risk and potential public opposition, and new units of the current generation are not expected to compete broadly in the U.S. market. Growth in electricity demand will be highest in the developing economies of Asia, providing opportunities for significant nuclear-capacity additions. Among the nations that will seek nuclear technologies in the 21st century are those that do not currently possess advanced technological infrastructures required to support the development of nuclear power. Thus, the next generation of reactors needs to address issues such as nonproliferation related to worldwide use, not just their resumed deployment in the U.S.

The potential revitalization of nuclear power in the U.S. and its continued worldwide expansion strongly underscore the need for a fourth generation of nuclear power plants. Generation IV has been defined by DOE as "a new generation of nuclear energy systems that can be made available to the market by 2030, offering significant advances toward challenging goals in the broad areas of sustainability, safety reliability, and economics."

The INEEL's roots are in nuclear energy. Opportunities created by this renewal of interest will form the basis for a number of strategic activities at the INEEL. The laboratory has designed, built, and operated 52 reactors in its 50-year history. It currently operates the largest and most versatile test reactor (the Advanced Test Reactor) in the DOE complex. DOE has committed to take the appropriate steps to increase the Test Reactor Area budget to ensure its continued operation. The INEEL's leading-edge advanced reactor design, fuel development and testing, and nuclear energy R&D programs are conducted for a broad spectrum of customers including NE, SC (Fusion Energy Sciences, and Biological and Environmental Research), as well as the Nuclear Regulatory Commission and other U.S. agencies and international customers.

In 1999, DOE selected the INEEL and Argonne National Laboratory to serve as lead laboratories for nuclear reactor technology to assist NE in maximizing the value of the various reactor technology research activities conducted by DOE. The lead laboratories will be a key contributor to the enhancement of U.S. leadership in nuclear energy internationally.

In FY 1999, DOE initiated the Nuclear Energy Research Initiative, a broad-based program of peer-reviewed research into innovative nuclear energy technologies at U.S. national laboratories, universities, and industry. The program provides for R&D to address key issues affecting the future of nuclear energy—economics, safety, waste management, and proliferation. In FY 2000, DOE initiated the

Nuclear Energy Plant Optimization program to conduct research to extend the life and improve the reliability, availability, and productivity of existing nuclear plants. In FY 2001, DOE initiated an International Nuclear Energy Research Initiative that supports collaborative R&D projects between the U.S. and other countries that have endorsed Generation IV. Also, beginning in FY 2001, DOE initiated the Generation IV Program, with major deliverables in FY 2002.

To maximize the value of these various programs, DOE is acting with the lead laboratories to:

- Create a Roadmap Integration Team jointly led by Argonne National Laboratory and the INEEL to execute the Generation IV roadmap
- Organize key national and international collaborations through the Generation IV International Forum
- Maintain world-class staff and key facilities
- Maintain a living knowledge base to understand, evaluate, and provide for future application of the results of its research programs
- Utilize the lead laboratories as a technical resource for NE decision-making.

Table 4 contains Nuclear Energy Program contributions to DOE missions and priorities.

Table 4. INEEL Nuclear Energy Program contributions to DOE missions and priorities.

DOE Energy Priorities	INEEL Nuclear Energy Programs
1. Strengthen our ability to identify and protect our critical infrastructure that supports the production and delivery of energy	
2. Implement the President's National Energy Plan	Generation IV Nuclear Reactor Nuclear Energy Research Initiative International Nuclear Energy Research Initiative Nuclear Energy Plant Optimization Program Power Plant Life-Extension Program
3. Identify new sources of energy for the future	
4. Direct R&D budget toward relatively immature ideas and innovations and ensure greater application of mature technologies	

(b) Strategic Objectives

The INEEL has the following four strategic objectives in nuclear energy over the next 5 years:

Complete a Roadmap for Generation IV in FY 2002, with Key Involvement of International Stakeholders, U.S. Industry, Academia, and National Laboratories

The roadmap will be the basis for a long-term Generation IV R&D Program. The roadmap will (a) survey a broad portfolio of relevant technologies and system concepts, (b) explore technical issues that must be resolved, (c) recommend a long-term program to address the issues, (d) identify valuable needed collaborations, and (e) identify institutional challenges facing Generation IV.

With the completion of the Generation IV Roadmap, NE will have a guide for developing the most promising concepts toward commercial deployment on or before 2030. They will have a structured process to (1) select the concepts that have the best prospects for substantial progress toward the Generation IV goals, (2) assess the expected performance of those concepts against the Generation IV goals, (3) evaluate their technology gaps, and (4) estimate the needed R&D to close the gaps. These later stages are expected to produce a detailed R&D plan that will be used for Generation IV program planning and technology development.

Make Substantial Contributions to Generation IV

Following the Generation IV roadmap, the Generation IV R&D program begins in FY 2003. There are likely to be major projects in the areas of fuel design and testing, high-temperature materials and systems, reactor analysis and design, and new regulatory analyses. The lead laboratories will make substantial contributions to the R&D needed for Generation IV through cutting-edge research, strong international collaborations, and key industry partnerships. Following the R&D program, the ultimate objective is the demonstration and deployment of the next generation of nuclear reactors.

The Generation IV R&D Program has put DOE at the forefront of an active international effort to develop revolutionary nuclear power systems that can be deployed worldwide before 2030. Generation IV provides DOE the opportunity to be a leader on a new international program to develop next-generation nuclear energy systems. Generation IV will have a major impact on the ability of the U.S. to renew its vital nuclear infrastructure and international nuclear leadership.

Renew Key Nuclear Infrastructure at the INEEL in FY 2002 through 2006

Key infrastructure at the INEEL will be renewed during FY 2001 through 2005, with mission initiatives in broader areas of nuclear technology such as:

- Operate a national user facility for tritium research to support fusion and defense R&D needs. This facility, known as the Safety and Tritium Research Facility, is being commissioned in FY 2002 at the Test Reactor Area.
- Enhance the in-pile experimental capabilities of the Advanced Test Reactor with facilities such as the Irradiation Test Vehicle, a flexible in-pile facility that can irradiate more than a dozen different tests with individual temperature and flux control.
- Produce Pu-238 for deep space missions.

Due to the age of most site facilities, maintaining the current infrastructure demands both corrective and preventive maintenance. Extensive refurbishment and upgrades to support facilities (hot cells, laboratory spaces, engineering support facilities, etc.) will be needed to successfully develop the initiatives outlined above.

These infrastructure enhancements will provide DOE with capabilities more closely aligned with the vision for future missions of the INEEL and will better enable meaningful, challenging mission activities to be accomplished.

Establish New User Facilities Based on the ATR

The INEEL will enhance the ATR by developing plans for user facilities with broad participation by potential customers and stakeholders. The goal of this activity is to increase the attractiveness and utility of the ATR for users while minimizing impacts on its primary mission. Designation of new user facilities will lay the groundwork for increased sponsorship of the ATR, as well as provide the basis for increased collaborations with industrial and international partners.

By making the ATR available to a larger customer base, DOE will be better able to retain and maintain the unique capabilities of the world's largest nuclear test reactor as an asset for all future nuclear research.

The above objectives will be accomplished in cooperation with Argonne National Laboratory. The INEEL and Argonne are co-lead laboratories for nuclear reactor technology.

(c) Strategies

The INEEL will pursue the following strategies toward these objectives:

Co-Lead Generation IV Roadmap Development

The lead laboratories will conduct Generation IV roadmapping activities that feature international stakeholder participation and strong connections to the nuclear industry. An international consensus for Generation IV will be built and strengthened through the Generation IV International Forum. The INEEL will contribute to a vital Generation IV R&D program that is guided by the roadmap. Generation IV is a laboratory initiative. See Section IV for more information.

Support NE as Lead Laboratory

The lead laboratories will support NE in analyzing and implementing recommendations from the Nuclear Energy Research Advisory Committee. The INEEL will provide support for the activities of the Nuclear Energy Research Advisory Committee, particularly with respect to developing and implementing the Long-Term R&D Plan. The laboratory will also help DOE integrate the Nuclear Energy Research Initiative and the International Nuclear Energy Research Initiative with Generation IV. The lead laboratories will be a key resource for NE program planning and assessment.

Develop ATR as a User Facility

New user facilities will be established based on the Advanced Test Reactor including:

- Fuel performance studies based on the Irradiation Test Vehicle in FY 2002
- A shuttle irradiation system for research and production use
- Associated capabilities to support postirradiation examination and materials testing.

While the user facilities will attract a broad spectrum of research projects, they will require funding for their development as well as for their continued operation and maintenance.

2. National Security

(a) Situation Analysis

The National Security mission is driven by policies that arise from the increasingly complex global environment since the end of the Cold War. The complexity of that global environment was highlighted by the September 11th attacks in New York, Virginia, and Pennsylvania. Although the threat of a broad-based global conflict is reduced, regional instabilities increase the potential for nuclear proliferation and terrorist deployment of weapons of mass destruction. Political and economic instabilities caused by the breakup of the former Soviet Union have increased concerns of accountability, control, and disposition of nuclear weapons and fissile materials. Further, potential employment of weapons scientists by rogue nations or terrorists enhances the risk that nuclear weapons could be produced by new hostile entities.

Theft or diversion of nuclear weapons or materials is a well-established threat to national security. Greater technical and planning sophistication of terrorists provides an increasing threat to the U.S. population and infrastructure. As a result, DOE and other branches of the federal government are increasing their focus on threat mitigation through the Homeland Security strategy effort.

Historically, key DOE policies have been directed toward reducing the global nuclear threat by supporting the Strategic Arms Reduction Treaties (START I, II, and planning for III), nuclear-testing moratorium, Treaty on the Nonproliferation of Nuclear Weapons, and Presidential Decision Directives on the Nonproliferation of Weapons of Mass Destruction and Counterterrorism. Currently, the administration is defining the direction for such policies. In the interim and for the foreseeable future, DOE maintains a key mission supporting the country's nuclear deterrence capability.

With the Department of Defense (DOD) and other federal agencies, DOE has priority Homeland Security programs focused on detecting, deterring, and countering terrorism involving weapons of mass destruction. Programs at the INEEL continue to support development of improved detection and response technologies, and the laboratory will continue to provide considerable technology development and environmental planning for the chemical weapons destruction program of DOD.

DOE's effort to counter nuclear proliferation includes programs to prevent and detect proliferation and to monitor treaties and agreements. DOE manages some of these programs directly and supports other government branches for others.

The U.S. and countries of the former Soviet Union work together on efforts to redirect scientists formerly engaged in work on weapons of mass destruction and to increase protection for nuclear materials. In addition, with the Russian Federation, programs are under way to cease any further production of weapons-grade materials and to reduce the stocks of excess highly enriched uranium and weapons-grade plutonium.

If and when new bilateral agreements are finalized, DOE is scheduled to develop two new programs with Russia. One involves cooperative development of spent fuel storage and waste repository options to provide Russia with a viable alternative to the continuation of its current practice of separating plutonium from civilian nuclear fuels. The second program will engage Russia on work to develop more proliferation-resistant nuclear fuel technologies. The INEEL's leadership roles for the National Spent Fuel Management Program and Office of Nuclear Energy position it to play key roles in both of these initiatives.

Of increasing importance to DOE is the Critical Infrastructure Protection Program that correlates with the Homeland Security initiative of the current administration. Under the Critical Infrastructure Protection Program, DOE supports the Presidential Decision Directive 63 in May 1988 in three ways through its Critical Infrastructure Protection Office. It:

- Protects its own infrastructure, addressing needs for physical and cybersecurity
- Leads in interagency efforts focused on protecting energy infrastructures
- Applies capabilities of the national laboratories to solve problems within the 12 infrastructure sectors of the initiative.

The INEEL supports this ongoing program with expertise to target national needs in the areas of information and communication infrastructure, cyberintrusion detection and mitigation, counterterrorism sensors (biological and chemical), counterterrorism response within the transportation infrastructure, electric power control and distribution systems, and vulnerability assessment and consequence management. By establishing a presence on many committees currently looking into the issue of homeland security, the INEEL will establish a diverse program building on the strengths it has developed in other mission areas of DOE.

Environmental security is threatened from both past and current activities of the military, industry, and terrorists. A priority for environmental security is increased funding in federal agencies. Examples of areas requiring increased funding include U.S. efforts to assist the Russian Federation with the decommissioning of its nuclear submarines and international efforts to end nuclear-weapons testing by substituting testing with simulation modeling.

Experience, expertise, and challenges at the INEEL related to DOE's Environmental mission provide opportunities to support DOE's nuclear deterrent mission. Appropriate infusion of INEEL expertise into the National Nuclear Security Administration complex provides an opportunity to help DOE decrease its cost for meeting environmental compliance requirements in the nuclear weapons complex while increasing operating efficiencies. Past efforts have included support for the design, construction, and initial operation of specialized equipment and systems that support waste characterization, minimization, treatment, and disposal. Continuing support is being provided for various project activities.

A large fraction of the INEEL's evolving national security work originates as "Work for Others," with non-DOE U.S. Government organizations. This reflects well on specialized capabilities that exist at the INEEL for designing and building unique engineered systems. Examples include the Specific Manufacturing Capability, Mobile Munitions Assessment System, Future Combat Systems, and projects supporting advanced military command and control systems. Development needs in these areas will continue for the foreseeable future.

During the past 18 months, National Security at the INEEL has experienced several mission-related accomplishments. An R&D 100 Award was received for the Gamma/Neutron Dosimeter. The digital signature technology developed at the INEEL won two highly prestigious awards: DOE-HQ Pollution Prevention "Sowing the Seeds of Change" and the White House "Closing the Circle." Further, the establishment of a Material Science Support Laboratory in March 2001 at the INEEL was a major milestone that enabled the INEEL to take advantage of specialized plasma spray equipment as well as to provide a facility where ongoing support to other INEEL programs can be conducted.

Table 5 links INEEL National Security programs to the respective DOE mission and priorities.

Table 5. INEEL National Security Program contributions to DOE missions and priorities, 10/24/01.

DOE National Defense Priorities	INEEL National Security Programs
Safety and reliability of the nuclear stockpile	DOE Defense Programs (DP) Surety Program
Future R&D and production plans geared to the administration's nuclear strategy	DOE Defense Programs (DP) Surety Program
Enhancing homeland defense against terrorist threats	Critical Infrastructure Protection Program: Cyber Security Counterterrorism Energy Infrastructure Transportation Infrastructure Vulnerability and Risk Assessments
Address the proliferation of nuclear weapons and technology	Idaho Accelerator Center Initiatives for Proliferation Prevention
Provide safe, efficient, effective nuclear power plants to the U.S. Navy	Reactor Programs—Advanced Test Reactor (Note: Reactor programs are described under Nuclear Energy)

(b) Strategic Objectives

Strategic objectives outlined below directly support DOE's National Defense mission. In addition, the INEEL has an objective to be a valuable resource to Idaho and the surrounding region and a partner with regional universities in addressing national security issues.

The INEEL has the following four strategic objectives in national security over the next 5 years:

Provide Innovative Solutions to DOE's National Defense Priorities in Counterproliferation and Counterterrorism and Provide Increased Support to DOE and Other Federal Entities

The INEEL will build upon initiatives within DOE's Critical Infrastructure Protection Office and other federal agencies that address issues presented in the Homeland Security Program. In building upon these initiatives, the INEEL will draw upon the considerable expertise in areas of energy, computer science, security, and environmental technologies and apply them to meet the new and emerging threats that face the nation.

The INEEL will increase its role in support of DOE in increasing physical security for fissile materials in the former Soviet Union and for disposing of excess fissile materials. The INEEL, through its efforts with DOE programs, will work to redirect former weapons scientists in the Soviet Union by participating in various technical projects and programs.

Realizing benefits to other DOE mission areas from national security technologies continues to be an ongoing priority. Multiuse of technologies is viewed as a critical step in realizing the benefits of a multiprogram laboratory. In conjunction with realizing continued benefits from other mission areas within

DOE, increasing INEEL visibility within the federal agencies must occur in order to continue to enhance existing INEEL technologies as well as develop new ones to meet new and ongoing threats.

Develop Sustainable Regional Partnerships for the Mutual Benefit of the Region and DOE

Agreements for cooperative work with regional universities and institutes will be actively pursued to enhance the INEEL's capabilities to meet the needs of national security clients. The INEEL will seek to build upon research activities with the University of Idaho and Idaho State University in areas of cybersecurity and accelerator application.

Develop Innovative Solutions to DOE's Environmental Security Challenges

The INEEL will assist DOE in realizing a leadership role within the environmental security context. At the same time, activities will be enhanced to apply international expertise to environmental challenges at the INEEL and throughout the DOE complex, such as handling and storing spent nuclear fuel, high-level waste, and transuranic waste. In addition, the INEEL will continue to provide specialized environmental and engineering expertise to assist DOE's nuclear deterrent mission.

Continue to Meet DOD Needs for Specialized Engineered Systems

The laboratory will continue to apply specialized capabilities to develop and deploy systems supporting U.S. demilitarization and defense goals. Many of the engineered systems will take advantage of technologies developed for DOE and, in many cases, will allow the technologies to be redirected or re-engineered and put to a different use, which, in some cases, may benefit DOE through use in another mission area. DOE also benefits from work with the DOD and other national security agencies through the maintenance of capabilities and skills at the INEEL.

(c) Strategies

The following strategies will be employed to increase INEEL effectiveness in supporting the DOE National Defense mission:

Integrate R&D and Operations

A new multiprogram materials science laboratory, funded by General Plant Project funds, has been in programmatic use since May 2001. Combined with the existing Specific Manufacturing Capability, this laboratory will considerably enhance the INEEL's capability to provide technologies in support of nonproliferation objectives.

Counterterrorism programs will be focused around the National Security Division initiative for the Critical Infrastructure Protection Program. Concealed weapons detectors and other sensors will be integrated into the ongoing security upgrades at INTEC and other INEEL facilities. Cyberintrusion detection and mitigation protocols are being applied to INEEL information networks. The INEEL Live-Fire Testing Complex is being applied to counterterrorism systems testing for the Special Operations Command.

The INEEL will provide a lead role in developing more proliferation-resistant civilian nuclear technologies.

National Security is working closely with operations to employ specialized physical security and information science capabilities as well as site assets to help meet the needs of national defense customers. At the same time, cooperative efforts are under way to upgrade security at the INEEL.

Integration efforts now under way are resulting in improved support to DOE for enhancing the security of fissile materials in Russia and are enhancing the laboratory's cybersecurity capabilities.

Actively Pursue Corporate and Regional Partnerships that Enhance INEEL Capabilities

The INEEL will increase collaboration with the Idaho Accelerator Center at Idaho State University to develop technologies for detecting potential proliferation or terrorist initiatives. Further, through the Critical Infrastructure Protection Division Initiative, an enhanced collaboration with regional universities, including the University of Idaho, will better address cybersecurity threats.

In order to pursue new Asian opportunities in chemical demilitarization, fulfilling obligations under the Chemical Weapons Convention, the laboratory has entered into a collaborative effort with Sandia, Livermore, and Los Alamos national laboratories.

The INEEL will continue collaborative efforts with local law enforcement agencies to enhance their capabilities. A collaborative effort is under way with the Naval Air Warfare Center at China Lake to exploit new opportunities in ballistic protection and network-centric warfare.

Under a DOE-Department of Justice agreement, the INEEL will pursue a Regional Law Enforcement Center to further relationships with regional law enforcement organizations.

The INEEL has developed an extensive mobility assignment training activity for five individuals with the Army, DOE-NN, and Department of State to further extend its capabilities in critical areas important to national defense.

(d) Division Initiatives

Critical Infrastructure Protection

The overall purpose of the Critical Infrastructure Protection initiative is to protect national critical infrastructures from active threats and to integrate those efforts within the Homeland Security Program within DOE and other federal agencies. The immediate scope includes leading the development of a comprehensive program, fulfilling the need for cyber protection, physical protection, and definition of the interdependencies between complex infrastructure systems.

The INEEL will address these needs through R&D, testing, evaluation, and technology application within the targeted critical infrastructures—emergency services, electric power, government services, information and communications, transportation, and water supply. Further, leadership will be provided (a) through teaming with the private sector and other federal agencies and programs, (b) to meet the requirements and schedule of Presidential Decision Directive 63, and (c) in other critical infrastructure areas where the knowledge and expertise of the laboratory is applicable.

The INEEL will integrate its technologies and capabilities with multiple federal agencies within the scope of INEEL expertise in infrastructure interdependencies. Vulnerability assessments as well as risk management and mitigation will be employed in this initiative.

The critical infrastructure initiative provides an opportunity for the laboratory to apply its capabilities in computer science, materials science, electrical and power systems, and risk management to support a key DOE mission area.

To achieve these missions within the Critical Infrastructure Protection Program, the president's budget request for the program exceeded $2 billion in FY 2001, distributed among the 13 agencies participating in the initiative; $13 million will go to the DOE Critical Infrastructure Protection Office.

Within the R&D component that the INEEL can access of this $2 billion, the budget is approximately evenly split between the DOD (Defense Threat Reduction Agency/Defense Advanced Research Projects Agency, and new Defense Information Security Agency components), Department of Justice Counterterrorism Fund, DOE, Department of Commerce, and Department of Transportation (DOT) (Federal Aviation Administration).

The National Security Division supplies the arms control, intelligence, nonproliferation, law enforcement, and counterterrorism communities with integrated sensor systems and advanced sensor technologies to detect unauthorized movement of nuclear materials, explosives, armaments, narcotics, and other contraband wherever such movement may constitute a threat.

In addition to its physical security business line, the division will continue to improve information security, encompassing information warfare, command and control, computer and network reliability, and communications and data protection. The INEEL will develop new methods to detect manipulated electronic signals and deploy integrated, mobile, automated command and control systems with advanced cryptographic technology.

Environmental Security Initiative

U.S. Government activities require a multiagency effort to respond to the environmental risks and security issues. The governmental interest will be to coordinate efforts that integrate programs at various national laboratories, other federal organizations, the private sector, and academia with foreign organizations and institutions working in similar areas. The INEEL can provide technical as well as integrating support to the government needs through the highly developed and experienced support network that has been developed through previous collaborative efforts within the U.S. and the International Center for Environmental Safety (ICES) structure that exists in Russia.

Efforts within environmental security support the INEEL goal to become internationally recognized as a research facility that provides valuable research services to the government and other institutions throughout the world in environmental safety and security. These issues relate to INEEL expertise in subsurface science, long-term stewardship, and storage and monitoring of spent fuel.

Benefits that will accrue to the laboratory range from directly supporting the cleanup and operational missions of the site and the complex by exploiting international expertise to supporting DOE's nonproliferation and environmental security objectives. Within this range of benefits is the foundation to position the INEEL to become an internationally recognized repository for knowledge and environmental technology excellence. This base of support provides opportunities to prototype INEEL technologies and establishes direct communication pathways among the various projects dealing with the former Soviet Union at the INEEL. It also provides visibility for the laboratory's environmental expertise in areas such as management of radioactive wastes, spent nuclear fuel, decontamination and decommissioning of nuclear facilities, and environmental restoration.

The current overall environmental safety/security market size is well over $500 million. Within 3 years, this division initiative in the management structure of the division can capture over $10 million of this market.

The Division Initiative within Environmental Security supports three laboratory initiatives: Subsurface Science, Long-Term Environmental Stewardship, and Waste Treatment. Through creation of international programs and making available international expertise and talent to the INEEL, the initiative builds long-term scientific capabilities at the INEEL and enhances its recognition among current and future customers. The initiative further supports numerous other activities at the site, including spent fuel and waste management operations. The initiative also continues to build the site reputation for science and technology, thus supporting the multipurpose positioning of the laboratory.

In the shorter term, this initiative supports cost-effective resolution of DOE complex environmental issues critical to DOE. This initiative is extremely important for INEEL long-term strategy supporting the laboratory's transition to customer research and work on global issues essential to the nation.

There is no single organization within the DOE complex that has a mission similar to the Environmental Security Initiative. However, there are other organizations that have international missions that may create the potential for significant competition or cooperation. These organizations are the International Nuclear Safety Center at Argonne National Laboratory, International Cooperative Monitoring Center at Sandia National Laboratories, and the Nuclear Nonproliferation Center at Los Alamos National Laboratory. The advantage within this initiative is its focus on environmental safety/security problems and being a reflection of the INEEL and its capabilities. The Environmental Security Initiative represents the INEEL and fully utilizes its technical and project management capabilities.

3. Fossil Energy, Energy Efficiency, and Renewable Energy

(a) Situation Analysis

Last year's rolling black-outs in California; sharp increases in the costs of gasoline, electricity, natural gas, and other forms of energy; and terrorist attacks on mainland U.S. soil all raised concerns about the availability, affordability, and reliability of U.S. energy supplies. The recent rebound in natural gas and electricity supplies has not quelled these concerns. The current economic climate has resulted in energy companies shedding their R&D capabilities and focusing on short-term economic issues. Recent headlines have featured U.S. leaders expressing concern over how looming energy shortages may impact the U.S. economy and national security. The events of September 11th have underscored America's vulnerability to energy supply disruptions and their potential impacts to the U.S. economy and national security. At the same time, concerns continue about greenhouse gas emissions, global warming, and other environmental impacts of energy use. Against this backdrop, the need for federal R&D aimed at increasing energy production, increasing energy efficiency, tapping new sources of energy, and minimizing environmental impacts takes on new urgency.

The administration's National Energy Policy and subsequent legislative proposals both point to increased emphasis on production, increased access to federal lands and other onshore and offshore sites, increased use of coal and the simultaneous development of clean coal technologies, more use of renewable energy, continued emphasis on energy efficiency and conservation, and increasing the capacity and integrity of electricity, oil, and gas distribution systems. These priorities will require the increased exploitation of science and technology, applied engineering and research, and confirmatory tests and analyses to evaluate and develop new energy technologies and processes. Major responsibility for these activities falls to DOE's Offices of Fossil Energy (FE) and Energy Efficiency and Renewable Energy (EE). Although the challenges associated with concerns about the U.S. energy picture are formidable, they present a number of opportunities for laboratories that possess applicable scientific and engineering expertise. Table 6 shows the linkages between INEEL Fossil Energy, Energy Efficiency and Renewable Energy Programs and DOE's Energy missions and priorities released by the Secretary of Energy in October 2001.

Table 6. INEEL Fossil Energy, Energy Efficiency and Renewable Energy Program contributions to DOE missions and priorities, 10/24/01.

DOE Energy Priorities	INEEL Fossil Energy, Energy Efficiency and Renewable Energy Programs
1. Strengthen our ability to identify and protect our critical infrastructure that supports the production and delivery of energy	Energy System Reliability
2. Implement the President's National Energy Policy	National Hydropower Program Geothermal Research Program Energy Management Program/Building Energy Efficiency R&D Partnership for a New Generation of Vehicles/Power Source Validations Vision 21 and Clean Coal Technologies Global Climate Change Technologies/CO_2 Sequestration Industries of the Future Site-Specific Technologies for Agriculture Clean Energy (Bioenergy) Initiative INEEL Energy Storage Technologies Laboratory INEEL Hybrid Electric Vehicle Laboratory Bioenergy Research Program Compressed Natural Gas/Liquefied Natural Gas Deployment/Demonstration Innovative Oil and Gas Drilling and Completion Techniques to Maximize Productive Life Hydrocarbon Processing Program Microbial Enhanced Oil Recovery Research
3. Identify new sources of energy for the future	Hydrogen Production Fusion Safety Program Bioenergy Research Program
4. Direct R&D budget toward relatively immature ideas and innovations and ensure greater application of mature technologies	Hydrogen Production Methane Hydrates

By combining the capabilities and technologies that exist across the INEEL business lines, the INEEL has achieved many significant R&D-based technical accomplishments, supporting the DOE/INEEL mission to achieve abundant, affordable, efficient, reliable, and environmentally sound energy supplies and uses.

The laboratory has achieved several energy-efficiency technology breakthroughs and applications. The Rapid Solidification Process technology produced a 50-foot aluminum strip during a bench-scale spray-rolling demonstration and received Energy @ 23, R&D 100, and Federal Laboratory Consortium awards. The INEEL initiated the first Super Energy Savings Performance Contract in the State of Idaho to upgrade lighting and power transformers at a major INEEL office-lab complex. And the laboratory was awarded a DOE Office of Buildings foundation insulation study and seven new DOE-Office of Industrial Technologies (OIT) competitively bid R&D projects, including energy-saving separation technologies for the petroleum industry, industrial membrane filtration/separation systems (in collaboration with an Idaho industrial/research partner) for the agriculture/food processing industry, and modeling and optimization testing of more energy-efficient black-liquor spray nozzles for the forest products industry.

The laboratory has advanced cleaner and more efficient transportation power. Through local industry teaming, it established a multiple-use compressed natural gas (CNG) fueling station that won a Federal Energy Management Program award and have planned a Liquid Natural Gas station. These technologies are being planned for nationwide deployment and commercialization in FY 2002. Through Cooperative Research and Development Agreement (CRADA)-governed research, our thermal spray technology group developed interconnects for a solid oxide fuel cell. The INEEL produced a fully developed Battery Calendar-Life Predictive Model for lithium-ion batteries and several time-saving advanced battery analysis tools that added significant value to the nation's effort to develop advanced energy storage devices for transportation applications. Under a DOE-FE Vision 21 contract, the laboratory will complete a novel ceramic membrane that separates fuel quality hydrogen from traditional fossil fuel gas streams.

The INEEL has participated in technology planning groups such as offshore exploration and production technology and natural gas infrastructure and supported DOE in alternate fuels, energy sources, and fuel savings through bioenergy, geothermal, etc. The compact between the State of Idaho and DOE-OIT and the formation of the State of Idaho Industries of the Future Program facilitated INEEL work with the Idaho Wheat Commission on the selective harvest of wheat straw as an enhanced bioenergy/bioproducts feed stock. Additional support to DOE was evident by the recent Idaho Geothermal Energy Stakeholders Workshop hosted by Idaho's U.S. Senator Larry Craig, which resulted in the formation of the Idaho Geothermal Energy Development Working Group.

The laboratory recently established a severe weather test site with two test buildings to study energy use. The INEEL is supporting DOE-ID's effort to transfer a coal-fired steam-generating facility to private industry and to simultaneously serve as a large-scale engineering demonstration location for clean coal technology. Engineering and science R&D disciplines include crosscutting energy and environmental technologies such as biotechnology; earth and chemical sciences; interactions, overlap, and synergy with the Subsurface Science Initiative; geothermal and reservoir engineering; energy storage and test engineering; and industrial process and materials sciences. Each of these disciplines will play a key role in developing the technologies needed to solve America's energy challenges.

(b) Strategic Objectives

Make Important Scientific and Engineering Contributions to Increase Domestic Energy Reserves

The Secretary of Energy's mission and priorities for DOE emphasizes that the President's National Energy Policy should be implemented. The secretary's mission and priorities also calls for directing the R&D budgets for the development of energy technologies that are relatively immature and for ensuring greater application of mature technologies. This means that energy-related R&D must be performed to promote the clean, efficient, adequate, and environmentally sound production and use of fossil fuels. The INEEL will participate in developing technologies to increase the production and use of oil, gas, and coal. In terms of advanced fuels, the INEEL will dedicate substantial resources to advancing technologies for hydrogen production, storage, and use. The INEEL will participate in the Fossil Energy Vision 21 Program to develop and evaluate alternate gasification technologies and enabling technologies, including a process for gasification of coal, biomass, and noncoal or mixed feedstocks. The laboratory will perform cutting-edge research in the area of methane hydrates by continuing to develop its interdisciplinary research capability as it builds on its Subsurface Science Initiative and the strength of its conventional oil and gas activities. Work will be continued on seismic tools that detect and characterize methane hydrate deposits and on the ability to validate current logging data profiles against the seismic evaluations. In the field of bioenergy, the INEEL will develop and demonstrate a suite of key technologies (e.g., separations, sensors, intelligent process control, conversions, etc.) that both save and produce energy through "whole-crop utilization." INEEL efforts in this area are highlighted in the bioenergy division initiative at the end of this section. The laboratory will participate in the area of renewable energy development by expanding its role as a key laboratory in executing EE's geothermal program, including the new GeoPowering the West Initiative.

Expand Technical Leadership in the Improvement of Energy Conversion Technologies

The EE Strategic Plan addresses the secretary's mission and priorities by leading in "the research, development, and deployment of advanced energy efficiency, clean power technologies (oil and coal), biomass conversion, and practices." Key INEEL areas of emphasis in terms of energy conversion technologies include continued and expanded development and testing of advanced batteries and other energy storage technologies for use in advanced vehicles. The laboratory will continue to expand its role in the development of advanced batteries by developing chemistries, diagnostic methods, and analysis tools that enhance the INEEL's understanding of the technical barriers that limit their use in emerging energy-efficient systems. Related to this activity will be utilization of the laboratory's infrastructure (lab, test equipment, shops, fleet, etc.) for other federal agencies and industry. In addition, success in accomplishing this objective will involve further development and application of INEEL expertise in such areas as intelligent control of joining, casting, and coating; process control systems; robotics; sensors; separation chemistry and selective mass transport agents; advanced materials and materials processing (such as spray forming); and thermal processing.

Develop and Transfer Advanced Technologies that Decrease the Environmental Impact of Energy Production and Utilization

FE and EE Strategic Plans address the secretary's mission and priorities by emphasizing that their sponsored R&D and technologies for increased, diverse, and reliable energy with more efficient uses and practices must also be environmentally sound. The INEEL will achieve new levels of technical leadership by focusing on the development of technologies that prevent or mitigate environmental impacts associated with production, transportation, and use of energy. Examples of such focused science and engineering activities include work in the areas of carbon sequestration, renewable energy, clean coal, and energy efficiency and conservation. Work performed in pursuit of this strategic objective will include the development of advanced hydroelectric turbines to reduce fish mortality, the application of analysis and simulation capability to renewable energy sources in distributed power applications, and the continued participation in the Greater Yellowstone-Teton System Analysis Program, which is jointly sponsored by DOE, Department of Interior (DOI), DOT, and EPA. The INEEL's objective is to ensure that the laboratory meets federal requirements as a model for energy efficiency and to increase its expertise and reputation in the region and on a national level in support of current programs in the EE Office of the Federal Energy Management Programs, the Office of Building Technology, and State of Idaho.

(c) Strategies

The INEEL will pursue the following strategies to achieve the three broad objectives outlined above:

Develop and Strengthen Strategic Partnerships

The INEEL will gain increased expertise and visibility in this business area by leveraging its technical capabilities through developing new and existing strategic partnerships. Among these important partnerships are:

- New ties with the Clean Coal/Vision 21 programs at NETL, which will be created to foster continuing development of clean coal technologies and the potential for large-scale demonstrations at the converted Coal-Fired Steam-Generating Facility. New ties will be created with Bechtel to develop clean coal technology.
- Continued work with industrial partners (BWX Technologies, McDermott, and Pacific Gas and Electric [PG&E]) in areas of diesel and natural gas reformer development. The CNG/LNG (liquefied natural gas) vehicle fuel area will be continued as a significant role in collaboration with vehicle engine manufacturers (e.g., Ford Motor Co.) and utilities (e.g., PG&E in San Francisco). Also, continued work with our INRA university partners (e.g., University of Idaho and Montana State University) in order to demonstrate competence in addressing industry needs. Appropriate technical areas for collaboration and new ties will be created with other INRA universities, including the University of Alaska.
- The INEEL will work closely with NREL and Sandia to advance DOE's geothermal energy objectives in the EE Office, including its new GeoPowering the West Initiative.
- The INEEL will build on existing partnerships with the agriculture, aluminum, chemical, forest products, glass, metalcasting, mining, petroleum refining, and steel industries to advance the energy efficiency and conservation goals of the DOE-OIT Industries of the Future Program.
- The INEEL will work closely with the DOE Seattle Regional Office, regional State Energy Offices, and Bonneville Power Administration to meet regional energy technology needs.

Develop Technical Solutions in Energy Production and Conversion, and in the Prevention and Mitigation of Environmental Impacts

A current INEEL program for the DOE Office of Transportation Technologies (OTT) that is focused on developing efficient mid-sized hybrid electric vehicles will be the basis for expanding the laboratory's role through acquiring additional test equipment, facilities, and personnel. It is expected that interactions with other federal agencies and private industry will increase.

In support of the OTT 21st Century Truck Program, the INEEL will test experimental vehicles that are using new engines and energy storage devices, such as more efficient diesel, diesel/hybrid, fuel cell, and battery-powered systems. Future plans will expand current laboratory capabilities to include test systems having greater energy, power, and vehicular size.

The laboratory's work in the area of CO_2 sequestration R&D and applied engineering for DOE's Office of Fossil Energy in gas separation, specific polymer membranes, and microorganisms technologies will refine INEEL expertise and create alliances for future work. Successful proposals for entry in a joint industry partnership with British Petroleum will evaluate geological sequestration through use of the INEEL's strength in probabilistic risk assessment (PRA) techniques. Strategic partnerships will be developed with NETL, industry, and western states to resolve issues associated with the increased use of coal for electric power generation.

As the designated lead engineering support laboratory for the DOE Office of Power Technologies Hydropower Program, the INEEL will increase the viability of large hydropower systems in the United States through success in managing the Advanced Hydropower Turbine System Program. Similar INEEL engineering expertise is and will be applied to other hydropower environmental concerns and to the evaluation of environmentally friendly low-head/low-power hydro resources.

Through continued participation in the distributed power Interconnect Standard Committee, partnerships with industry, and association with the State of Idaho, the laboratory will provide the technology necessary to support distributed power resources and implement new project areas for the design and integration of renewable energy resources with energy storage systems, e.g., wind and renewable energy technologies that produce power intermittently.

The INEEL will complete the Yellowstone-Teton Program analysis that involves the interactions modeling portion of the methodology model, the infrastructure data collection and linking process, and obtaining stakeholder input and acceptance for the Yellowstone-Teton National Parks and surrounding areas. The program involves continual collaboration with INRA universities. After authentication in this pilot region, and with the sponsors' (DOE, DOI, DOT, and EPA) support, other geographical areas (e.g., other national parks, national labs, military bases, etc.) will be identified for application of the methodology.

The INEEL will contribute to improved energy efficiency of buildings through research and experimentation utilizing a severe weather test site established in collaboration with the University of Wyoming. Innovations to site-built and industrialized housing are studied in full-scale field application, leading to the transfer of emerging conservation technologies to the building community.

The INEEL will also develop energy efficiency and conservation projects for the Federal Energy Management Program Office. These projects focus on the application of energy-saving, renewable, and clean energy technologies as retrofits to the laboratory building systems; as design assistance for regional federal facilities; and for energy efficiency public education activities.

(d) Division Initiative

Clean Energy (Bioenergy) Initiative

A central element of the INEEL's strategy in this business area is the creation of the Clean Energy (Bioenergy) Initiative. With emphasis on development of bioenergy technologies, this initiative will not only develop alternate fuels and chemicals from biomass processing technology but also reduce environmental impacts of some agricultural practices and contribute to rural revitalization in Idaho and other agricultural areas of the United States.

The objectives of this division-level initiative are to:

- Develop and demonstrate a suite of key technologies (e.g., biocatalysts, physical and chemical separations, sensors, intelligent process control, etc.) that enable "whole-crop utilization" for the production of biobased energy, fuels, chemicals, and other products.
- In partnership with the INRA universities and regional industry, expand the portfolio of R&D bioenergy projects awarded from competitive solicitations.
- Establish a Northwest Regional Bioenergy Institute in which INEEL expertise in "production" and "processing" is coupled with INRA and other university expertise in "plant science" industry expertise in "utilization" and Pacific Northwest National Laboratory expertise in "genetics" and "processing."

The market and demand for biobased power and products will dramatically increase over the next decade. Currently, DOE and USDA provide approximately $250 million per year for the development and deployment of biobased power, fuels, and products. The administration recently announced a planned dramatic increase in this funding to approximately $1.2 billion beginning in FY 2004. The INEEL efforts in the areas of bioenergy and bioproducts, including the activities embodied in this initiative, will serve to position the laboratory to successfully compete for a significant portion of this available funding. While current funding is from EE, it is expected that crop and energy markets will drive the agriculture and commercial funding for further development and R&D in these and related technology areas.

In partnership with the INRA universities and regional industry, the INEEL's whole-crop utilization approach has seen great initial success in FY 2001, and endorsement by DOE and industry with the award of three new R&D development projects in the first year. The projects build on established INEEL scientific and engineering expertise in materials processing, biotechnology, computational fluid dynamics, and separations. It is this expertise along with unique capabilities in plant and crop production and biomass processing that will allow the INEEL to expand its R&D portfolio through competitive solicitations. The current bioenergy program will be continued and expanded through competitive DOE R&D project awards to further establish the INEEL's reputation in this important energy resource of the future.

The whole-crop utilization concept has the added advantage of providing the promise of revitalizing rural economies by providing an additional revenue source to growers as well as the new jobs and resources associated with new bioenergy and bioproduct industries. The INEEL team has a good mix of technical, managerial, and business development skills as well as good external recognition. Additional technical and managerial expertise will be retained as necessary to ensure the success of this initiative.

4. Science

(a) Situation Analysis

INEEL science programs serve DOE in three ways. First, the laboratory directly supports Office of Science (SC) programs in basic energy sciences, biological and environmental research, fusion sciences, and high-energy and nuclear physics. This support includes engineering sciences, materials science, chemical science, environmental sciences, and medical sciences programs. Support provided to the SC Fusion Sciences, and High-Energy and Nuclear Physics programs is described in Section III, “Energy Resources.” Second, these basic science investments are leveraged to support DOE applied research and technology programs such as EM's Energy Systems Research and Analysis program, Energy Efficiency's industries of the Future program, and numerous national security and energy programs. Third, laboratory initiatives are structured to develop new scientific capability through the Subsurface Science and Advanced Computing and Collaboration Initiatives described in Section IV, and in Nanomaterials, a division initiative described later in this section. Basic science also supports other initiatives in Energy Resources, National Security, and Environmental Programs, described elsewhere in Section III.

DOE has recently clarified its mission themes around four key areas, which include National Defense Programs, Energy Programs, and Environmental Programs. The fourth area is Science Programs, which support the first three, and with special priorities that include finding new sources of energy and Homeland Defense. Current INEEL research projects and capabilities directly support these themes. These linkages to the science mission are depicted in Table 7. Many of our science programs are sponsored through DOE’s Office of Science, within the Basic Energy Sciences and Biological and Environmental Research programs. Our support of those programs is as follows:

- *Chemical Sciences*. Research to extend our fundamental understanding of ion sources and emitters for mass spectroscopy. Current supercritical fluid research efforts are exploring novel chemistries for the production of ultraclean fuels, improved fuel quality, and nucleation and growth of nanomaterials. Researchers are also pursuing supercritical fluids as an environmental remediation option for removing radioactive metals from various environmental matrices. This research focus will expand to include characterization of surface chemical phenomena associated with heterogeneous catalysis and supercritical solvents.

- *Engineering Sciences*. Research to develop novel processing methods to enhance material quality and production efficiency. Examples of such research include extensive plasma spray processing and modeling, and using modern mathematical concepts such as fuzzy logic to create “intelligent” industrial processes. Additionally, the laboratory has the capability to characterize material integrity both at the macroscopic level through fundamental elastic and plastic behavior analysis, and at the microscopic level through such nondestructive evaluation methods as coupled mode laser acoustic microscopy.

- *Materials Sciences*. Research to develop a fundamental understanding of microstructure-mechanical property relationships for anisotropic materials, including functionally graded materials, through experiments with model systems and simulations. Research is also conducted on polymer synthesis, characterization, and engineering molecular structures, with a technical focus on developing molecular/nanomaterials using polymers in controlled environments. Through the Nanomaterials division initiative, research will include nanoscale nucleation and growth topics.

Table 7. INEEL Science Program contribution to DOE missions and priorities, 10/24/01. (The laboratory conducts a wide range of basic and applied research programs that support the top-level missions of national defense, energy, and environmental cleanup and protection. Many of these research programs contribute directly to technologies for energy and homeland defense. Below are examples of specific ongoing contributions from the INEEL's science programs.)

DOE Mission Priorities	INEEL Program Contribution
National Defense Detection science for weapons of mass destruction, and high-performance materials	- Rapid optical analysis for aircraft engine fatigue assessment - Fluid dynamics for protection of buildings from chemical and biological agents - Grain manipulation of tungsten alloys for improved characteristics - Severe plastic deformation research for high-strength alloys - Devitrified nanocomposite steel for wear resistance - Ultrasensitive measurement science for detection of chemical agents on surfaces
Energy Science supporting improved energy sources and energy infrastructure	- Plasma thermal processing for high-performance coatings - Nonlinear acoustics for material failure analysis - Turbine-blade fluid dynamics research for enhanced efficiency - Intermetallics for high-temperature and sulfur-resistant materials - Graphite nondestructive evaluation for use in reactors - Acoustic array technology for high-precision boiler tube inspection - Development of zirconia electrolytes and nickel alumina metallurgy for fuel cells - High-temperature materials for higher-efficiency coal-fired plants - High-strength aluminum for improved transportation efficiency - Nanocrystalline magnetic materials for high-efficiency electrical motors - Electron-positron annihilation science for characterization of nanophase materials - Fundamental materials science for high-temperature energy conversion - Impedance spectroscopy for concrete characterization - Coupled optical-acoustic analysis for incipient crack detection
Environmental Chemistry, biology, and geosciences programs enhance environmental management	- Environmental Science Research program for coupled environmental processes, alternative waste treatment processes, and applied technical support to operations - Subsurface Science Initiative addresses basic environmental science - Subsurface Geosciences Laboratory design study - Review and validation studies for Yucca Mountain waste storage - Rock-fracture dynamics science for fault-slip prediction - Intelligent control of bioprocesses - Long-life wireless probes for cap and barrier performance assessment - High-level-waste chemistry research - Fluid dynamics studies for drying and passivation of spent fuel - Fundamental studies of inorganic chemical systems and ion formation processes - Photorefractive-crystal holography for open-path photoacoustic spectroscopy - Nanostructures for high-performance sensing

- *Environmental Sciences*. Research to understand the feasibility of using naturally occurring microorganisms to remediate a variety of environmental contaminants, with significant focus on subsurface contaminants. Through the INEEL Clean Energy (Bioenergy) Initiative, this program will investigate microbial and plant physiologies with the goal of producing value-added products from renewable feedstocks.

- *Medical Sciences*. Research in physical, biophysical, and chemical sciences supporting the *development* of targeted radionuclide therapy, including neutron capture therapy. This includes the design, construction, and testing of reactor- and accelerator-based neutron sources for radiotherapy research and clinical application; development of new tools and protocols for computational and experimental medical radiation dosimetry; and the development and testing of improved boron agents for neutron capture therapy. This activity benefits DOE in providing new diagnostic and therapeutic medical tools, and tools for mitigating the biological effects of radiation.

- *Biological Sciences*. Research to understand the relationship between the structure and function of biological molecules, the dynamic and interactive behavior of biological molecules in cells, and the complete working of a cell. New research will focus on genomic-level determinations of protein structure, function, and interaction as a follow-on to genomic DNA sequencing. Examples include the development of molecular approaches to understand expression of genes among multiple microbial species from environmental media. The Research in this area has direct relevance to understanding complex physical, chemical, and biochemical reactions undergone by contaminants in the subsurface and to the need to develop effective bioremediation technologies. The research also has direct relevance to detection and decontamination of priority pathogens for national security missions.

Below are recent accomplishments in these programs:

- Developed a DNA microarray capability with the University of Idaho that is being used to characterize and confirm biological transformations occurring in contaminated subsurface environments.

- Developed the use of molecular techniques such as real-time PCR to rapidly and successfully identify *Brucela abortus* presence and activity in minute sample volumes.

- Completed 2X coverage and working toward total coverage of the genome for *Halomonas campisalis*, a halophile that has the capability to produce a number of enzymes that may be useful in various bioremediation applications.

- Developed a laser-based GHz acoustic microscope to understand and characterize material microstructure and microstructural flaws leading to failure.

- Developed nanostructured high-energy product permanent-magnet materials for application in very high-efficiency motors through controlled crystallization from a metallic glass.

- Based on an INEEL-university collaboration, a miniature ion mobility spectrometer about the size of a matchbox is currently being tested for detection of ultralow concentrations of chlorinated hydrocarbons in gases produced at subsurface interfaces such as those associated with well boreholes.

- Synthesized a series of inorganic polymers with the unique ability to transport lithium along their polymer backbones. Since the particular inorganic polymers selected for this application are known to be thermally and chemically stable, these polymers afford the potential for low-cost, long-lived, highly rechargeable lithium batteries.
- DOE-Bright Light Award for advances in solid polymer electrolyte for compact lithium battery technology.
- A Fourier transform mass spectrometer having laser ablation ionization has been shown to enhance the ability to perform spatially resolve subsurface characterization and has significantly advanced mass spectral analysis of surfaces.
- Actinide removal has been achieved from soils using supercritical solvents containing chelating agents. This novel extraction method offers a unique advantage for cleaning plutonium-contaminated soils while reducing or eliminating secondary waste.

Laboratory-level and division-level initiatives are the laboratory's vehicles for developing new scientific research capabilities to support current and developing DOE R&D programs. The INEEL is investing significantly increased discretionary resources in several laboratory initiatives relevant to SC. The Subsurface Science, Generation IV Nuclear Energy Systems, and Advanced Computing and Collaboration initiatives are described in detail in Section IV.

The INEEL has also developed an interdisciplinary Nanomaterials division initiative in collaboration with its INRA partners and other national laboratories. The focus of this program is to understand the fundamental mechanisms of nucleation and growth common to the synthesis of nanostructured materials by condensed state, vapor phase, and biological processes. The objective of the research is to develop one-, two-, and three-dimensional nanostructures with precisely tailored optical, magnetic, and electronic properties. Significant discretionary resources are being invested in this initiative, which is described in more detail at the end of this section.

(b) Strategic Objectives

Continue and Strengthen the Subsurface Science Initiative

Common problems are shared around the world in dealing with environmental and energy issues. For instance, understanding of subsurface processes is incomplete, and tools for characterizing and monitoring these processes are inadequate. As a result, the full consequences of placing materials and contaminants into long-term subsurface repositories cannot be determined, and environmental remediation efforts are hampered. The SSI will focus on real-world field problems through a combination of laboratory-scale, mesoscale, and field-scale R&D. The INEEL is establishing a leadership role in multidisciplinary research to better understand basic hydrological, geochemical, and microbiology processes in the subsurface. Future technology development will build on our research results, enabling more accurate technology testing and deployment of new and improved methods of dealing with environmental problems. Through the SSI, the laboratory will be an active participant in the system of Core Laboratories, established to coordinate the efforts of EM's primary laboratories. INEEL research leadership will support the DOE environmental management mission by providing a sound technical basis for cost-effective cleanup solutions and the long-term stewardship of DOE lands. It will also support DOE's Vision 21 and Ultraclean Fuels programs.

Realize R&D and Operations Integration

The laboratory will continue to leverage capabilities that support science objectives to the benefit of INEEL operations. Staff will work to solve the cultural issues that create barriers to integrating science and technology into the EM cleanup mission by participating in roadmap development and program planning. It is important that R&D personnel continue to focus on documented, end-user problems. This will accelerate site cleanup, reduce cost, lower programmatic risk, and improve environmental safety and health.

Expand Environmental Management Science Program Activities

The focus of the Environmental Management Science Program (EMSP) is to fund research that addresses critical environmental remediation, waste treatment, and disposal issues such as determining the fundamental properties of legacy DOE waste, testing and evaluating proposed cleanup processes, and developing optimal waste forms. The INEEL supports EMSP goals in two ways. First, the INEEL will continue to use discretionary funds to investigate research topics that directly support EMSP objectives. This includes increased emphasis on collaborative research partnerships with other national laboratories, INRA schools, and other universities. Second, successful EMSP research results will be actively incorporated into ongoing technology deployment efforts and EM focus-area activities at the INEEL and across the DOE complex. These activities directly support the DOE EM R&D Plan.

Establish the INEEL Advanced Computing and Collaboration Initiative

During FY 2002-2006, the Advanced Computing and Collaboration Initiative will expand by (1) extending the INEEL advanced computing and networking infrastructure in collaboration with INRA, (2) developing an integrated framework of advanced computing infrastructure and capabilities to support INEEL science programs, and (3) establishing collaborative partnerships with other national laboratories, federal agencies, INRA schools, and other universities. Two documents have been developed to guide these efforts: *Roadmap for INEEL Advanced Scientific Computing Research* and *Scientific and Engineering Computing Infrastructure Plan.* These documents describe the INEEL's scientific computing history, summarize the baseline roadmap for future advanced scientific computing research, and outline a laboratory approach to achieve roadmap objectives.

The capabilities developed through the Advanced Computing and Collaboration Initiative will directly support INEEL programs to further all the strategic laboratory initiatives such as Subsurface Science, Long-Term Stewardship, Generation IV Nuclear Energy Systems, and Nanomaterials.

Create a Focused Nanomaterials Program

The laboratory is establishing a focused research program to extend our understanding of the mechanisms of nucleation and growth common to the synthesis of nanostructured materials by condensed state, vapor phase, and biological processes. The objective of this division initiative is to develop a self-sustaining scientific capability at the INEEL and support the SC Nanoscale Science & Engineering Technology Initiative, applying the science developed in this initiative to DOE energy and security missions. Establishing the Nanomaterials Program will involve (1) extensive collaboration with INRA schools and other universities, facilitated through the exchange of staff and graduate students, as well as with other DOE national laboratories; (2) leveraging resources when possible by utilizing unique SC user facilities and expertise; and (3) providing sufficient discretionary research funding to build a critical mass in personnel, experience, equipment, and partnering opportunities at the INEEL.

Expand the Supercritical Catalysis Program

To support SC's Energy missions, the INEEL has initiated a multidisciplinary basic research program in supercritical catalysis to produce environmentally sound fuels and to treat halogenated organic wastes. The research is extending our understanding of fundamental surface science, catalysis, and chemical dynamics associated with heterogeneous catalyzed chemistry in supercritical fluids. The goal of the research is to better understand the fundamental mechanisms by which conversion of hydrocarbons, halogenated organics, desulfurization of organosulfur compounds, synthesis of unique and novel compounds, and polymerization of methane analogs occur. These fundamental studies will support applied Fossil Energy research, OIT Industries of the Future programs, EMSP, and the EM R&D Plan.

Establish Matched Index-of-Refraction Facility as an International Resource

The INEEL's Matched Index-of-Refraction Facility is the world's largest facility for optically studying fluid and transport physics using index-matching techniques. This facility will be established as a regional, national, and international research resource by (1) leveraging investments made through the Advanced Computing Initiative to build computationally intensive research capability in the areas of fluid dynamics and transport physics, and (2) expanding and improving the current diagnostic suite at the facility to include more advanced experimental capability. The Matched Index-of-Refraction Facility will provide research capabilities that support the INEEL's Subsurface Science Initiative.

(c) Strategies

Assume a Leadership Role in Field-Oriented, Multidisciplinary Research on Subsurface Science

The INEEL is working with DOE and the broader research community to establish, define, and fund the Subsurface Science Initiative by (1) developing a peer-reviewed research agenda based on DOE's environmental remediation and long-term stewardship mission, (2) identifying and hiring scientists and engineers with advanced degrees who specialize in subsurface research, (3) developing strategic collaborations with organizations having complementary expertise and equipment, and (4) planning for the SGL as a national user facility.

A research agenda is being developed based on science and technology needs identified in the National and INEEL Vadose Zone Science and Technology Roadmaps, the Environmental Stewardship Initiative, recommendations to DOE by the National Research Council, and technical interactions with subsurface problem holders from DOE sites, including the INEEL. Collaborations are being developed with INRA schools and other universities and with other national laboratories. Facility plans feature a new and unique SGL, scheduled to be completed in 2007. The SGL will enable mesoscale investigations of the coupled physical, chemical, and biological processes that control the movement and transformation of contaminants in the heterogeneous, variably saturated subsurface. This facility will house highly specialized laboratory and field equipment, allowing detailed long-term field observations and investigations of coupled nonlinear subsurface processes under controlled boundary conditions with rigorous mass balancing using DOE-relevant contaminants and materials.

Increase INEEL Capability to Participate in New SC Initiatives

The INEEL has structured its major research initiatives to support the SC initiatives of Advanced Scientific Computing, Nanoscale Science, Engineering, Technology (which now includes Complex Systems), and the EM Science Program. Initiative research positions the INEEL to support the SC fundamental science mission, DOE strategic goals, and scientific foundation of energy and environmental programs.

Integrate Computational and Experimental Fluid Dynamics Research

A major thrust of the INEEL Advanced Computing and Collaboration Initiative will be to provide the resources and capabilities to support computationally intensive programs in fluid dynamics and transport physics. The INEEL's advanced computing researchers will work with specialists in fluid dynamics and transport physics to define and procure advanced computing capabilities that will be coordinated with research in microfluidics, building-scale flows, and subsurface transport at the INEEL Matched-Index-of-Refraction facility.

Actively Participate in the Laboratory Integration Process

The R&D branch will actively participate in the formal process being developed to maximize the integration of research advances into the INEEL's environmental management efforts. The Environmental Technology and Engineering Division is developing a liaison interface between R&D and EM operations staff. The liaisons will maintain a baseline integration plan that includes detailed needs information, relational mapping of all R&D projects, and master schedules for technology insertion points. The benefits of improved coordination and integration are already being realized. For example, R&D is supporting nondestructive examination through real-time radiography systems, waste assay efforts through expert-system software and automated data validation, and atomic force and scanning electrochemical microscopy. These technologies and services improve the efficiency of environmental management activities, accelerating schedules and reducing costs.

Create Complementary Strategic Alliances with Laboratories and Universities

Strategic alliances with other DOE laboratories, INRA schools, and other universities will be established to advance the INEEL initiatives. Alliances will focus on subsurface science, nanomaterials, and other science-based initiatives. The laboratory will also substantially increase relevant graduate and postdoctoral staff at the INEEL, in coordination with education programs at INRA universities. At the senior researcher level, exchanges between INRA and the INEEL will help develop additional cooperative programs and a better understanding of each other's resources. Additionally, the INEEL will explore the concept of establishing a virtual Subsurface Science Department with the INRA universities.

(d) Division Initiatives

Nanomaterials Initiative

Research into the fundamental mechanisms of nucleation and growth common to the synthesis of nanostructured materials by condensed state, vapor phase, and biological processes will be expanded to develop a focused, self-sustaining scientific capability. The objective of this initiative is to control these mechanisms so that one-, two-, and three-dimensional nanostructures with precisely tailored optical, magnetic, and electronic properties can be developed.

The initiative builds on the INEEL's distinctive strengths in the nucleation and growth of nanostructured materials, primarily through research in magnetic, ceramic, and polymeric nanostructures. Significant capability has also been developed in plasma processing diagnostics for nanostructures and modeling of particle and thin-film nucleation and growth. Laboratory capabilities will be enhanced through collaboration with INRA partners and other national laboratories. The INRA universities, particularly the University of Idaho, Washington State University, and Montana State University, have complementary strengths in synthesizing magnetic and electronic materials by plasma, vapor phase, supercritical, and biological processes. There is also ongoing collaboration between the INEEL and Montana State University on polymeric nanostructures and on self-assembly of biological materials into viral cages. Collaborations will include individual and/or joint proposals to federal agencies that are participating in the National Nanotechnology Initiative. The laboratory will seek university collaborations that enable the exchange of staff and graduate students.

The INEEL is a member of the Basic Energy Sciences Nanotechnology Network in "Nanostructural Photonics" with six other national laboratories and will collaborate with the University of Idaho in this general area of research. When possible, the laboratory will collaborate with other national laboratories to take advantage of unique user facilities and leverage the expertise of its staff to develop this initiative.

In future years, it is anticipated that basic scientific research funded primarily through SC and the National Science Foundation (at universities) will create opportunities for applied research in the following areas:

- Specific nanostructured membrane materials of interest to environmental restoration
- Sensor materials applicable to national security interests for detection of weapons of mass destruction
- Mineralization in the subsurface and the formation of methane hydrates.

As this applied nanomaterials research expands into EM, EE, and NN programs in the coming years, the INEEL will expand this initiative to meet program goals.

5. Technology Transfer and Commercialization

(a) Situation Analysis

DOE laboratories are required by law to (a) transfer technology in support of U.S. industrial competitiveness, (b) protect intellectual property developed at the laboratories, (c) provide technical assistance to local industry and community organizations, and (d) help diversify local economies.

The purpose of technology transfer is to ensure that the U.S. taxpayer and industry benefit from the research done at national laboratories. The transfer of research results enhances U.S. industrial competitiveness and ultimately leads to job creation, a larger tax base, and improved products.

The INEEL uses a variety of commercial arrangements such as CRADAs, technology licenses, Work-for-Others agreements, and other business agreements to establish technology partnerships. The laboratory also works with local economic development groups to create new companies based on technology developed at the INEEL.

An integrated invention-patenting process is in use at the INEEL. This process involves working with technical staff through industry focus teams to select inventions for patenting, supporting the development of patent disclosures and applications, following the patent process through to completion, and managing the INEEL intellectual property portfolio. The laboratory's technology portfolio reflects its primary mission areas of environmental programs; nuclear energy; fossil energy, energy efficiency, and renewable energy; and national defense.

In a financial environment of level DOE budgets, inflation erodes the purchasing power of available funding. By obtaining supplemental funding from other federal agencies and commercial entities, the INEEL helps ensure the availability of technology required by DOE to fulfill its mission objectives. Laboratory stability and growth increasingly depend on these external sources of funding.

(b) Strategic Objectives

The INEEL has the following objectives in technology transfer:

Form at Least Four High-Technology Spin-Out Companies by 2006

Spinning out a business means helping INEEL personnel form a new business based on laboratory technology. In creating a spin-out, both personnel and technology are transferred to the new company. Technology licenses are granted to spin-out companies that are adequately financed and have viable business plans.

In addition to contributing to the competitiveness of the U.S., spin-out companies help to diversify the regional economy. The entrepreneurial possibilities associated with spin-outs have also furthered the recruitment of high-quality scientists and engineers, who bring valuable new ideas and perspectives to the INEEL. There will be an average of one spin-out company formed per year during the planning period.

Issue at Least Four Major New Licenses During FY 2002 and a Comparable Number During Each Succeeding Fiscal Year

Licensing is an important way of transferring INEEL-developed technology. In FY 2002, new and existing licenses are forecast to generate a revenue stream of at least $625,000 (a 150% increase over FY 2000 revenues). These revenues will be used to reward inventors and provide funding for additional technology development. For subsequent years, an annual growth rate of 25% is forecast.

Work with INEEL Groups to Expand Work-for-Others Funding

Work for Others provides significant new INEEL funding, transfers technology to other federal and commercial entities, and supports physical and intellectual resources required for the DOE mission. In FY 2002, Work for Others will be increased by at least $4 million. A minimum of one new major program (in excess of $1 million over its life span) will be initiated. Similar increases will be sought in subsequent years of the planning period.

Support Deployment of New Technologies to the EM Mission

EM technology deployment efforts are supported by facilitating interactions between technology problem holders and technology solution providers at the INEEL and throughout the DOE complex. The INEEL will also provide an understanding of and interact with external markets for environmental technologies to further their development and deployment.

Establish a Long-Term Industrial Alliance with Multiple Initiatives

Partnering is a critical method used by industry to supplement internal capabilities. Industry prefers to establish long-term relationships because of the expense related to their establishment. The INEEL will establish a long-term relationship with multiple projects with at least one industrial partner. This will provide the laboratory ready access to industrial support in that technical sector and will reduce the cost of the access.

(c) Strategies

To accomplish the above objectives, the INEEL will employ the following strategies:

Invest Royalty Money in Selected Technologies to Hasten Commercialization

Providing funding to move a technology closer to commercialization improves the INEEL's chances of prompting venture-capital firms to invest in its technology and commercial entities to purchase licenses. Royalty funds will be used for support of technology with spin-out potential or high licensing-revenue expectations.

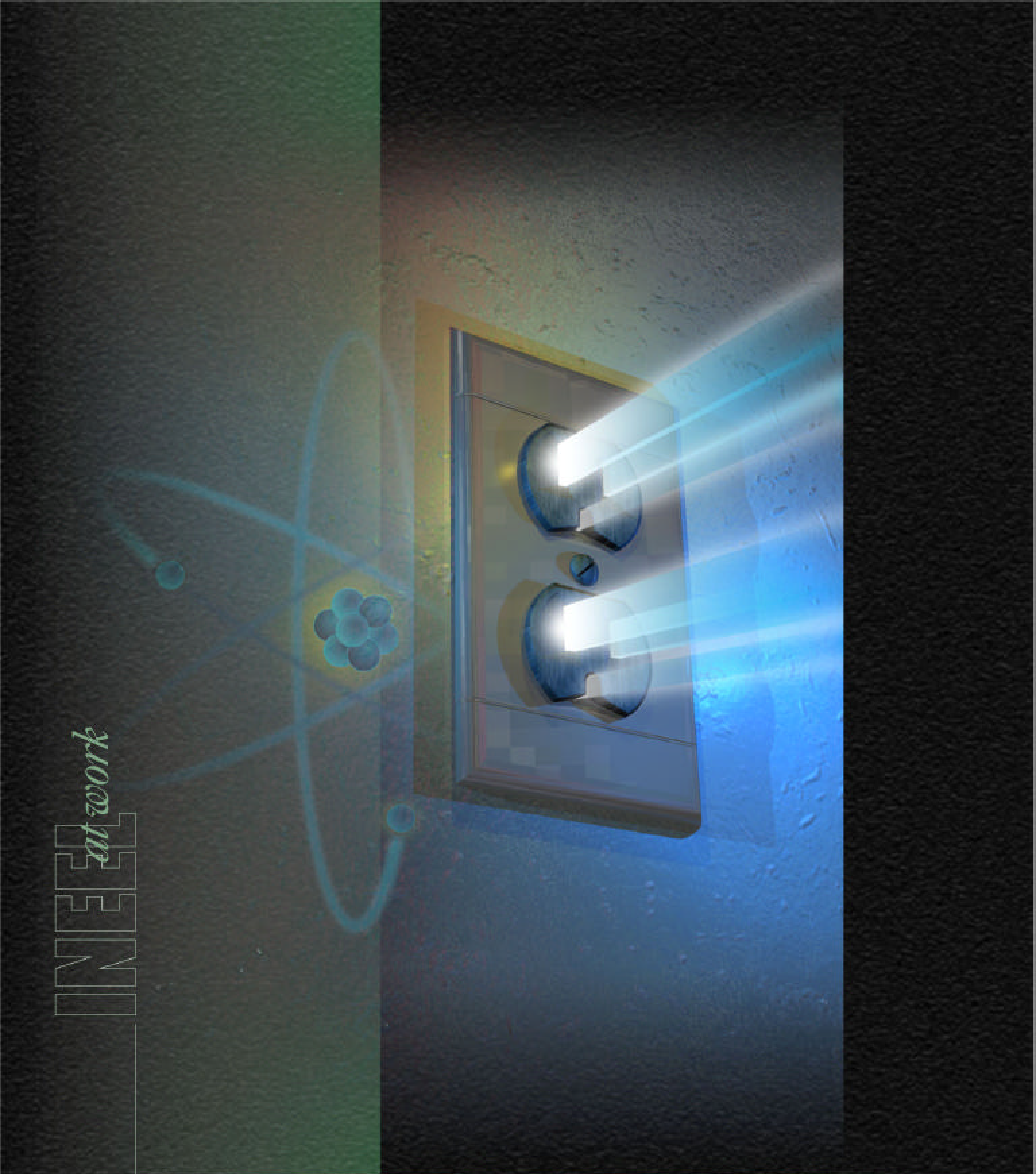
Concentrate Resources on Marketing Technology in Areas of Significant Competency

As product quality and marketability increases, so does the probability of successfully completing technology transfer. Success in one area will be employed to advance other areas. Resources include CRADA funding and product royalties. This concentration of resources will lead to world-class capabilities.

Concentrate on Projects that Align with Major Initiatives

The INEEL will align its commercial marketing efforts related to CRADA and Work for Others with the major initiatives identified in the *Institutional Plan*. Effort will be concentrated on developing long-term alliances with industrial partners that support the technology base identified in the initiatives. The initiatives will have to develop the technology to a point where it is marketable to the commercial sector. The market interaction will provide feedback on the value of INEEL initiatives and refine the technical concepts developed.

Laboratory Initiatives



Generation IV

The DOE and White House imperative of assuring reliable, affordable and environmentally sound energy for America's future is being addressed through the Generation IV Nuclear Energy Systems Initiative and related efforts. The INEEL serves as one of DOE's two Nuclear Energy, Science and Technology lead laboratories.

IV. LABORATORY INITIATIVES

In an effort to further focus on its vision and strategic objectives, the INEEL has adopted a two-tiered initiative approach. Laboratory initiatives are selected because they offer a large benefit to DOE, represent a signature for the laboratory, offer opportunities for integration across disciplines and mission areas, and are fundamental to laboratory core competencies discussed in Section II. The Subsurface Science, Environmental Stewardship, and Advanced Waste Management Solutions initiatives also directly support the laboratory's lead role for EM. The Generation IV Nuclear Energy Systems initiative is aligned with the INEEL's lead laboratory role for NE. The Advanced Computing and Collaboration initiative is a crosscutting initiative designed to strengthen the laboratory's R&D capacity, directly benefiting the other four laboratory initiatives as well as current INEEL missions.

Division initiatives that address needs specific to a particular mission area or have not reached the level of maturity necessary for consideration as a laboratory initiative are included at the end of each mission-area description in Section III.

This section provides a detailed description of the five laboratory initiatives:

- Subsurface Science
- Generation IV Nuclear Energy Systems
- Advanced Waste Management Solutions
- Environmental Stewardship
- Advanced Computing and Collaboration.

Initiatives are provided for consideration by DOE. Inclusion in this plan does not imply DOE approval of or intent to implement the initiatives.

A. Subsurface Science Initiative (Sponsor: EM, Proposed Sponsor: SC)

1. Customer Need

DOE has stewardship of about 1,000 waste locations that are sufficiently contaminated that remediation will likely be required. Remediation may take the form of removal and treatment, or of leaving waste in place (in situ) using stabilization and containment technologies. Much of this radioactive and chemical contamination will constitute a long-term hazard, since significant amounts of it will remain in the ground after DOE cleanup. For most sites, major cleanup costs will be incurred in the early years following signing of the various Records of Decision. The currently projected life-cycle costs to closure at DOE sites is estimated at $200 billion. The most contaminated sites will require many years for remediation—completion of cleanup at the INEEL is projected in 2050 and at Hanford in 2046. Whether contaminants are moved or stabilized in situ, the vadose (unsaturated) zone of the earth will host much of the postcleanup contaminated material as well as spent nuclear fuel. An estimated 129 DOE sites will require monitoring indefinitely at an estimated cost of $100 million per year.

DOE-EM has set a goal of cutting $100 billion from cleanup costs and reducing the schedule by 30 years while reducing risk to the public. If this is to be achieved, new technology will be required. Breakthrough advances in environmental science and technology would have the effect of significantly advancing schedules and cutting costs. The need for new science and technology is widely acknowledged in DOE and in the scientific community.

One major challenge that must be met for developing improved cleanup and monitoring options and reliable risk assessments is a better understanding of processes influencing the movement and transformation of contaminants in the subsurface. Recent publications by the National Research Council and DOE (see Bibliography) have reviewed the knowledge gaps affecting cleanup and monitoring of DOE sites and have made recommendations for strengthening DOE's environmental research program. These publications agree that a major research thrust should be to develop numerical models that yield reliable predictions of the behavior of contaminants under interrelated influences of geological conditions, fluid flow, chemical reactions and biological activity in the subsurface. In order to devise such models and provide the data to drive them, research is recommended to:

- Understand coupling mechanisms among subsurface geology and mineralogy, fluid flow, geochemical interactions and microbiological activity, as well as the basic nature, rate , and other parameters governing each of these processes individually.

- Understand the effects of spatial and temporal scale on laboratory-scale and mesoscale measurements, along with means to extend those measurements to the field scale and to apply results obtained from practical experimental durations to predictions reliable for hundreds or even thousands of years.

- Improve methods for characterizing and monitoring the geology, geochemistry, and microbiology of the highly heterogeneous subsurface and for characterizing and monitoring the location, nature, movement, and transformation of contaminants.

- Improve methods to determine uncertainty in all facets of subsurface measurements, data acquisition, and models in order to make reliable assessments from various candidate remediation and stewardship options of future risks to human and ecosystem health.

A second research challenge discussed by the National Research Council and DOE is the development of effective, durable monitoring systems for validating containment performance and for early warning of containment failure. Research successes have the potential to substantially reduce the $100 million per year monitoring costs cited above. New sensors are needed that will last decades in the subsurface rather than a few weeks to a few years, the typical lifetime of today's sensors. Improved models and a better understanding of containment systems are needed to help define surface and subsurface monitoring points. Research on coupled processes is needed to determine which chemical species will likely give earliest indications of contaminant movement in specific geologic environments. New, noninvasive geophysical and geochemical monitoring techniques are needed as alternatives to sensors placed in expensive drill holes.

A third research challenge is the development of containment and stabilization systems that are more robust and reliable than today's systems. The lack of experience with long-term performance of engineered caps and barriers, coupled with the heavy reliance on them in DOE's cleanup plans, dictate the need for research in this area. Many of the CERCLA barriers in place have a design lifetime of 100 years or less, far too short for DOE needs. Development of effective, long-lasting reactive barriers will require a better understanding of subsurface hydrological, geochemical, and microbiological processes. Design of long-lasting, self-healing caps holds promise, but is still on the horizon.

While the above discussion applies to the subsurface in general, the need to meet these challenges in the vadose zone is particularly urgent in view of the fact that the majority of anticipated remediation and monitoring costs across the DOE complex are for vadose-zone contamination, and vadose-zone processes are significantly more poorly understood than are processes in the saturated zone.

2. INEEL Solution

The INEEL's SSI will focus on and make substantial headway against the challenges discussed above. The objectives of the SSI are to enhance the scientific and engineering underpinnings of DOE's Environmental Programs activities and to provide better options for cleanup, monitoring, and long-term stewardship of contaminated sites. The laboratory recognizes that considerable work of importance to these areas has been and is being done under other programs sponsored by DOE and other agencies. Our initiative is being planned to leverage, complement, and establish coordination with such work. The laboratory's approach is to focus collaborative, multidisciplinary, and multi-institutional effort on the most vexing problems, and to provide a research infrastructure that promotes new avenues of attack on these problems. An integral part of this infrastructure is the proposed Subsurface Geosciences Laboratory (SGL) for collaborative mesoscale experiments.[c]

The SSI offers direct and primary support to the remediation and stewardship missions of EM programs and to the science programs of SC. Additionally, improvements in understanding, modeling, and monitoring the subsurface will be broadly applicable to and provide support for DOE's fossil energy, geothermal energy, and carbon sequestration programs, among others.

The SSI research agenda is being developed through integration and prioritization of science and technology needs identified by EM, the National Vadose Zone Science & Technology Roadmap, the INEEL's Vadose Zone Science & Technology Roadmap (now under development), the INEEL's Long-Term Environmental Stewardship Initiative, recommendations to DOE by the National Research Council, and interactions with problem holders from across the DOE complex. The eight universities making up INRA, our many collaborative partners, and the general science community are also engaged in helping develop our research agenda and in identifying required infrastructure needs. The SSI is being guided by a review panel of nine noted scientists, representing environmental research experience in the national laboratory and academic arenas.[d]

One of the major barriers to advancing subsurface science is scaling. Processes studied and data obtained at the laboratory (benchtop) scale generally do not apply directly to the field (cleanup) scale. Yet, field experiments themselves have significant limitations. It is difficult and costly to instrument a field experiment thoroughly—the researcher has control neither of the starting nor of the boundary conditions, a field experiment cannot usually be dissected for further study after its completion, actual contaminants can rarely be used because of environmental regulations, the field experiment can rarely be replicated, and field experiments are quite costly. None of this means that laboratory experiments or field experiments are not needed, because they have an important role to play in subsurface research. However, a supplementary alternative is needed to help cross the scaling barrier and for those cases where neither laboratory nor field experiments are adequate to study a process or obtain a required data set. The INEEL

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c. The mesoscale experiment is large enough that coupling of field processes takes place and can be studied in the controlled, instrumented setting of a laboratory. The actual physical scale for a mesoscale experiment depends on the processes of interest and the experimental objectives. They may range from somewhat larger than benchtop to experiments in vessels tens of feet on a side.

d. The members of the SSI review panel are Chair, Dr. Raymond Wildung (PNNL); members Dr. John Corey (SRTC), Dr. Al Cunningham (Montana State University), Dr. Robert Glass (SNL), Dr. Gary Jacobs (ORNL), Dr. Peter Kitanidis (Stanford University), Dr. Gene Madsen (Cornell University), Dr. Ernie Majer (LBNL), and Dr. John Westall (Oregon State University).

believes that mesoscale experiments provide the benefits of a controlled laboratory environment while conducting experiments large enough to more effectively mimic the field scale.

Performing experiments at the mesoscale is by no means new, but it appears to have been vastly underutilized in subsurface science research. This was the conclusion of an INEEL-hosted workshop held in May 2000 in Salt Lake City entitled, "*Subsurface Processes at the Mesoscale–A Workshop to Evaluate Research Direction and Facility Needs in Support of DOE Environmental Management Programs.*" This workshop involved some 37 participants from DOE, INEEL, PNNL, LBNL, SNL, ORNL, SRTC, and 11 universities, including the INRA schools. Workshop participants agreed that mesoscale experiments are critical to understanding the complex and coupled nature of processes in the subsurface and that the importance of mesoscale research stems from its ability of help fill the gap between small-scale laboratory research and large-scale field research. Mesoscale investigations were also deemed to be critical for observing phenomena that are not apparent at smaller scales, or cannot be definitively isolated in uncontrollable field environments.

Mesoscale research can contribute to the development of improved cleanup and monitoring technology in several ways:

- Hydrological, geochemical, and microbiological processes taking place in the subsurface are coupled, i.e., they interact with one another. This coupling is poorly understood, however, and is not usually included in predictive models of the fate and transport of contaminants in the subsurface. Coupling of processes generally cannot be studied at the laboratory scale, but they can often be studied at the mesoscale. One facet of the INEEL's SSI is to perform mesoscale experiments specifically designed to study the coupling of processes—to determine which processes interact most closely and to quantify the parameters governing coupling so that the processes can be included in numerical models. For example, the laboratory is currently conducting a mesoscale experiment in a large lysimeter to determine under what conditions uranium may be mobilized due to changes in vadose zone pH brought about by variations in the growth rate of subsurface microbes. The experiment is designed to simulate conditions believed to be operating at the INEEL's Subsurface Disposal Area and will have direct application to the SDA performance assessment.

- Validation of predictive, numerical models of the subsurface is difficult, and many of our current models have not been properly validated. Peer review of a model may lead to validation, but this is not possible in some important cases. The other accepted method of model validation is to run a model against a set of experimental data. However, there are few data sets available that are adequate to validate subsurface models. Field data sets are usually too sparse for use in validation, and few good field experiments have been run because of cost and time considerations, as well as the difficulty in replicating field experiments to increase confidence in and place error bars on the data obtained. A very attractive alternative is to obtain experimental data sets from mesoscale experiments specifically for the purpose of calibrating and validating models. Data sets obtained from mesoscale experiments can be dense, can include many independent parameters, and data uncertainty can be evaluated by repeating the experiment, perhaps several times. For example, a DNAPL spill could easily be simulated in a mesoscale tank using the actual contaminant, and its spread in the liquid and vapor phases could be monitored under known conditions. Models could then be run on the data set and improved until they were able to explain the experimental data.

- Engineered cap designs can be studied at the mesoscale in experimental vessels (large tanks and geocentrifuges) and subjected to accelerated aging with freeze-thaw cycles, wetting-drying cycles, and by simulating subsidence. Design of reactive barriers can be studied in mesoscale experiments by subjecting them to rapid fluid flow and chemistry that is more extreme than the barriers are likely to encounter in actual application.

The proposed SGL will be a critical element in performing mesoscale experiments of the types illustrated above in support of DOE programs. The SGL will be a DOE user facility unique in its collection of equipment and instrumentation, and will form an important focus for stimulating rapid advances in the subsurface sciences through collaboration with the best minds in DOE, academia, and the private sector.

Planning for the SGL is in progress. The conceptual design of the facility (see Figure 5) has been performed by the Zimmer-Gunsul-Frasca Partnership, the same group that designed the Environmental Molecular Sciences Laboratory at PNNL. The current schedule calls for detailed construction designs in March 2005, for construction to proceed immediately thereafter, and for this 200,000 square-foot, $150 million facility to be ready for service in mid-2007. The facility will be equipped with a 6-m radius geocentrifuge for accelerating fluid flow in instrumented payload packages, a large soil tank measuring 9 m (high) by 15 m by 20 m for studying aging and mechanical effects on artificial caps and barriers and for conducting experiments on coupled biogeochemical and fluid flow processes. Smaller tanks and lysimeters will also be available. The researchers will be supported by standard chemistry, electronics and other laboratories. The SGL will be a signature facility designed to draw top-quality scientists and engineers in collaborative research, technology development, and demonstration.

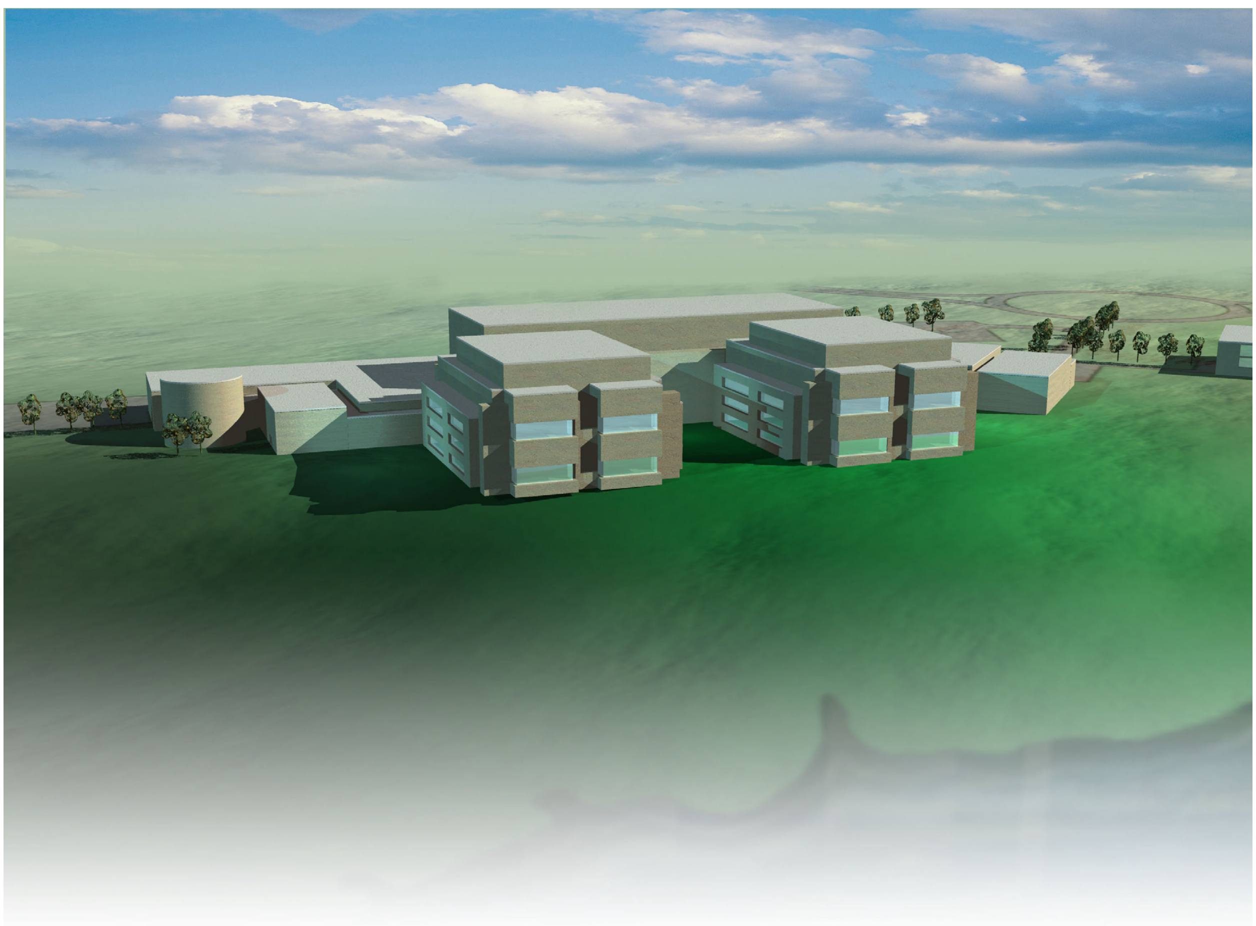

Figure 5. Artist's rendition of the conceptual design for the SGL.

An aggressive vadose-zone research program is under way at the INEEL that will provide significant research results in the near-term, well before the SGL is operational. Bechtel corporate funds have been invested to purchase a 2-m geocentrifuge, which will be installed in 2002 in the Bonneville County Technology Center, near the INEEL Research Center (IRC). It will be used to accelerate fluid flow in instrumented soil and rock packages, and to help design the larger experimental campaigns to be conducted in the SGL. Laboratory space is being converted in the IRC to house smaller mesoscale experiments currently being started. Staffing plans call for continued recruiting of advanced-degree scientists and engineers with expertise in vadose zone and other subsurface processes.

Results from the SSI will be applied throughout the DOE complex. However, initial research activities will focus on understanding subsurface processes associated with the vadose zone in arid environments typical of DOE sites in the western U.S. The INEEL's RWMC, vadose zone contamination at INTEC, and the mixed plume at TAN are characteristic of western DOE sites contaminated with mixtures of metal, radionuclide, and organic wastes buried in a thick vadose zone. Work on the problems at these sites will help focus SSI research activities and lead to the effective integration of INEEL science and technology programs into site operations. This integration will maximize the SSI benefit to both the INEEL and the DOE complex as a whole.

Particularly important to the SSI is the INEEL's Advanced Computing and Collaboration Initiative, since computing and data-handling capability will be essential to developing and improving models of the subsurface and to interpretation of experimental results. Also important is the division initiative in nanotechnologies. Nanoscale processes govern the sequestration, release, mobility, and bioavailability of nutrients and contaminants in the subsurface, and engineered nanoparticles appear to have great potential for application in remediating subsurface contamination.

DOE has invested significant resources throughout the complex in fundamental and applied molecular-scale studies and extensive field-site investigations of the nature, extent, and behavior of subsurface contaminants on DOE lands. The SSI is taking advantage of these investments through partnering with other laboratories, universities, and the private sector. Strong partnering relationships have been developed with PNNL, SRTC, ORNL, SNL, LBNL and LLNL, each of which is working to help develop experimental campaigns they would like to conduct in the SGL. Strong ties with the Environmental Molecular Sciences Laboratory, the Subcon Focus Area (with its programs at several field sites) and the Natural and Accelerated Bioremediation Research program (with a field site at Oak Ridge) are also being developed, since the SGL will provide a facility for working at scales intermediate between the laboratory and the field. An important component in the INEEL's collaboration is INRA partnering, which is expected to lead to joint research facilities, including shared laboratory and office space. The Idaho State University–University of Idaho Center for Science and Technology (CST) will be built on the Idaho Falls campus of these two universities, and the INEEL will lease about half the space in this 50,000 square-foot building for conducting subsurface research. Other partnering relationships are being established with LANL, other universities, and selected private companies.

Subsurface research has already made a difference in INEEL cleanup operations. Cleanup of the trichloroethylene plume in groundwater continues using in situ bioremediation for the highly contaminated hot spot and natural attenuation in the dilute, distal portions of the plume. The selection of in situ bioremediation over the pump-and-treat approach specified in the Record of Decision (ROD) was based on a successful demonstration of the technology. Cost savings of ~20% and acceleration of the hot-spot remediation by a factor of two will result from this work. Other applications of the same technology at the INEEL, Portsmouth, and LLNL are expected to reduce costs by 58% and cut remediation times in half. The fundamental studies leading to the application of bioremediation and natural attenuation at TAN were supported by SC and EMSP, and involved numerous national laboratory and university collaborators. This successful case exemplifies the role that improved understanding of subsurface processes can play in cleanup decisions.

In summary, the SSI will work in collaboration with its partners to provide DOE with:

- An improved science-based rationale for establishing cleanup levels that are protective of health and the environment while eliminating unnecessary remediation requirements
- An enhanced ability to design new, or improve existing, in situ remediation technologies that capitalize on the advancements made in the fundamental understanding of geochemical and biological processes
- Accelerated deployment of new in situ remediation technologies that minimize human exposure to contaminated media through underground treatment with minimal or no secondary waste streams
- Enhanced vadose zone and groundwater monitoring systems that allow definitive evaluation of contaminant migration and the performance of engineered subsurface barriers
- Superior simulation and visualization capabilities for predicting the transport and transformations of contaminants and for enabling more realistic risk and performance assessments.

Funding requirements are shown in Table 8.

Table 8. Subsurface Science Initiative funding projections ($ in millions).
(Funding projections are a preliminary and represent an early estimate of resources required for this initiative. The funding projections contained in this table are NOT currently included in the Resource Projection tables in Section VI.)

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Operating*	11.8	13.0	14.0	14.5	15.0
Capital Equipment	0.0	1.5	2.0	2.5	3.0
Construction	1.0	4.2	5.0	63.4	65.1
Total	12.8	18.7	21.0	80.4	83.1

* The projected support of the SSI from INEEL site operations is not included in these totals and is projected to be $4, $7, $10, and $12 million for FY-02 through FY-06, respectively. SSI operating funds given here are derived from Strategic Investment funds, LDRD funds, ESRA funds, and other direct funding from proposal awards and R&D collaborations. Guidance was sought and received through the Funding Determination Committee to ensure allocation to proper accounts.

3. Milestones

FY 2002 – Complete the SGL conceptual design and report, an independent review and an ESAAB review of the SGL, and achieve the Critical Decision-1 milestone.
FY 2002 – Let contract for Title-I design of the SGL.
FY 2002 – Begin collaborative experiments using the 2-m geocentrifuge.
FY 2002 – Begin collaborative work on advanced sensor design for instrumenting field sites, pre-SGL mesoscale experiments, and experiments in the SGL.
FY 2003 – Complete Title-I design of the SGL, and let contract for Title-II design.
FY 2003 – Begin development of advanced vadose zone conceptual models and computer simulation codes.
FY 2004 – Begin to develop the detailed science plan for initial large mesoscale experimental campaigns to be conducted in the SGL, in collaboration with national laboratory and university user communities.
FY 2005 – Complete Title-II design of the SGL, and let construction contract.
FY 2007 – Complete SGL and initiate collaborative mesoscale experiments.

B. Generation IV Nuclear Energy Systems Initiative (Sponsor: NE)

1. Customer Need

The electricity crisis in California is a dramatic example of the inadequacies of existing energy policy. Unfortunately, the problem is not confined to California. The fundamental problem is inadequate supply, and it is being felt across the country. An adequate supply of electricity is essential for health, safety, national security, and economic expansion.

More than 400 nuclear power plants operate throughout the world, supplying about 17% of the world's electricity. These plants perform safely, reliably, and without pollutant emissions. By 2030, the worldwide demand for energy and electricity is projected to be 50% higher than it is today, and to nearly double by 2050. The growth of nuclear power in developing countries, the global concerns regarding greenhouse gases from carbon-fuel cycles, the need for better air quality, and the need to strengthen nuclear power as a viable energy option in the highly competitive U.S. markets strongly reinforce the necessity for a new generation of nuclear power plants.

The world is now in its third generation of nuclear power plants (see Figure 6). Small reactors in the early Atoms for Peace era were the first generation. Second-generation plants include the majority of central-station nuclear plants now in operation. The third generation is the set of advanced light-water reactors that emerged from public-private cooperation in the 1980s and 1990s. The Nuclear Regulatory Commission has certified three such designs, although they face an uncertain future domestically. This third generation is finding general acceptance outside the U.S. and may be actively deployed abroad. In the future, of course, growing concerns for the environment and for national economies will favor clean and economical energy sources.

If significant advances are made to fully apply the potential benefits of nuclear energy systems, a fourth generation of nuclear reactors promises to enhance the global energy picture.

2. INEEL Solution

New nuclear energy programs supported by Congress recognize the potential that nuclear power holds to provide a sustainable energy source for centuries. Until recently, these programs lacked the focus necessary to lead to the development of one or more advanced nuclear energy systems that could be deployed over the next few decades. This changed, however, with the formation of the Generation IV Nuclear Energy Systems Initiative. The INEEL and ANL, as NE lead laboratories for nuclear reactor technology, are conducting a broad-based program planning, or "roadmap," effort.

The Generation IV project is designed to work on an international basis to identify, assess, and develop the most sustainable nuclear energy technologies that are competitive in most markets with cost-efficient technologies extant in 2030 and beyond, while further enhancing nuclear safety, minimizing nuclear waste, and reducing the risk of proliferation.

Begun in FY 2001 as a 2-year effort, the purpose of the roadmap is to identify nuclear energy system concepts and associated fuel cycles that offer the greatest potential for meeting the goals of the Generation IV initiative and to set forth a long-term research, development, and demonstration plan for those concepts and potential fuel cycles. The roadmap, when completed in September 2002, will provide the foundation for an active international effort to develop revolutionary nuclear power systems that can be deployed worldwide before 2030. It will form the plan for a long-term R&D program in nuclear energy.

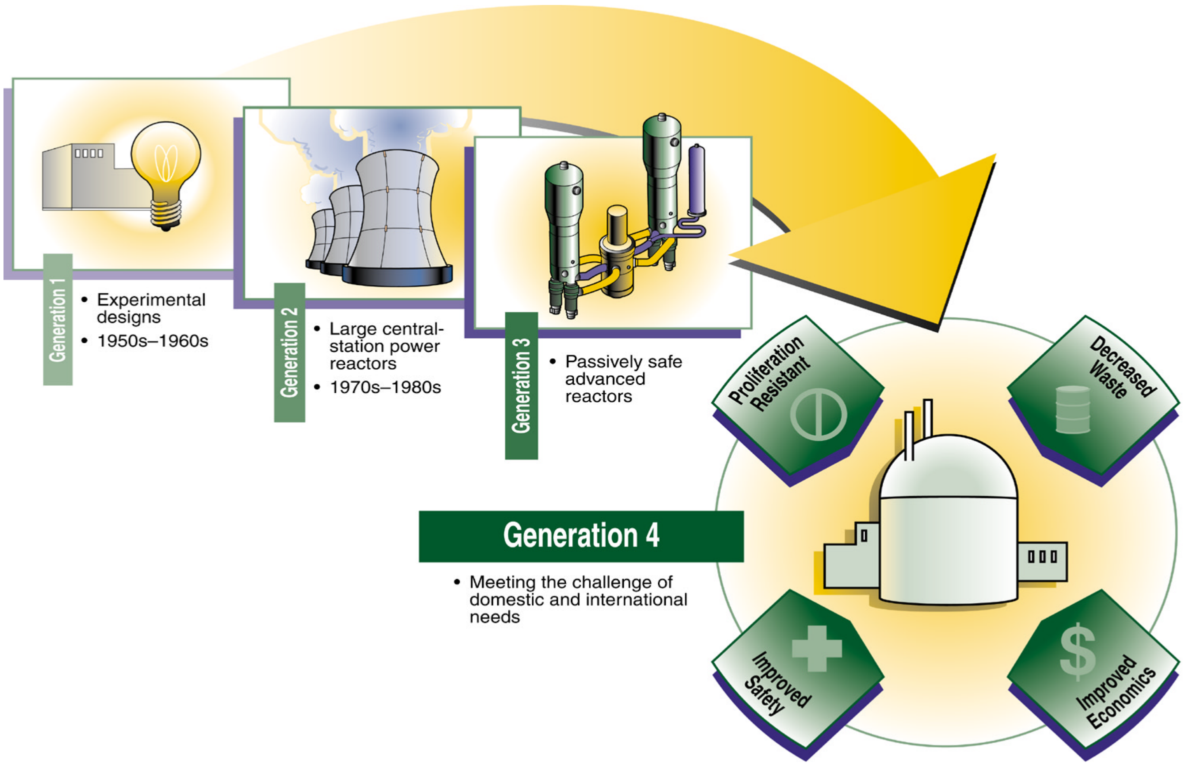

Figure 6. Four generations of nuclear reactors.

Generation IV provides the U.S. with the opportunity to be a leader on a new international program to develop next-generation nuclear energy systems. These next-generation systems will offer improvements over existing designs in sustainability, nonproliferation, safety, and economics. Capitalizing on this opportunity, DOE and the INEEL have led the formation of a Generation IV International Forum to begin discussions with other countries on possible collaborative nuclear energy R&D programs. Argentina, Brazil, Canada, France, Japan, the Republic of Korea, the Republic of South Africa, and the United Kingdom are partners in the U.S.-led effort.

Generation IV will have a major impact on the ability of the U.S. to renew its vital nuclear infrastructure and international leadership. In addition to fulfilling the lead laboratory role of planning, analysis, and integration, the INEEL will focus on development and execution of research programs that directly address key areas of Generation IV technology.

Funding requirements are shown in Table 9.

3. Milestones

FY 2002	Issue draft roadmap in January 2002. Issue interim roadmap in May 2002. Issue final roadmap in September 2002.
FY 2003–2006	Contribute to key aspects of the Generation IV R&D program, renew key nuclear fuel-cycle infrastructure, and create additional alliances and partnerships.

Table 9. Generation IV Initiative funding projections ($ in millions). (Funding projections are preliminary and represent an early estimate of resources required for this initiative. The funding projections contained in this table are NOT included in Section VI, "Resource Projections.")

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007
Operating	8.5	13.5	18.0	22.0	27.0	35.0
Capital Equipment	1.0	1.0	1.5	2.0	2.0	3.0
Construction	0.5	0.5	0.5	1.0	1.0	25.0
Total	10.0	15.0	20.0	25.0	30.0	63.0

C. Advanced Waste Management Solutions Initiative (Proposed Sponsor: EM)

1. Customer Need

DOE has ownership of more than 250 types of spent nuclear fuel stemming from operation of Naval, DOE research, university research, foreign research, and commercial production reactors. In addition, the DOE weapons complex generated a significant inventory of legacy wastes during the Cold War, including transuranic, mixed, and high-level streams. The INEEL has supported many DOE and predecessor agency missions over the past 5 decades. Consequently, an onsite inventory of these radioactive waste streams and materials exists at the INEEL that must be processed and dispositioned in accordance with the governing legal and regulatory requirements. Management of these wastes and materials, including characterization, treatment, packaging, transportation, and disposal, presents many technical and regulatory challenges for the INEEL and DOE complex.

The Settlement Agreement between the State of Idaho and DOE is a major driver that mandates various interim and final milestones for disposition of the most challenging legacy wastes, spent nuclear fuel, and associated facilities at the INEEL. The INEEL Environmental Programs effort has identified several key challenges associated with the requirements of the Settlement Agreement. For example, the agreement requires immobilization of the liquid sodium-bearing waste stored in the INEEL tank farm by 2012, and subsequent closure of the storage tanks. The complex chemistry of this waste stream presents many uncertainties in processing the inventory, regardless of whether thermal or nonthermal treatment technologies are used. Additionally, cleaning the storage tanks in accordance with the performance assessment and closure plans requires more cost-effective sampling, inspection, and heel-removal technologies. In addition to the Settlement Agreement, the Voluntary Consent Order establishes schedule requirements for characterizing, cleaning, as required, and closing more than 700 small tanks located throughout the INEEL. Nonintrusive inspection and cost-effective methods for homogenizing and sampling tank contents for characterization are needed. Hanford has identified several similar needs associated with the Hanford River Corridor Project, which is responsible for D&D of the 300-Area.

The Settlement Agreement also mandates that all transuranic waste, including contact-handled and remote-handled material, be shipped out of Idaho for disposal by 2018. However, of the approximately 65,000 m^3 of transuranic waste stored at the INEEL, an estimated 20–40% of this inventory does not currently meet the WIPP acceptance criteria for disposal. This includes organic-contaminated transuranic wastes, and other orphan transuranic wastes, which will most likely require treatment prior to packaging and shipment to WIPP. Additionally, some of these waste streams will require remote handling. Many of these problematic waste streams had been planned for processing in the thermal treatment system at the Advanced Mixed Waste Treatment Plant. However, opposition to this approach resulted in convening of the "Blue Ribbon Panel" of experts that made recommendations to investigate alternatives to the incineration technology planned for the plant. Currently, these treatment technologies and systems have not been validated. Characterization of the transuranic waste inventory for WIPP disposal, particularly the remote-handled portion, must be performed using nondestructive assay and evaluation techniques to reduce costs and worker exposure. These systems are not currently available. The characterization, processing, and transportation needs identified for INEEL transuranic wastes are common to the entire DOE complex transuranic waste inventory.

Additionally, the Settlement Agreement requires that all high-level waste calcine and spent nuclear fuel be treated and shipped out of Idaho for final disposition by December 31, 2035. The high-level waste calcine inventory at the INEEL is stored in bin sets not designed for retrieval of the material. Nor do the bin sets provide accessible sampling capabilities. Characterization, retrieval, and processing of the calcine waste inventory are significant future challenges identified by the INEEL Environmental Programs. Other DOE sites have identified additional needs associated with disposition of their high-level waste inventories. Radionuclide separations is a process included in both Hanford and Savannah River Site treatment trains for certain high-level waste inventories. Simpler, more cost-effective technologies are needed to address these complexwide needs.

Many of the same issues associated with specialized processing and characterization technologies for the remote-handled transuranic wastes also exist for the INEEL spent nuclear fuel inventory. Although the Settlement Agreement provides specific milestones for management of INEEL spent nuclear fuel, this is a DOE complexwide challenge. DOE has the responsibility to develop a system for safe, final disposition of all spent nuclear fuel under its purview. Specifically, DOE must ensure safe storage and resolve vulnerabilities of existing DOE-owned spent nuclear fuel; achieve safe, secure interim storage of DOE-owned spent nuclear fuel; and prepare all DOE-owned spent nuclear fuel for disposal in a geologic repository. Subsequently, DOE will have to develop a strategy for completing transfer and D&D of the surplus spent nuclear fuel storage facilities. Several challenges have been identified in complying with these requirements. Specifically, the Advanced Waste Management Solutions Initiative will support remote welding and nondestructive evaluation of canister welds, radionuclide release rate testing resulting from degradation, advanced neutron absorber development for criticality control, and fuel-drying standards and methodologies. The initiative will also support development of standardized and high-integrity canisters for storage and transportation of spent nuclear fuel, as well as development and testing of innovative characterization technologies.

A key challenge facing the INEEL EM program is accomplishing cleanup work on an accelerated schedule. The INEEL believes that progress toward reaching closure status is possible with a realignment of projects and implementing alternative solutions to those currently in the baseline.

2. INEEL Solution

The near-term mission of the Advanced Waste Management Solutions Initiative is primarily focused on addressing the challenges identified by the INEEL Environmental Programs relative to compliant disposition of the legacy waste and spent nuclear fuel inventories. These challenges can generally be grouped into four categories: (1) disposition of high-level waste calcine and sodium-bearing waste; (2) closure of tank farm and Voluntary Consent Order tanks, including characterization, inspection, cleaning, and retrieval; (3) characterization, treatment, and disposition of organic transuranic sludges, remote-handled transuranic wastes, and other orphan transuranic waste; and (4) improved characterization of spent nuclear fuel and calcine for treatment and shipment offsite. Additionally, this initiative is addressing environmental cleanup challenges at other DOE EM sites (e.g., separations and filtration needs at Savannah River Site and Hanford) and non-EM sites (e.g., chemical reactivity process modeling needs at Pantex DOE-DP).

The INEEL has developed extensive scientific and engineering expertise in spent nuclear fuel and waste management technologies. The Advanced Waste Management Solutions Initiative focuses these capabilities on research, development, engineering adaptation, demonstration, and deployment efforts, in order to deliver cost-effective, timely solutions to the cleanup challenges.

In some instances, basic research and technology development is necessary to provide a break-through, innovative technology, such as spent nuclear fuel and remote-handled transuranic waste characterization. The Advanced Waste Management Solutions Initiative is supporting R&D efforts to provide technologies such as the "Gamma Spectroscopy with Acceptable Knowledge" system for characterization of radionuclides in remote-handled transuranic waste, as well as the Gamma Coincidence Assay System for characterization of radionuclides in spent nuclear fuel and remote-handled transuranic wastes. This initiative has provided multiple solutions to the fast-track 3100 m^3 Project. These solutions have been delivered through deployment of innovative, cost-effective technologies, such as the Data Review Expert System, as well as resolving key regulatory issues, such as minimizing transuranic waste drum age requirements for WIPP certification.

This initiative also leverages R&D work performed by the National Spent Nuclear Fuel Program. The National Spent Nuclear Fuel Program is providing cost-effective, standardized packaging, transportation, and consistent repository acceptance requirements for disposition of all DOE spent nuclear fuel. In addition, the R&D efforts of the National Spent Nuclear Fuel Program play a key role in establishing the safety basis for DOE spent nuclear fuel. For example, the standardized and high-integrity canisters and their associated material science studies are key elements in the safe packaging for all types of DOE spent nuclear fuel. Additionally, research in advanced neutron absorber materials and radionuclide release rate testing will benefit the INEEL and DOE complex in criticality control issues and degradation impacts that may occur from long-term exposure to the repository environment. The National Spent Nuclear Fuel Program also provides the necessary preclosure, postclosure, and criticality analyses to establish the DOE spent nuclear fuel safety basis, which strongly influences the repository waste certification process (i.e., package configuration, radionuclide inventory, etc.)

The Advanced Waste Management Solutions Initiative works to identify other resources to support investigation of alternatives to the current INEEL EM baseline. For example, the potential benefits of cold crucible induction melters are well publicized for application to high-level waste treatment, but have not been validated. Through this initiative, the INEEL is working with the Tanks Focus Area, as well as the INEEL Environmental Systems Research and Analysis Program to implement a comprehensive technology development, demonstration, and validation effort to quantify the benefits of cold crucible induction melters. Additionally, because this technology has potential application to several other DOE complex waste streams, a technical team representing the INEEL, Savannah River Site, and Hanford has been established to leverage the respective capabilities.

The best solutions for some INEEL EM cleanup challenges may be available off the shelf, at another site, or within INEEL site boundaries. The Advanced Waste Management Solutions Initiative has been successful in deploying technologies that have only required engineering adaptation to cost-effectively and expeditiously address an INEEL cleanup need. A specific example is the fluidic pulse sampler deployed to homogenize and sample the heel materials in some of the Voluntary Consent Order tanks. This technology was adapted from a system developed by AEA Technologies and offered at low cost to the INEEL. Because of this project, several other potential solutions to INEEL EM cleanup needs have been identified and are being pursued. In another case, a technology developed through the DOE National Security Program to nonintrusively examine munitions for demilitarization purposes has been demonstrated to be effective for determining the presence of residual heel materials in small-volume, aboveground tanks.

Key to providing solutions to the INEEL and DOE EM cleanup challenges are bench-scale, pilot plant, and other cold and hot laboratory facilities. The Consolidated Laboratory Facility has been designed to provide the appropriate infrastructure to support many of these needs. This project, which consists of a newly constructed 160,000 ft^2 building at the site facility and a 65,000 ft^2 leased building in Idaho Falls, will include laboratory space for cold testing of bench- and pilot-scale processes, and some limited hot testing. Much of the 225,000 ft^2 of available space will directly support the spent nuclear fuel and high-level waste cleanup missions at the INEEL. Consequently, this will benefit the DOE complex in addressing environmental cleanup challenges at other sites.

The long-term mission of the Advanced Waste Management Solutions Initiative is to effectively leverage INEEL spent nuclear fuel and waste management expertise and capabilities to support the other DOE sites in accomplishing their cleanup missions. Many of these efforts are ongoing. For instance, treatment of organic-contaminated transuranic wastes, characterization of spent nuclear fuel and remote-handled transuranic wastes, and spent nuclear fuel management, in general, are all complexwide challenges that are being addressed through INEEL-led multisite activities and interactions. As a result, several collaborations have been established with other DOE laboratories (i.e., ORNL, LANL, ANL, SRS, and PNNL), which also serve to strengthen the INEEL's role within the EM Core Laboratories in helping address cleanup needs throughout the DOE complex.

Advanced separations and filtration science are examples of how INEEL expertise is being deployed to solve cleanup challenges facing other DOE sites. INEEL scientists are currently supporting Savannah River Site and Hanford with specific chemical extraction and filtration needs. Nondestructive characterization, innovative waste processing, off-gas control technologies, and intelligent information processing are also recognized capabilities of the INEEL technical staff. Many DOE sites, other federal agencies, and private sector industries have identified needs in these areas. Similarly, the INEEL has nationally and internationally recognized expertise in the management of spent nuclear fuel due to the past and ongoing R&D projects and management activities. Opportunities to leverage this capability to the commercial nuclear power industry, as well as foreign governments, continue to expand and will help ensure safe storage and management of those spent nuclear fuel inventories. The Advanced Waste Management Solutions Initiative is also aggressively pursuing integration between DOE EM, FE, and EE programs at the INEEL to enhance our ability to be successful in identifying and transferring expertise, capabilities, and technologies across programs that can provide cost-effective solutions to common needs.

Funding requirements for the Advanced Waste Management Solutions Initiative are shown in Table 10.

Table 10. Advanced Waste Management Solutions Initiative ($ in millions).
(Funding projections are preliminary and represent an early estimate of resources required for this initiative. The funding projections contained in this table are NOT included in Section VI, "Resource Projections.")

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Operating	$ 14.0	$ 17.8	$ 15.4	$ 15.6	$ 14.8
Capital Equipment	$ 0.0	$ 0.0	$ 0.0	$ 0.0	$ 0.0
Construction*	$ 3.1	$ 5.3	$ 4.5	$ 5.1	$ 16.8
Total	$ 17.1	$ 23.1	$ 19.9	$ 20.7	$ 31.6

*Data represent 76.25% of the total Consolidated Lab Facility new construction costs, which is the portion of the facility that will support the mission of the Advanced Waste Management Solutions Initiative.

3. Milestones

FY 2002 – Deploy an integrated tank wall cleaning and heel homogenization system for closure of the pillar and panel tanks at the tank farm.

– Provide a more effective solids sampling end-effector for deployment of the Light-Duty Utility Arm in collecting heel solids samples in support of sodium-bearing waste characterization and tank closure.
– Demonstrate a technology for sampling solids below liquid level to minimize future Light-Duty Utility Arm deployments and reduce sampling costs.
– Establish a basic bench-scale cold crucible induction melter system at the INEEL to support evaluation of potential DOE applications.
– Support the Savannah River Site EM cleanup mission through testing and validation of the Caustic Side Solvent Extraction process.
– Deploy an automated system for performing review, analysis, and interpretation of assay data for characterization of transuranic waste drums in support of the 3100 m^3 Project (i.e., data review expert system).
– Provide an integrated equipment monitoring system to ensure proper operation using intelligent information processing techniques (i.e., advanced data validation and verification system ready for deployment).
– Provide initial performance data on alternative technologies to incineration for processing of organic-contaminated and orphan transuranic wastes for WIPP certification.
– Deploy high-integrity canisters for spent nuclear fuel storage and transportation.
– Provide initial radionuclide release rate test data for specific spent nuclear fuel types resulting from degradation in a long-term repository environment.
– Provide initial performance data on advanced neutron absorber materials for criticality control in a long-term repository environment.
– Provide performance data on nondestructive technologies for characterization of radionuclides in remote-handled transuranic waste (i.e., gamma spectroscopy with acceptable knowledge ready for deployment).

FY 2003 – Develop initial performance data on solid-liquid separations technologies for application to treatment of sodium-bearing waste (i.e., thermal and nonthermal processes).
– Provide initial comparative performance data on innovative cesium ion exchange sorbents for application to treatment of sodium-bearing waste (i.e., thermal and nonthermal).
– Deploy a technology for performing nonintrusive real-time field inspections of small-volume tanks to determine if residuals are present (i.e., field-portable digital radiography system).
– Provide performance data on nondestructive technologies for characterization of hazardous constituents in transuranic waste (i.e., prompt gamma neutron activation analysis ready for deployment).
– Provide initial radionuclide release rate test data for specific spent nuclear fuel types resulting from degradation in a long-term repository environment.
– Provide performance data on an improved film cooler for treatment of off-gas if a thermal treatment is selected for processing sodium-bearing waste.
– Provide initial performance data on steam reforming for application to processing sodium-bearing waste.

FY 2004 – Deploy a large-scale decontamination system that will significantly reduce the volume of secondary liquid waste generated (i.e., NPOx System).
– Provide comparative sample analytical data that will allow deployment of a below-riser solids sampling technology for below-liquid-level applications that will eliminate the need for Light-Duty Utility Arm deployments and significantly reduce sampling costs.

– Provide comprehensive comparative performance data (bench-scale), relative to joule-heated melter operations, for cold crucible induction melters in processing INEEL, Savannah River Site, and Hanford waste.
– Provide performance data on mercury removal and control technologies generated during processing of sodium-bearing waste if a thermal treatment system is selected.
– Provide key data for mass balance and disposition options for secondary waste streams resulting from treatment of sodium-bearing waste.
– Provide initial radionuclide release rate test data for specific spent nuclear fuel types resulting from degradation in a long-term repository environment.
– Deploy a remote welding test setup and demonstrate an optimized weld repair technique for spent nuclear fuel canisters.
– Provide preliminary performance on a break-through nondestructive assay technology that can characterize the radionuclide inventory in spent nuclear fuel and remote-handled transuranic waste (i.e., gamma coincidence assay system).
– Provide performance data to Savannah River Site and Hanford on alternative solvent extraction technologies for alkaline waste applications (i.e., modified universal extraction process).

FY 2005 – Establish an integrated pilot plant cold crucible induction melter system at the INEEL to evaluate performance on applicable DOE waste streams (i.e., feed system, melter, key off-gas components).
– Provide initial performance data on in situ characterization technologies for calcine in bin sets (i.e., laser ablation with mass spectroscopy, laser-induced breakdown spectroscopy).
– Provide final data to down-select a cesium ion exchange technology for sodium-bearing waste treatment applications.
– Provide final data to down-select a solid-liquid separations technology for sodium-bearing waste treatment applications.
– Establish an integrated off-gas system for use on the sodium-bearing waste pilot plant treatment system that is fully MACT compliant and suitable for permitting.

FY 2006 – Initiate construction of the Consolidated Laboratory Facility.
– Establish an integrated sodium-bearing waste pilot plant treatment system capable of hot operations with full feed, processing, off-gas, control, and secondary waste immobilization systems, as necessary.
– Perform hot operations of the fully integrated sodium-bearing waste pilot plant treatment system.
– Demonstrate pilot-scale cesium ion exchange technology for sodium-bearing waste treatment application.
– Demonstrate pilot-scale solid-liquid separation technology for sodium-bearing waste treatment application.
– Provide comprehensive performance data on pilot-scale cold crucible induction melter operation for processing INEEL, Savannah River Site, and Hanford waste streams, as applicable.
– Perform a hot demonstration of an in situ calcine characterization technology.
– Provide a protytype system of a break-through nondestructive assay technology for characterization of the radionuclide inventory of spent nuclear fuel and remote-handled transuranic waste (i.e., gamma coincidence assay system).

D. Environmental Stewardship Initiative (Sponsor: EM)

1. Customer Need

"Long-term stewardship encompasses all activities, including physical and institutional controls, monitoring and surveillance, information management, and other mechanisms required to protect human health and the environment from hazards remaining at DOE sites after the selected cleanup strategies are complete." (U.S. DOE/EM-0466, October 1999)

EM is responsible for cleaning up the radioactive, chemical, and other hazardous substances left after 50 years of nuclear weapons production in the U.S. At an estimated cost of $147 billion, this is one of the largest environmental management programs in the world. Due to the nature and complexity of this massive cleanup responsibility, as well as the limitations of currently available remediation technologies, numerous DOE sites are not expected to be cleaned up to the point that they can be released for unrestricted use.[e] Figure 7 illustrates when DOE anticipates completing cleanup and commencing long-term stewardship across its 144 sites.[f] Specifically, DOE anticipates that long-term stewardship will be required at various sites to ensure protection from over 75 million m^3 of contaminated soil and 1.8 billion m^3 of contaminated water. Specific risk-reduction activities will include sampling and analysis of more than 11,000 monitoring wells and maintenance of engineered barriers at hundreds of the over 3,000 existing sites contaminated with hazardous and/or radioactive materials.

DOE is not alone in facing these environmental stewardship challenges. As the environmental remediation market matures, emerging issues surrounding the long-term performance of remediated sites are garnering greater attention from the public, federal agencies, tribal nations, state and local governments, and regulators.

A recent report by the National Research Council (NRC) Committee on the Remediation of Buried and Tank Wastes,[f] suggests that the scientific understanding of factors governing long-term behavior of residual contaminants in the environment is not adequate. In addition, the NRC concludes that unrestricted use will not be possible at many DOE legacy sites and that remediation decisions are often made with a considerable degree of uncertainty. The NRC recommends that the best decision strategy is one that avoids foreclosing future options, takes into account contingencies, and factors in the possible failure of engineered barriers and institutional controls.

2. INEEL Solution

The INEEL Environmental Stewardship Initiative will improve remedial decisions, stewardship implementation, and long-term institutional management by leading an international effort to integrate environmental science, social science, engineering, and decision and risk analysis. The issues associated with environmental stewardship are diverse, and broader than the EM mission. This initiative will support DOE with its management of residual waste sites, facilitate thorough environmental stewardship planning in the INEEL's operational activities while simultaneously supporting ongoing DOE missions. Through this initiative, the INEEL's environmental stewardship capabilities will be made available to other agencies and organizations for environmental management, enhanced environmental solutions, decision analysis, and stewardship operations.

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e. From *Cleanup to Stewardship, a Companion Report to Accelerating Cleanup: Paths to Closure and Background Information to Support the Scoping Process Required for the 1998 PEIS Settlement Study*, DOE/EM-0466, October 1999.

f. *Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites*, National Academy Press, ISBN: 0-309-07186-0, July 2000.

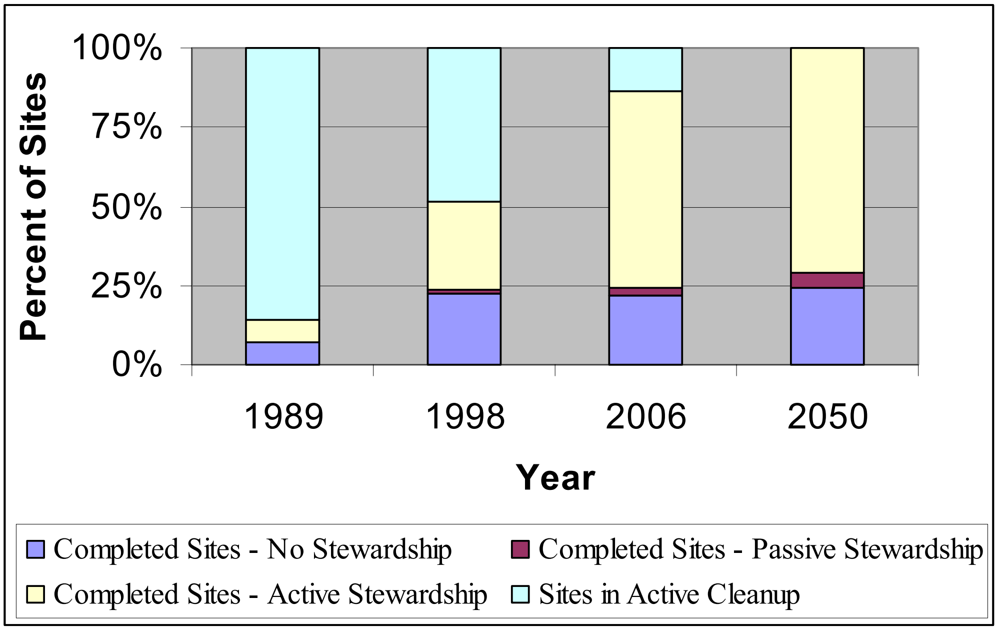


Figure 7. Cleanup/stewardship transition timeline.

First, the INEEL will continue to support the DOE-HQ and DOE-ID in the execution of DOE's national Long-Term Stewardship program. In this role, the laboratory will serve a pivotal function in ensuring that DOE's long-term stewardship needs are met. The INEEL will improve DOE's ability to identify and implement appropriate long-term environmental solutions as well as ensure that an effective decision analysis process is in place that focuses on continual process improvements. The laboratory will work with DOE to establish a robust R&D program to address science and technology needs. In this capacity, the INEEL has been named the lead laboratory for Long-Term Stewardship Science and Technology. The INEEL is ideally suited to fill this role, given its climate, geology, and land size; the diversity of its mission (ranging from spent nuclear fuel to low-level waste storage and environmental cleanup to decontamination, decommissioning, and dismantling); and the numerous test-bed opportunities available.

Second, the INEEL will lead by example. The Environmental Stewardship Initiative will support the INEEL as it integrates the best science and engineering available into environmental stewardship operations. This initiative will promote communication, education, and collaboration across DOE, other government agencies, external customers, and stakeholders. For example, partnerships are being formed with INRA, other DOE laboratories, and private industry to meet this objective. Science and technology advancements offer opportunities for improving the reliability of engineered systems and reducing scientific and technical uncertainties. This initiative will deliver science and technology to (1) reduce the scientific and technical uncertainty, (2) improve the reliability of engineered solutions, (3) improve the ability to detect failures as early as possible, (4) enhance the ability to retrieve materials, (5) increase the effectiveness of land-use controls, (6) reduce overall costs associated with residual hazards/risk management, (7) improve and maintain information for the long term, and (8) improve hazard communications.

Third, the laboratory will leverage its environmental stewardship expertise to help solve related environmental problems regionally and internationally. For example, residual contamination (i.e., selenium, zinc, acid mine drainage, etc.) resulting from mining and milling operations pose a considerable risk throughout the Rocky Mountain West. In addition, other U.S. Government agencies (e.g., DOD, EPA, DOI, etc.) as well as the international community are faced with considerable challenges associated with the remediation and subsequent management of residual waste sites. Some of these organizations are responsible for related forms of environmental stewardship implementation, while other organizations sponsor R&D for environmental stewardship-related issues. INEEL environmental stewardship capabilities will be made available to these agencies and organizations for R&D, decision analysis, and operational implementation.

Funding requirements are shown in Table 11.

3. Milestones

9/30/02 Complete Phase-1 DOE LTS Science & Technology Roadmap.

9/30/03 Complete INEEL LTS Implementation Plan.

10/1/04 Implement INEEL LTS Project Baseline Summary.

Table 11. Environmental Stewardship Initiative funding projections ($ in millions).
(Funding projections are preliminary and represent an early estimate of resources required for this initiative. The funding projections contained in this table are NOT included in Section VI, "Resource Projections.")

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Operating	$7.25	$7.5	$8.6	$9.8	$12.3
Capital Equipment	$0.5	$1.2	$1.6	$2.0	$2.0
Construction (SGL is in SSI)	—	—	—	—	—
Total[a]	$7.75	$8.7	$10.2	$11.8	$14.3

a. Operating budget includes EM-51 direct, Work for Others, and indirect but does not include EM 30 and 40.

E. Advanced Computing and Collaboration Initiative (Proposed Sponsors: EM, SC)

1. Customer Need

High-performance computing has revolutionized the process of scientific inquiry by allowing models of complex processes to be examined in greater detail and to be compared with experimental data much more rapidly and thoroughly than in the past. Advanced computing is an integral component of all major science and engineering research programs conducted by DOE. At the same time, DOE's scientific programs are being increasingly conducted by collaborative teams of researchers at multiple national laboratories, universities, and international research institutes. These collaborative programs or "collaboratories" are being mediated by high-speed communications networks and computer-based collaborative tools.

The revolution enabled by high-performance computing and collaboration technologies is only beginning. New strategies for applying computing and collaboration technologies will continue to increase the pace of scientific discovery. Effective application of these technologies to the design and operation of complex technical systems has begun even more recently. The DOE Scientific Discovery through Advanced Computing (SciDAC) program has been established within SC to provide a focal point for developing computing infrastructure, networking, and collaboration tools to achieve these missions. In order for the INEEL to keep pace and effectively support DOE programs in the 21st century, it is essential to develop and utilize next-generation tools for computing and collaboration. The Advanced Computing and Collaboration Initiative has been established to enable the INEEL to develop and apply these revolutionary tools to perform leading-edge scientific research, engineering, and operations to address critical national needs.

The major research initiatives of the INEEL will require order-of-magnitude enhancements in computing capability and connectivity to achieve mission goals. Faster machines, more efficient processing modes, and more effective numerical techniques are necessary to understand and model the fate and transport of contaminants as part of the Subsurface Science Initiative. Long-term stewardship programs require advanced computational and data management methods and enhanced connectivity for the long-term monitoring and management of distributed DOE waste sites. The *DOE National Vadose Zone Science and Technology Roadmap* describes the need for enhanced computing capability, advanced numerical algorithms, and a vadose zone problem-solving environment to improve the efficiency of research programs for understanding the subsurface environment. Similarly, greatly increased capabilities in advanced computing and collaboration will be essential to the INEEL Generation IV Nuclear Energy Systems program. Tools for simulation-based design, computational reactor physics and thermal performance, and management of large databases will be required to efficiently analyze fuel-cycle options and to design Generation IV reactor systems.

2. INEEL Solution

The INEEL Advanced Computing and Collaboration Initiative employs two complementary pathways to apply revolutionary computing and collaboration tools to address the needs of DOE. The first pathway will lead the INEEL to develop the computing and networking infrastructure required to provide essential capabilities to laboratory programs and initiatives. Implementation of the second pathway will result in the laboratory performing research, in partnership with others, that allows the INEEL to attack fundamental challenges in scientific research, engineering, and operations for DOE programs.

Regarding the first pathway, the initiative has embarked on a concerted effort to develop the INEEL’s next-generation computing infrastructure and capabilities, integrate these resources to support INEEL missions, and develop new computing-focused programs to enhance the opportunities for all laboratory programs. Foundational computing resources have been significantly improved by the procurement of a 64-processor shared memory machine for performing fate and transport simulations, and installation of a DS-3 (45 megabits per second) connection from the INEEL to Idaho State University and the Internet2 high-speed backbone. This connection will be used to support collaborative programs with INRA and other Internet2 universities. In addition, another DS-3 connection has been installed from the INEEL to the DOE Energy Sciences Network (ESnet) at LLNL to enhance opportunities for collaboration with other DOE national laboratories. The laboratory plans to upgrade this connection to Optical Carrier 3 (155 megabits per second) during FY-02.

To address the second pathway, the Advanced Computing and Collaboration Initiative will conduct research to create and apply tools and technologies for collaborative scientific research, engineering, and operations in domains such as environmental management, Generation IV nuclear systems, and national defense. Partnerships with universities, other national laboratories, other federal agencies, and international research institutes will be formed to bring together the required capabilities in advanced computing, visualization, intelligent systems, and human interfaces to develop and implement these revolutionary technologies. Internal INEEL research programs on advanced computing and collaboration will be supported through the LDRD program.

Long-term activities of the Advanced Computing and Collaboration Initiative will build upon this foundation to support major laboratory missions (such as subsurface science, environmental stewardship, and Generation IV); and develop new computationally focused programs for the laboratory. A major thrust has been to work with all INEEL initiatives to systematically identify the scientific challenges faced by each initiative, the resulting computing and collaboration requirements, and strategies to coordinate investments from laboratory sources to form an integrated solution for advanced computing. Based on the resulting report, *Roadmap for INEEL Advanced Scientific Computing Research,* the INEEL will be working with DOE offices to assemble the necessary resources to fully utilize advanced computing and collaboration opportunities.

In particular, the Advanced Computing and Collaboration Initiative is working closely with the Subsurface Science Initiative to develop the next-generation computing resources and capabilities that will be essential to support fate and transport modeling and the experimental programs of the SGL. Methods will be developed to facilitate the transfer of large data sets from field sites and the SGL to researchers at the INEEL, other national laboratories, and INRA universities. The INEEL will work with universities and other national laboratories to form a collaboratory for subsurface science programs. This partnership will work with EM programs to establish a computationally focused program for understanding subsurface fate and transport with sufficient depth to develop and implement engineered solutions for waste treatment and disposition. Once EM support has been obtained, SC will be approached with concepts for specific programs focused on the challenges of subsurface science.

Another major strategy for the Advanced Computing and Collaboration Initiative will be to facilitate active, high-level partnerships among INEEL, DOE, other federal agencies, INRA, and other university computing programs. For example, the National Aeronautics and Space Administration (NASA) has large agencywide programs in the computational sciences with goals similar to the DOE SciDAC program. The laboratory will build on ongoing INEEL support to NASA programs to stimulate the development of high-level partnerships among these programs. These partnerships will enable capabilities developed jointly by the INEEL and NASA to be applied to INEEL programs, and enable the INEEL to act as a catalyst to apply NASA capabilities for the benefit of DOE programs.

Development of the subsurface science collaboratory and other multi-institution programs involving the INEEL, INRA universities, and other national laboratories will require long-range planning to ensure that adequate high-bandwidth connectivity is available to the partners. While current and planned connections from the INEEL to Internet2 and ESnet will meet near-term laboratory needs, the regional communications infrastructure will not be adequate to supply long-term connectivity demands. To prepare for this eventuality, the laboratory will work with INRA universities, other regional universities, and telecommunication carriers to ensure that long-range connectivity requirements are satisfied.

In order to ensure an integrated approach across the INEEL, activities of this initiative will be closely coordinated with Information Resource Management planning activities such as the *Scientific and Engineering Computing Plan* and the *Information Technology Long-Range Plan* (see Section V). Requirements from all major INEEL research areas as well as engineering and operations programs will be gathered to define an integrated foundation for computing and networking capabilities. New senior-level personnel will be recruited to fill gaps in strategic capabilities in the computational sciences. The initiative will serve as the focal point to coordinate investment from the full range of INEEL and DOE programs to develop infrastructure and capabilities that can be applied for the benefit of all programs. Finally, the Advanced Computing and Collaboration Initiative will coordinate program development activities to help laboratory initiatives bring new computationally enabled programs to the INEEL and to develop new programs in advanced computing and collaboration.

Funding requirements are shown in Table 12.

3. Milestones

FY 2002 – Develop an integrated architecture for INEEL advanced computing and collaboration.
– Establish a partnership with NASA computational sciences programs to facilitate application of advanced computational methods to DOE programs.

FY 2003 – Establish the subsurface science collaboratory in partnership with INRA universities and other national laboratories.
– Hire four senior-level personnel with key capabilities in computational sciences and collaboration.

FY 2004 – Develop the computational architecture for the SGL.

FY 2006 – Begin subsurface model verification using computing capabilities of the SGL.

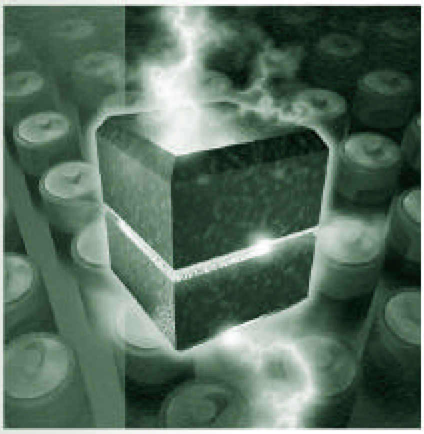
Table 12. Advanced Computing and Collaboration Initiative funding projections ($ in millions). (Funding projections are preliminary and represent an early estimate of resources required for this initiative. The funding projections contained in this table are NOT included in Section VI, "Resource Projections.")

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Operating *	$2.2	$3.8	$5.8	$6.3	$7.0
Capital Equipment **	$0.4	$5.0	$2.0	$4.1	$2.5
Construction	0	0	0	0	0
Total	$2.6	$8.8	$7.8	$10.4	$9.5

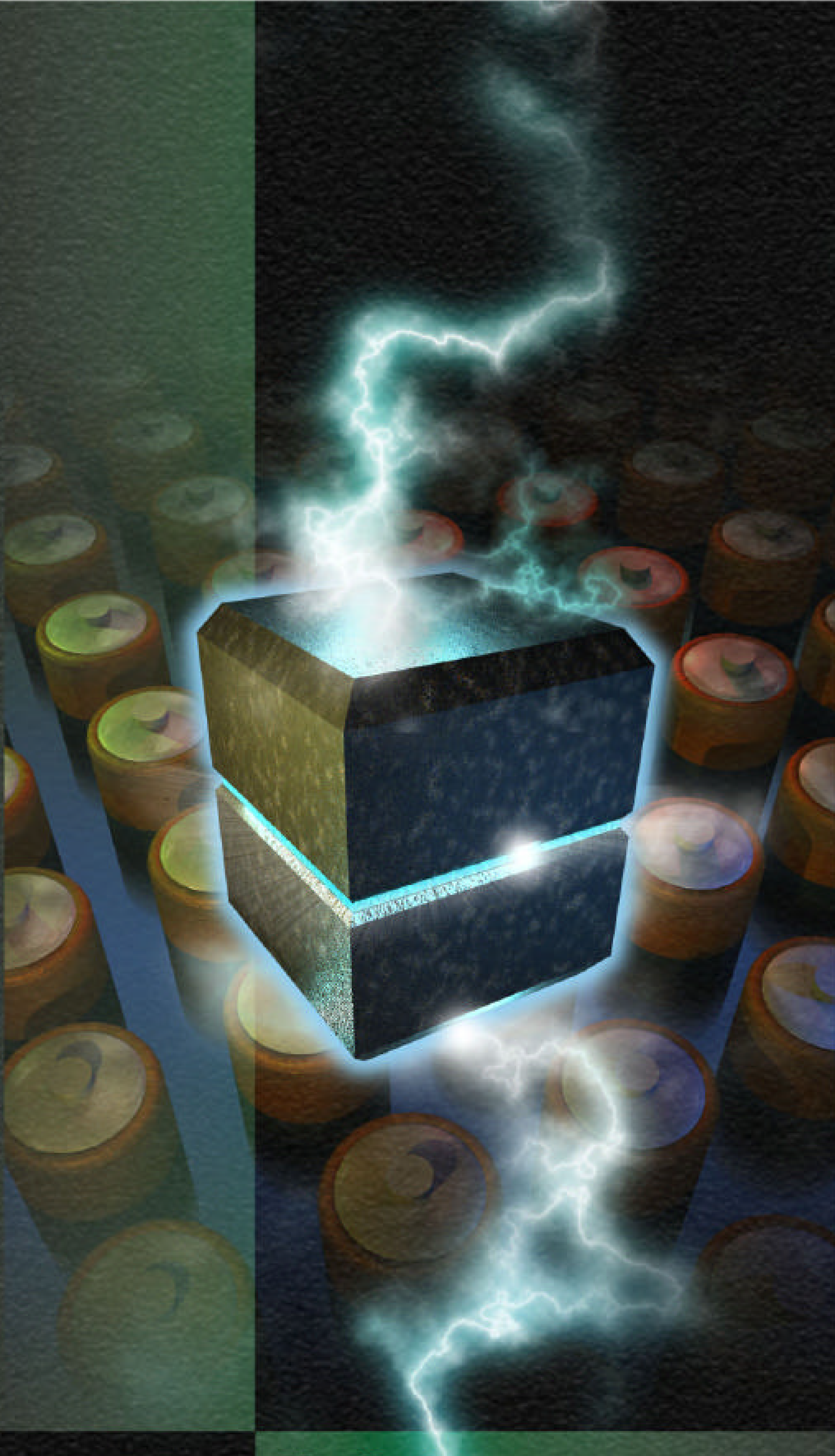
* Operating funds include staff, maintenance costs for computing equipment, and lease charges for offsite connectivity.

** Capital equipment includes computing and connectivity hardware including shared memory processors, clusters, mass storage, and associated equipment.

Infrastructure and Support Services



INEEL at work



Advanced Batteries

DOE's objective in exploring matter and energy is addressed at the INEEL through a series of programs including microengineering of polymers. A noteworthy development is an improved lithium rechargeable battery that functions at the low temperatures found in outer space, has a much longer shelf life, and is safer than conventional batteries.

V. INFRASTRUCTURE AND SUPPORT SERVICES

A. Introduction

This section of the *Institutional Plan* describes plans for key components of the laboratory's infrastructure and support services management. The overriding objective is to operate the INEEL in a cost-efficient, effective, and safe manner while protecting the assets entrusted to it by DOE and positioning the laboratory to fulfill future needs.

Section B describes the INEEL's integrated management practices and how they interrelate to form the basis for managing the laboratory. Section C covers activities to enhance stakeholder communication and trust. Section D presents the strategic direction and several support functions that have critical importance to enhancing the scientific and technical capabilities of the laboratory. Section E describes the current condition assessment of laboratory infrastructure, the infrastructure requirements to achieve DOE missions, and the current funding for infrastructure.

B. Integrated Management Practices

1. Planning Alignment

The INEEL plays an integral role in supporting a number of DOE plans including the Secretary of Energy's Annual Performance Plan, *Powering the 21st Century*, and the comprehensive national energy strategy, *Accelerating Cleanup: Paths to Closure*. The INEEL also supports the National Energy Policy (May 2001) and the principles outlined in the *Secretary of Energy's Mission and Priorities for DOE (October 24, 2001)***.** In addition, the laboratory is required to prepare numerous site plans for various DOE offices.

To ensure plan alignment, the *INEEL Institutional Plan* is the controlling strategic plan. As a result, this plan aligns with DOE plans, and all site plans must align with the *Institutional Plan* (see Section III.A.2, "INEEL Planning Hierarchy"). This alignment ensures clear direction with DOE missions, understanding priorities, and consistent focus across the laboratory. For example, Table 13 shows the alignment of the corporate management objectives in DOE's Strategic Plan and INEEL management objectives.

(a) Integrated Business Decision Framework

The INEEL uses an integrated business decision framework to ensure comprehensive management decisions regarding programmatic priorities, laboratory initiatives, resource allocations, human resource needs, and infrastructure improvement opportunities. Business system improvement priorities are integrated and aligned. This framework also provides assurance that planned work and actions associated with integrated decisions are implemented consistently and communicated across all organizations.

Key elements of this integrated framework include:

- Ensuring that all laboratory planning activities are aligned and consistent
- Using all information required to evaluate the impacts of decisions on the current and future state of the laboratory's plans
- Involving all leaders of the internal organizations impacted by decisions in strategic, operational, and resource planning activities

Table 13. Relationship between DOE corporate management areas and INEEL infrastructure and support service functions.

DOE Strategic Plan: Corporate Management Objectives	INEEL Management Objectives
Objective 1—Ensure the safety and health of the DOE work force and members of the public, and the protection of the environment in all DOE activities.	• *Achieve operational excellence through successful integrated safety management that includes the Voluntary Protection Program, Conduct of Operations, Conduct of Maintenance, and other related programs.* • *Maintain and continuously improve INEEL Integrated Safety Management System processes.* • *Continuously improve INEEL safety performance.* • *Achieve and maintain full environmental regulatory compliance.* • *Implement and maintain a compliant Quality Assurance program that promotes employee and management participation and strives for continuous improvement.* • *Implement a standards-based management system to integrate work processes, procedures, guidelines, checklists, source documents, and roles, and make documentation readily available to employees and stakeholders.*
Objective 2—Manage human resources, diversity initiatives, and implement best management practices to improve the delivery of products and services.	• *Diversify the work force to ensure that it is of high quality and represents the general population, consistent with the goals of DOE's Work Force-21 initiative.* • *Attract world-class talent with advanced degrees.* • *Retain and enhance the skill levels and flexibility of the existing work force.*
Objective 3—Ensure public confidence in DOE's contractual and financial transactions.	• *Increase stakeholder understanding of the INEEL's mission and roles and enhance the laboratory's credibility.* • *Provide clear, concise, and understandable science-based communications on technological issues that enable informed public and political decisions.* • *Continually streamline the supply chain management processes with a goal of empowering the end user while maintaining an approved purchasing system.* • *Maintain a results-oriented, socioeconomic program that provides diversity in subcontracting by identifying small businesses and Idaho small businesses that can fulfill the INEEL's subcontracting needs.* • *Ensure that the "green purchasing" program maintains its status as an Affirmative Procurement showplace for the DOE complex, thus contributing to the INEEL's designation as "the" environmental solution provider.*

Table 13. (continued)

DOE Strategic Plan: Corporate Management Objectives	INEEL Management Objectives
	• *Serve as the catalyst for new industries in Idaho and help to diversify the economy. Help the traditional industries of agriculture, mining, and forestry employ new technologies and business practices, thus becoming more competitive.*
Objective 4—Improve DOE's efficiency and effectiveness through information technology systems and infrastructure.	• *Develop a distributed-architecture-computing environment that enables the INEEL to develop and run world-class software to solve the world's environmental, energy, and security challenges.* • *Provide a world-class technical library to retain "scientific knowledge" and manage information in INEEL focus areas.* • *Develop integrated business systems using commercial off-the-shelf software and commercial practices to achieve significant productivity improvements.* • *Create and institutionalize a comprehensive risk-based project management system that will be a recognized leader across the complex.*
Objective 5—Promote the efficient, effective, and economical operation of DOE.	• *Provide a safe, secure, and compliant workplace through comprehensive capital investment and infrastructure management that is aligned and integrated with INEEL missions. Reduce overall infrastructure cost while improving the condition of infrastructure using a graded approach.* • *Identify and maintain the mission-critical infrastructure assets of the INEEL. Create an environment of cost sharing based on realistic return-on-investment models.* • *Demonstrate leading-edge energy saving and other "sustainable design" technologies and distributed power applications onsite within 5 years.* • *Continue to provide a Safeguards and Security program in support of INEEL operations that meets the* Site Safeguards and Security *and* Material Control and Accountability Plans *within available funding.*

- Communicating decisions and associated actions necessary to ensure consistent understanding and implementation
- Assessing implementation progress by all leaders of the internal organizations impacted by decisions.

This framework promotes employee understanding and alignment; provides a consistent management approach; ensures integration of all planning activities and content; and optimizes the application of all resources on the INEEL's vision, mission, and strategic objectives.

2. Integrated Safety Management System

The INEEL employs the Integrated Safety Management System (ISMS) to ensure human health and safety, public safety, and environmental protection, while providing the means to efficiently accomplish programs and projects. Formal declaration of full ISMS implementation was issued in August 2000. The ISMS framework ensures that noteworthy practices, opportunities for improvement, strengths, and issues arising from the independent assessments are in place to maintain and improve safety management processes.

A key element of the INEEL ISMS is worker involvement in all aspects of the system. The laboratory uses DOE's Voluntary Protection Program (VPP) to set the standard for management leadership and employee involvement in developing and maintaining an effective safety and health culture. VPP establishes the behavioral framework for employee health and safety as work is accomplished. Following a formal review, Star status was granted to the INEEL in June 2001.

Continuous improvements will be made to ISMS processes to ensure that a safe work environment is maintained. All ISMS process elements will be consistently implemented in conjunction with VPP processes, so that the work controls established by ISMS are effectively used to accomplish work safely while protecting the environment.

3. Environmental Management System

The INEEL Environmental Management System (EMS) is designed to integrate environmental protection, environmental compliance, pollution prevention, and continual improvement into work planning and execution throughout all work areas as a function of the Integrated Safety Management System (ISMS). The INEEL EMS is founded in the five core elements of the International Organization for Standardization (ISO) Environmental Management System Standard (ISO 14001), which parallel the five core functions of the ISMS. The major elements of the EMS include policy, planning, implementation and operation, checking and corrective action, and management review. The EMS is designed to implement the INEEL's environmental policy and to focus on controlling INEEL activities in a manner that minimizes the potential to significantly impact the environment. The INEEL is working toward the goal of ISO-14001 registration of the EMS by June 30, 2002. Registration will be performed by an independent ISO-14001 registrar following a review and determination that the INEEL's EMS contains the necessary elements and operates effectively.

4. Standards-Based Management System

The Standards-Based Management System (SBMS) provides the framework for managing the INEEL by defining and maintaining an integrated set of systems and processes. Through SBMS, policies and standards of performance are in place that establish the INEEL's top-level operating philosophy and communicate expectations. Integrated management systems are aligned within the overarching policies and standards of performance and are detailed in management system description documents. Management systems provide clear roles and responsibilities, with emphasis on establishing authority at a level that supports reasoned decision-making. Boundaries are clarified and interrelationships are institutionalized, which enables a new measure of collaboration between operations and R&D in support of laboratory programs and missions.

SBMS provides procedures, guidelines, and forms based on an evaluation of internal and external requirements. Once requirements are identified, they are linked to implementing work processes. When requirements change, impacted information is identified and revised as needed. In this way, SBMS provides workers with current, accurate, and relevant information regarding their responsibilities, helping them to perform their jobs more effectively. SBMS processes will be fully implemented by the end of FY 2004.

5. Performance-Based Management System

The laboratory has implemented a systematic, outcome-oriented, and objective performance-based evaluation and measurement system that builds a culture of customer focus. DOE priorities drive the INEEL's missions, performance outcomes, and critical objectives. Self-assessments are used with direct accountability for disposition of identified issues. The laboratory's *Performance Evaluation and Measurement Plan* is founded on clear and well-understood mission/vision and strategic planning.

The INEEL has four performance outcomes (see Section II.A.2) that provide a balance of DOE priorities between EM cleanup missions and other national laboratory missions. These were derived from the *Institutional Plan*, the DOE Strategic Plan, and the EM Paths to Closure Plan. The performance outcomes define success in terms of results that must be accomplished in the next 5 years.

The 5-year focus is then broken down into objectives that are multiple-year initiatives in which significant progress must occur to support the performance outcomes. To clearly define and communicate contract performance expectations, DOE-ID and INEEL officers jointly agreed on the strategic direction of the *Institutional Plan* and on the INEEL performance outcomes, objectives, and measures. Laboratory management also defined INEEL values (see Table 14) and imparted them to employees through a series of workshops.

Table 14. INEEL values.

1.	**Treat colleagues with mutual respect, trust, and dignity** and believe they are acting in the best interest of the INEEL.
2.	**Help each other**; ask for and give help and welcome it freely (it is not a sign of weakness). Go out of the way to provide extra support to fellow employees. Share experiences and lessons learned, both successes and failures.
3.	**Communicate early, honestly, and completely** with all who have a direct interest in the subject. Listen to others' points of view.
4.	**Earn trust** by accepting and honoring agreements, keeping promises, and discussing needed changes before acting.
5.	**Work to understand goals and strategies** and proactively support them through discussions, communications, and actions (for example, sharing resources).
6.	**Never undermine colleagues** directly or indirectly.
7.	**Work jointly to resolve disagreements in good faith**. If necessary, go to a higher authority together, then accept and support the solution.
8.	**Contribute constructively** by exercising the highest level of professional and ethical behavior.
9.	**Promote continuous use of INEEL values.**

6. Project Management System

Formal project teams with well-defined roles, responsibilities, accountabilities, and authorities form the basis of the laboratory's project management system. The teams comprise members with the skills and experience to successfully execute the project. The project manager is trained in project management concepts and techniques and has the tools to effectively manage the project.

The project management system is an integrated system of requirements, procedures, and methods, including a common set of planning and control tools. Use of these planning tools results in well-defined project plans that address scope, schedule, and cost. The project control tools provide the necessary information for the project and program managers to manage the work and remain in financial and managerial control. The project management system is continually improved to integrate DOE project management requirements.

On an annual basis, prior to the start of the fiscal year, a rolling 3-year integrated detailed work plan is developed that effectively communicates the work scope, schedule, and estimated costs required to accomplish the given work. Detailed work plan execution schedules are resource loaded so they depict the necessary staffing by organization.

7. Business System Improvement Project

The Business System Improvement Project is a key component of the laboratory's plan to improve its business processes, systems, and procedures. The project replaces aging legacy business processing applications and systems with commercial off-the-shelf software. Legacy systems targeted for replacement include project management/project controls (completed in FY-00); work management and supply chain (completed in FY-01); human resources, payroll, and benefits (completed in FY-01); and financials (scheduled for FY-02).

8. Balanced Matrix Organizational Structure

The INEEL has instituted a balanced matrix organization structure that ensures performance excellence through establishing clear roles, responsibilities, accountabilities, and authorities (R2A2). The balanced matrix organization structure has been defined and the division of responsibilities established among the home organizations and work organizations. The home organizations with primary emphasis in engineering, R&D, safety, project management, planning and controls, quality assurance, supply chain, and records management establish the processes, systems, and procedures necessary to standardize work approach across the INEEL. The home organizations also ensure the integration between R&D and operations and project teams. The R2A2s have been completed for directors and above. R2A2 profiles have been finalized for managers and staff. They clearly define the contributions each employee will make to mission accomplishment and how each employee fits into the laboratory structure. R2A2s will be reviewed annually, or as needed, to keep them up to date. The clarity of purpose provided by the R2A2s will assist in creating the synergy needed to more clearly focus the energy of the total work force on common goals.

9. Six Sigma Process Improvement Program

Six Sigma is the proven approach the INEEL has selected to accelerate improvement in work-process quality and related work culture. Six Sigma is a systematic method of applying step-by-step improvements to current work processes. It is a rigorous, statistically based, customer-focused business methodology to measure, analyze, improve, and control key work processes. Its goal is to determine as precisely as possible what internal and external customers require of us, minimize redundancy and waste, and reduce cost. Six Sigma provides a valuable tool to help us identify and pursue cost-saving improvements in management and operations systems and processes. Six Sigma implementation began in 2001, with senior leadership training and the selection of key personnel to be trained as black belts, i.e., experts in Six Sigma methods.

10. Interrelationship Between Management Practices

The management practices described above are critical to enhancing performance and customer focus. When taken alone, these practices will move the INEEL in the desired direction. When integrated with one another, they result in a synergy that substantially improves the laboratory's ability to successfully execute programs.

The project management system will allow the INEEL to effectively manage projects to cost, scope, and schedule. When coupled with matrix management and the integrated software systems of the Business System Improvement Project, the laboratory has the capability to effectively assign the right people to project teams when needed and for the proper duration; collect the project data, and quickly transmit the information to a number of other enterprise systems to manage funding; capture personnel skill usage and needs; and notify procurement personnel of planned requisitions.

Planning alignment provides every employee with an understanding of INEEL direction and priorities that are consistent, regardless of which plan is primary to the employee work area. The Performance-Based Management System tells employees what is important to customers. By coupling plans, customer expectations, and SBMS, an employee knows the policies, procedures, and guidelines associated with the jobs he performs. The employee has a clear understanding of where his work fits within the INEEL's overall strategy, how it ties to customer desires, and what is required to perform that work in a safe, compliant, and cost-effective manner.

It is expected that these management practices will transform the INEEL from one of the many national laboratories to the best-managed, most cost-effective laboratory in the DOE complex. The practices will allow the INEEL to fully understand customer requirements, expectations, and needs, and quickly mobilize resources as required.

C. Stakeholder Communication and Trust

The INEEL will enhance the recognition of its position as a national laboratory and as a regional resource through strategic communications. The INEEL Strategic Communications Plan integrates and supports the *INEEL Institutional Plan*, by accomplishing specific communication objectives.

Objectives for FY-02 include:

- Continue to implement and sustain a comprehensive INEEL image/brand identity that will distinguish the INEEL, increase its visibility within DOE, and enhance opportunities for growth within current DOE missions.
- Mitigate controversial and publicly negative operations/program issues across the INEEL by developing and using an overarching integrated issues management communication model
- Enhance the INEEL's efforts to promote and communicate technical, scientific, and business achievements using innovative communication approaches, techniques, and state-of-the-art technology.

- Support the INEEL's mission, reputation, and competitive position by investing in and broadening the business and technological communication capabilities of the communications staff.

- Build trust with key regional stakeholder groups through better two-way communications.

D. Integrated Functional Management

This section covers key functional areas of the balanced matrix organization structure at the INEEL. These support organizations establish the processes, systems, and procedures necessary to standardize the work approach across the laboratory and ensure line management integration between R&D and operations.

1. Information Resource Management

The rapid change in technology in the computing and data communications industries is creating a revolution in the tools available for scientists and engineers to perform scientific computations, modeling, and simulation of complex phenomena. These activities require access to powerful systems capable of processing large volumes of complex information quickly, running complex simulations, providing multidimensional visualization and tera-flop computations. The Scientific and Engineering Computing Infrastructure Plan completed in February 2001 delineates the path forward for revitalizing advanced computing and providing a distributed architecture computing environment that enables laboratory scientists and engineers to develop and run world-class software applications. In order to ensure the appropriate integration across the INEEL, information resource planning activities will be closely coordinated with the activities of the Advanced Computing and Collaboration Initiative.

Projects such as the EM cleanup mission associated with business management and site operations need computer power and information systems tailored to their respective tasks. These systems are focused on sharing information needed to manage and execute day-to-day R&D and project work. Sharing information requires a robust network infrastructure. To improve productivity and provide new communications capabilities within the laboratory and out to the Internet, several key upgrade projects are required. For communications inside the INEEL, plans are incorporated in the Sitewide INEEL Information Network (SIINET) project to upgrade the backbone transmission facility and replace aging wiring infrastructure and outmoded shared network infrastructure. The INEEL is connected to robust high-speed network environments managed by DOE (ESnet) and the University Consortium for Advanced Internet Development Internet 2. The laboratory has increased the size of its ESnet connections from 3 megabits per second (Mbs) to 45 Mbs. The laboratory has also implemented a 43 Mbps link to Internet2 and plans to increase external connectivity to 155 Mbps.

INEEL telecommunication systems must be upgraded to support increased transmission requirements for advanced scientific computing as well as existing operational needs. The SIINET project will implement an internal high-speed multi-gigabit per second (Gbps) network backbone to deliver network services to all locations of the INEEL. The SIINET design employs a scalable architecture that supports 10 Gbps – 2.4 Tbps. Funding to begin the SIINET, INTEC, and TRA Dial Room replacement effort begins in 2002, with completion scheduled for 2006.

The laboratory will establish common desktop solutions that maximize integration, reduce cost, improve resource utilization, and increase information availability. Directory-enabled computing is being implemented to realize these goals. Directory services will increase the quality of information available to users and managers, enable improved interpersonal communication, reduce the cost of administration, and enable e-commerce and extranet initiatives.

Actions taken by the National Telecommunications and Information Administration require the laboratory to convert radio communications to narrow-band operation. This conversion must be accomplished by January 1, 2005, for radio operation in the 162–174 MHz band (VHF) and by January 1, 2008, for radios operating in the 406.1-420 MHz band (UHF). A contractor has been selected to perform this work, and site radio coverage surveys have been initiated to identify coverage problems.

In collaboration with the University of Idaho Foundation, the INEEL will complete an expansion program to keep its technical library information management capabilities world-class. This includes a network upgrade inside the library to all-switched, 100 MB/s connectivity to the desktop. High-speed access between the technical library and the balance of the laboratory community also is being provided (see Section II.D.3).

2. Operations

An integrated management structure for operations has been implemented at the laboratory. This management structure integrates programs (cost, scope, and schedule), site operations (performance and execution), and site services and infrastructure (support for programs and site operations) into one organizational structure. This management structure allows senior operations management to establish priorities and integrate activities to ensure completion of programs and projects.

Senior line management is responsible for establishing and maintaining consistent Conduct of Operations, Conduct of Maintenance, and work-force training, and for embedding the principles of ISMS and VPP within day-to-day work.

3. Environmental, Safety, Health, and Quality Assurance

Functional activities are ongoing to improve the Environment, Safety, Health, and Quality Assurance (ESH&QA) posture at the laboratory, including:

- Integrated ISMS and VPP programs in pursuit of ISO 14001
- Integrated assessment
- Environmental management system verification
- Fire protection program
- Radiological protection program
- Industrial safety program
- Improved and balanced Quality Assurance Program based on Nuclear Quality Assurance (American Society of Mechanical Engineers committee)-1 that will consistently meet Nuclear Regulatory and Office of Civilian Radioactive Waste Management requirements
- Improved Issues Management Program.

ESH&QA will continue to provide guidance and support improvements to INEEL safety performance as measured by established safety performance indicators, such as recordable case rate, lost work day case rate, severity index, and radiological performance indicators (such as contamination events, dose level excesses, and the reduction in radiological contamination area foot prints). ESH&QA will also continue to provide guidance and support improvements to environmental regulatory compliance as measured by the severity and number of citations and commitment to effective corrective actions and to continuously improve procedure compliance as measured by events attributed to noncompliance.

4. Supply Chain Management

Supply Chain Management is committed to providing cost-effective and value-added solutions and services to its customers. The INEEL supply chain management system provides an integrated approach to the management of material, information, and funds for acquiring, storing, distributing, and disposition of materials and services for its customers. Activities include work scope development, requisition processing, sourcing, acquisition administration, material handling, inventory management, warehousing, transportation, and asset life-cycle control. The supply chain management system has a broad scope that includes subsuppliers, suppliers, end-users, and purchasers. Adapting leading-edge commercial principles of supply chain management to INEEL needs, the supply chain management system contributes to the development of a strong INEEL competitive advantage, while facilitating the improvement of its own internal operations.

Supply Chain Management continues to develop commercial-like practices throughout its operations to support INEEL critical outcomes. Significant initiatives under way to realize objectives that provide best value support for achieving INEEL critical outcomes include:

- Implementation of e-business processes through leveraging information technology to streamline supply chain planning and execution
- Developing unique supply chain solutions for commodity and service groups to ensure the cost-effective availability of materials and services
- Improving supply chain planning by increasing integration with projects during early phases of detailed work planning
- Streamlining asset management life-cycle processes from receipt through disposal.

Implementation of e-business processes through leveraging information technology to streamline supply chain planning and execution includes both near- and long-term implementation activities. Near-term information technology activities include expansion of the impact of the supply chain modules of the newly implemented Passport system to strengthen integration with maintenance and operations through material control processes and implementation of online bidding for acquisition of materials and services. Long-term activities include development and implementation of e-business acquisition processes that provide supplier integration to streamline application of supplier knowledge and capabilities to achieve INEEL critical outcomes.

Development and implementation of unique supply chain solutions for commodity and service groups encompass both the planning and execution elements of the supply chain process. Improved supply chain planning through earlier forecasting of needs provides the ability to develop unique solutions for INEEL mission accomplishment. Improved supply chain execution delivers the needed materials and services on time at lower costs. Implemented supply chain solutions that have improved support and reduced costs include master task agreements for environmental program labor augmentation and a reseller program for computers.

Streamlining asset management life-cycle processes from receipt through disposal directly supports INEEL operational excellence and leadership critical outcomes. The recent implementation of the Passport supply chain software has set the stage for dramatic improvements in inventory management, physical distribution, and purchasing operations. Technology improvements have significantly reduced the cost of maintaining an approved government property management system. Springboarding off these recent improvements to achieve streamlined processes will result in on-time and cost-effective material delivery for operations, maintenance, and R&D activities.

Supply Chain Management has also distinguished itself as a leader, nationally recognized by DOE, in supplier partnerships by maximizing opportunities for small, disadvantaged, and women-owned businesses. The INEEL has focused on successfully using Idaho businesses to maximize the economic base in Idaho. Continuing this focus and leveraging off other nationally recognized efforts like its affirmative procurement program, Supply Chain Management will support the overall success of the INEEL in meeting institutional goals.

5. Security, Intelligence, and Nonproliferation

The INEEL Safeguards and Security program is based on the Integrated Safeguards and Security Management (ISSM) system policy adopted by DOE and emphasizes effective planning and personnel involvement in adopting protection measures that address the changing threats and requirements within our country and the DOE system. The Safeguards and Security organization and INEEL Counterintelligence (CI) program work with laboratory operations, employees, and DOE-HQ to form an effective network responsive to operational needs and sustain a high level of awareness of and accountability for individual security.

Integrating the capabilities of the Safeguards and Security and National Security programs at the INEEL provides a unique opportunity to enhance research, development, and application of technological security enhancements. The Safeguards and Security organization provides infrastructure and programmatic and technological expertise to evaluate new security technologies during development to ensure their effective performance within the framework of a comprehensive security program.

INEEL Safeguards and Security objectives are to:

- Provide an adequate Safeguards and Security program, within budget constraints, in support of operations that implements the Site Safeguards and Security Plan and the Material Control and Accountability plans
- Fully utilize existing INEEL nuclear fuel and material storage facilities and their associated protection elements to support national security and INEEL core competencies
- Provide effective technical and programmatic support to INEEL operations, DOE-HQ, national security programs, and other entities across the nation and abroad, and promote and facilitate the development of new technologies to enhance national security
- Provide expertise and guidance to the INEEL to detect and prevent unlawful CI activities through conventional and cyber means.

INEEL Safeguards and Security strategies are:

- Proactively implement an ISSM system that brings Safeguards and Security and operational management resources together to effectively protect the security assets at the INEEL
- Proactively analyze the increased risks and terrorist threats in our country and develop and implement appropriate programmatic and protection enhancements that will mitigate those threats

- Enhance Safeguards and Security organizational capabilities in response to changing technologies and the evolving DOE threat basis, and work with national security programs and R&D to develop enhancements and new technologies (cyber technology, physical detection, etc.)

- Enhance cyber, analytical, and programmatic CI capabilities and increase CI awareness at the INEEL.

E. Human Resources

A recently completed Integrated 5-Year Staffing Plan and the INEEL R&D Capability Assessment point out that the INEEL must take a more aggressive approach to increasing personnel in strategic disciplines. This augmentation of existing science and technology staff is essential to support large-scale R&D programs in environmental quality, nuclear and nonnuclear energy research, and national defense. This aggressive position is further warranted by the many reports indicating the aging scientific work force across the DOE complex. Efforts are under way to attract highly skilled candidates. Summary and detailed tables containing estimated laboratory personnel levels are included in Section VI. Appendix E contains an organization chart of senior INEEL officers.

To recruit and retain world-class scientific and engineering talent required by the INEEL, a strong linkage must be developed between the recruiting strategies and the R&D missions and operational objectives. The following strategies will be pursued to attract and retain individuals with advanced degrees to fulfill these important positions.

- Implement actions to attract, retain, and motivate world-class scientific and engineering talent that will enhance laboratory core competencies.

- Substantially broaden the base of universities from which the INEEL recruits and strengthen relationships with students and professors to focus on schools known for fields and disciplines important to INEEL missions.

- Use INRA relationships to communicate INEEL needs and technical challenges within the university community. This communication will enhance the INEEL's reputation for offering meaningful work on scientific and technical problems.

- Implement a comprehensive total benefits plan in order to be competitive with other national laboratories and private industry.

In addition, the laboratory will:

- Strengthen its Professional Development Program by giving personnel who acquire advanced degrees and critical skills enhanced developmental opportunities.

- Encourage employees to collaborate with universities, other laboratories, and private industry to learn from colleagues and share accomplishments. These opportunities will help attract seasoned, mid-career professionals in the scientific and engineering fields to enhance technical competitiveness. This visibility will also enhance the stature of the individual and the INEEL.

- Increase the number of internships for university, college, and high school students, postdoctoral positions, and summer and part-time positions to high-potential college students to build a reputation for the INEEL on university campuses.

- Address loss of institutional knowledge as aging workers depart from the laboratory work force, encouraging utilization and transfer of legacy knowledge from the scientific population.

- Posture the INEEL for new research programs, missions, and nationally recognized personnel.

- Further link compensation programs to performance, and benchmark the programs against other DOE institutions and the private sector.

- Use staff augmentation to effectively manage fluctuations in short-term staffing needs.

As part of the recruiting strategy discussed above, the INEEL will further diversify the work force by actively recruiting top-level minorities and women with advanced degrees, focusing on schools with highly reputable scientific and engineering curricula; strengthen its relationships with Historically Black Colleges and Universities and other minority institutions; enhance successful diversity programs such as the INEEL Idaho Hispanic Youth Symposium, Providing a Trusting Hand, and Promoting a Successful Outcome; establish a company-sponsored mentoring program for all high-potential employees with particular emphasis on minorities and females to enhance career progression; and encourage high school students to pursue degrees in sciences or engineering. Increase the science and math education outreach program discussed in Section II.D.

Additional strategies to retain and motivate the existing work force will include expanding our current academic exchange program, sponsoring an apprenticeship program for individuals interested in pursuing careers in one of the INEEL maintenance and operations crafts or trades, developing a training program for management and leadership development, and developing/fostering a process for talent management and continuous learning that matches employee strengths, needs, and interests with the INEEL's long-range plan, core competencies, and key capabilities.

With INEEL focus areas evolving to meet emerging DOE and national priorities, the skill mix required of the work force will change significantly during the next several years. While the primary objective is to have the right skills and level of expertise, an assessment of current and future funding levels requires the laboratory to take appropriate action to mitigate potentially disruptive shortfalls in funding. Accordingly, the INEEL has implemented a work-force restructuring plan in FY-02, which resulted in 441 employees opting for early retirement, 176 employees volunteering for separation, and 126 employees involuntarily being separated from the laboratory. Based on the FY-02 detailed work plan, project completion dates, milestone achievements, and projected new work, the laboratory may need a further work force reduction in FY-02.

F. Infrastructure

1. Site and Facility Management

In 1997, the INEEL published the second edition of the *Comprehensive Facility and Land-Use Plan* (DOE/ID-10514). An assessment of federal land and facility plans by Cornell University—sponsored by the Federal Planning Division of the American Planning Association—resulted in the INEEL's *Comprehensive Facility and Land-Use Plan* being recognized as the best infrastructure planning project in the federal system. INEEL planning was compared against plans produced by other DOE laboratories, all branches of the military and other large federal campuses. The success of the INEEL's infrastructure management and planning is based on a thorough knowledge and effective communication of the inventory, use, age, and condition of INEEL facilities.

In February 2001, the INEEL published the *Infrastructure Long-Range Plan* (INEEL/EXT-2000-01052). That plan details the INEEL's buildings, structures, systems, and services on an area-by-area basis; compares future infrastructure needs against projected availability, compares forecast costs against projected funding, and identifies infrastructure need and cost shortfalls. The *Comprehensive Facility and Land-Use Plan* and the *Infrastructure Long-Range Plan* are bolstered by the *INEEL Projects Five-Year Plan* (INEEL/INT-01-01560) and the *INEEL Excess Facility Action Plan*. The *INEEL Projects Five-Year Plan* provides a year-by-year description and costs of approved and projected INEEL infrastructure capital projects. The *INEEL Excess Facility Action Plan* lays out the timing and costs for INEEL facilities that will be inactivated, cleaned up, and eventually demolished. In addition to these onsite tools, the INEEL maintains and contributes its portion of the DOE-wide Facility Information Management System database. These tools and their associated management and planning activities enable infrastructure decisions and actions that result in a well-rounded system for providing effective, cradle-to-grave infrastructure support at the INEEL.

Based on information compiled in INEEL infrastructure documents and databases, the INEEL was able to produce a report for *Optimizing the INEEL Infrastructure* (INEEL/INT-01-00797, -00798, -00799) in September 2001. That report provides the DOE-ID Office of Infrastructure Management with alternative projects and plans for managing the INEEL infrastructure into the foreseeable future. Recommendations in the *Optimizing the INEEL Infrastructure* report include:

- Combining several INEEL cleanup laboratory upgrade requests into one or two consolidated capital projects
- Relocating INEEL employees to available, more cost-effective, work locations and closing older, cost-intensive facilities
- Reducing other capital project requests to only those few that directly support the remaining, necessary, mission-critical infrastructure.

Collectively, implementation of the infrastructure optimization recommendations can narrow the INEEL infrastructure funding gap (operational and capital funding needs vs. target funding) by over $416 million through FY 2010.

Near-term challenges facing INEEL infrastructure managers include improving maintenance processes while reducing square-foot maintenance costs and achieving significant INEEL infrastructure footprint reduction.

The INEEL's infrastructure management system has resulted in efficient and effective infrastructure availability, capability, and allocation to support mission needs while mitigating environmental, safety, and health risks. The INEEL's infrastructure documentation and databases enable sound assessments of supporting infrastructure capabilities and costs compared against changing mission-forecast scenarios. Continued improvement in some processes will reduce infrastructure management and maintenance costs while ensuring the preservation of safe, efficient, mission-critical assets.

2. Description of Laboratory Site and Facilities

Work is conducted in Idaho Falls and at six primary facility areas on the 889-mi^2 (569,135-acre) INEEL site (see Figure 8). Argonne National Laboratory–West and the Naval Reactors Facility are also located on the site but are managed by DOE-Chicago and DOE-Pittsburgh Naval Reactors Office, respectively, and are not included in this plan.

Infrastructure under DOE-ID purview comprises over 1,000 support structures; 508 owned laboratory, R&D, engineering, reactor, storage, maintenance, and office buildings; and 18 leased laboratory, storage, and office buildings (primarily located in Idaho Falls) for a total of 526 buildings. A full complement of utility infrastructure, 177 miles of paved INEEL roads and public highways, 800 miles of unpaved roads and trails, 61 miles of electrical transmission lines, and 14 miles of railroad lines are also located on the site. The Sitewide area encompasses the whole INEEL site, excluding the land within primary facility boundaries.

The 526 buildings located at the site and in Idaho Falls encompass over 5 million ft^2 of space (see Table 15) and have an estimated replacement value of $4,185 million (see Table 16). Figures 9 and 10 summarize the condition and age of INEEL facilities. For detailed infrastructure asset information, refer to the *INEEL Infrastructure Long-Range Plan*.

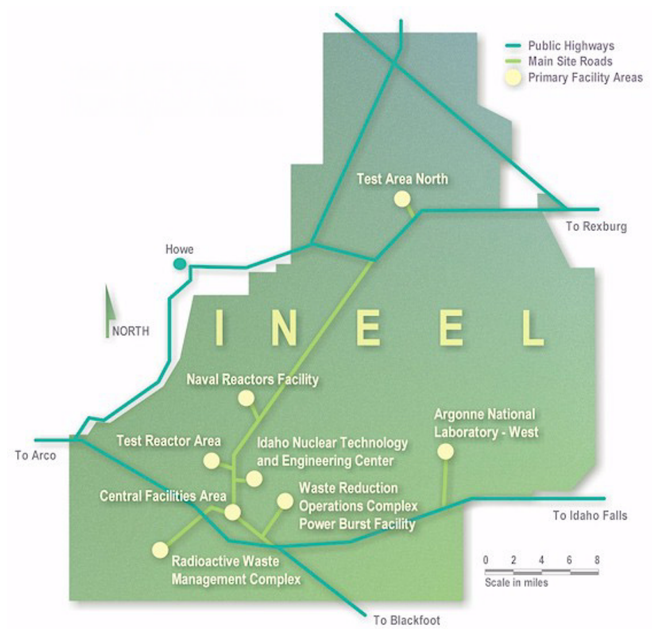


Figure 8. The INEEL site is 889 square miles of semiarid desert located approximately 32 miles west of Idaho Falls. The laboratory consists of six primary facility areas under DOE-ID purview, plus Argonne National Laboratory-West and the Naval Reactors Facility. INEEL facilities are also located in Idaho Falls.

Table 15. FY 2001 INEEL space distribution.

Location	Area (square feet)
Main site—owned	3,891,686
Idaho Falls—owned	243,841
Idaho Falls—leased	889,443
Total	**5,024,970**
Offsite—leased	5,235

Table 16. INEEL facilities replacement value.

Facility Type	Replacement in Current ($ millions)
Buildings	2,360
Utilities/systems	1,561
Land and improvements	5
All others	259
Total	**4,185**

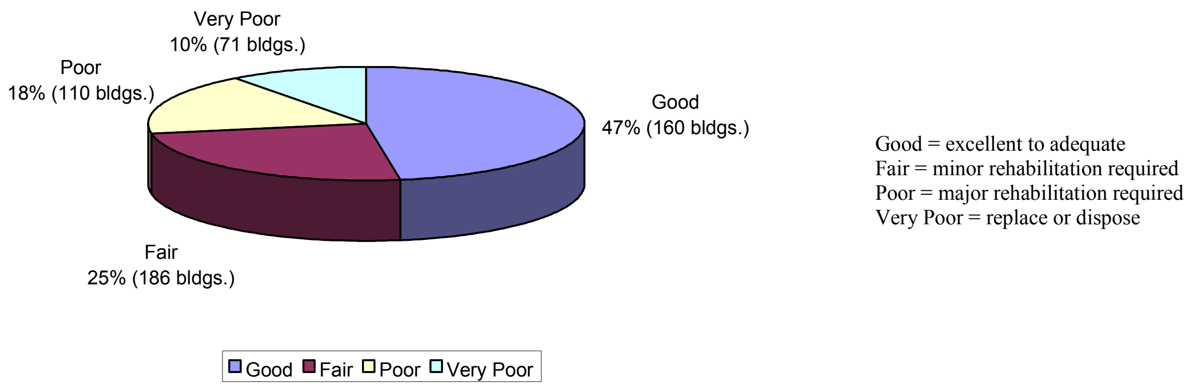


Figure 9. Condition of INEEL space as a percentage of total floor area.

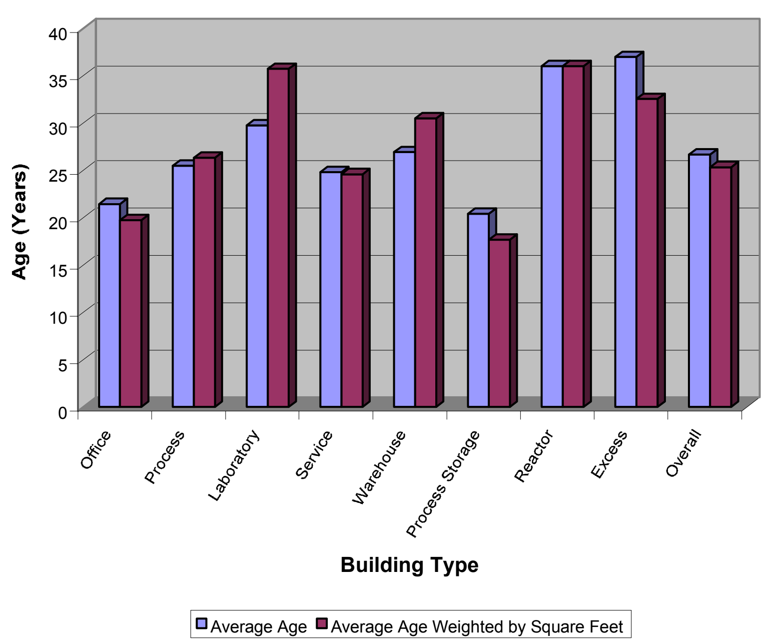


Figure 10. Age of INEEL buildings by type.

3. INEEL Infrastructure Objectives and Strategies

The INEEL must provide a safe, secure, and compliant workplace that enables mission activities to be accomplished. Infrastructure management must continue to provide infrastructure support within the constraints of a flat to decreasing EM budget. The INEEL will focus on identifying and providing effective, mission-critical infrastructure needs while reducing the overall scope and cost of the infrastructure.

INEEL infrastructure objectives and strategies include:

- Infrastructure management will set specific goals, assign actions, provide assets, and oversee progress toward achieving a safe, efficient, and effective INEEL infrastructure. Specific goals and processes include:
  - Implementing recommendations from the infrastructure optimization proposal to cost-effectively upgrade, manage, and maintain mission-critical INEEL infrastructure
  - Completing the Consolidated Laboratory line-item project
  - Consolidating employees to the most functional and cost-effective workplaces and closing vacated facilities
  - Restoring the most mission-critical infrastructure
  - Maintaining plans and databases that enable sound assessments of supporting infrastructure capabilities and costs compared against changing mission-forecast scenarios
  - Reducing the laboratory infrastructure footprint
  - Providing effective project controls and oversight from project conceptualization through closeout
  - Completing construction projects within cost and schedule commitments under a new "commercial practices" methodology
  - Reducing maintenance costs while improving maintenance processes
  - Achieving energy conservation and cost-reduction goals
  - Completing deactivation, decontamination, and demolition projects on a prioritized basis to mitigate environmental, safety, and health hazards and reduce or eliminate surveillance and maintenance costs.
- Infrastructure managers will apply organizational and systems management techniques, enlist professional expertise, optimize existing resources, apply advanced technologies, and implement proven processes to achieve operational excellence.
- Land and facility planning will focus on optimization of the INEEL infrastructure and footprint reduction. Land and infrastructure planning documents will be consolidated. All activities and documentation that support critical decisions for infrastructure optimization project proposals will be completed as scheduled. Buildings will be closed and the

infrastructure footprint will be reduced through (1) work-force restructuring, (2) workplace realignment, and (3) infrastructure optimization. Footprint reduction will reduce costs and release large areas for reuse or closure.

- Construction project management will focus on completing projects under a new "Commercial Practices" methodology. Key to the success of this new methodology is the preparation and identification of the total project scope before finalizing estimates and proceeding. Project teams will work closer together in the conceptual stage of the project as well as during the construction phase. Line-Item Construction Projects and General Plant Projects will be completed in accordance with approved Project Execution Plans milestones.

- Infrastructure maintenance is embarking on a concerted effort to improve processes and significantly reduce costs across the INEEL. Focus in this planning period will be to bring per-square-foot maintenance costs more in line with industry standards. Maintenance work planning and scheduling will also be streamlined and direct, on-the-job work percentages will be improved. Plans and strategies to achieve these objectives have been developed and some are already under way including schedule and cost reductions for maintenance administrative activities, reduction of support costs, and development of a proposal to reallocate some maintenance charges through direct-charge practices. Due to the age of most site facilities, maintaining the INEEL infrastructure demands a tremendous amount of corrective and preventive maintenance. Management will target maintenance deployments to those facilities and systems determined to be the most mission-critical. Emphasis will also be placed on addressing issues that have created barriers to improving maintenance processes and reducing costs.

- Energy management will focus on meeting Federal Energy Management Program performance improvement goals to systematically and continuously reduce energy consumption. At the INEEL, those goals are aligned with requirements in DOE Order 430.2, *In-house Energy Management*. Important energy conservation tools at the INEEL are Energy Savings Performance Contracts implemented at key INEEL facilities. Additionally, employees are continuously encouraged to reduce energy consumption by implementing energy-saving techniques.

- Deactivation, decontamination, and demolition projects at the INEEL have resulted in significant facility and area cleanup and closures in the past decade. Infrastructure management will use the experience and expertise gained over the course of those activities to apply available funding, on a prioritized basis, to the deactivation, decontamination, and demolition of those INEEL facilities that will provide the most "payback." Facilities will be addressed on the basis of the potential for mitigation of environmental, safety, and health hazards and the reduction or elimination of surveillance and maintenance costs.

4. Laboratory Site and Facility Trends

Over time, the square footage of INEEL facilities has been altered through construction of new facilities, demolition and removal of old facilities, changes in leased square footage, and additions or reductions in space provided by temporary facilities. The overall trend in facility space at the INEEL is a decrease in total square footage as the cleanup mission is accomplished (see Table 17). Laboratory infrastructure revitalization plans include upgrades to existing facilities and the addition of new facilities and systems to enhance the specific infrastructure capabilities necessary to cost-effectively achieve the INEEL's missions. Table 17 provides a history of INEEL infrastructure trends, current status, and a trending forecast.

Table 17. INEEL infrastructure trends.

Measurements	FY 1994	FY 2002	FY 2006
Number of owned INEEL buildings	566	508	**491
Number of leased INEEL buildings	31	*18	*17
Total number of INEEL buildings	**597**	**526**	**508**
INEEL owned square footage	4,522,401	4,135,527	**3,534,781
INEEL leased square footage	1,073,153	*889,443	*882,743
Total INEEL square footage	**5,595,554**	**5,024,970**	**4,417,524**
Number of contaminated facilities	192	163	**150
(contaminated facility square footage)		(1,927,033)	(1,377,884)
Number of surplus facilities to be excessed		85	158
(surplus facility square footage)		(396,156)	(1,062,657)

* Does not include Center for Science and Technology projected to be occupied 4/03.

** Does not include 11 active contaminated facilities transferred to BNFL (543,297 square feet).

As illustrated previously in Figure 11, many INEEL buildings are old. Old facilities that are approaching, or are past, the end of their design life require significant expenditures for maintenance and upgrades. This fact, combined with limited budgets, has resulted in a trend towards less-acceptable building conditions.

Although the overall space condition appears good/fair (see Figure 11), the majority of deficiencies reside in facilities most integral to the INEEL cleanup mission. Those facilities are also the most costly to operate, maintain, upgrade, and replace. It also appears that there will be significant, attendant deficiencies in the support infrastructure, which includes structures, utility systems, transportation systems, and communications systems.

Figure 11. Current condition of active INEEL space.

Areas most involved with nuclear operations, laboratory, and processing work contain the most deficient space. Those areas include TRA and INTEC. TAN also contains a large percentage of deficient space, but that percentage is exacerbated by 25% of the space being deemed excess. Table 18 provides a summary view of INEEL space condition, by area.

Table 18. Summary of the condition of INEEL space, with the area in best condition listed first.

Condition Rank	Area	% Good/Fair	% Poor/Replace
1	Idaho Falls	100	0
2	RWMC	99	1
3	Sitewide	93	7
4	CFA	72	28
5	WROC/PBF	68	32
6	INTEC	54	46
7	TRA	50	50
8	TAN*	49	51

* 25 percent of TAN space is deemed excess to the current needs of the INEEL.
Good = excellent to adequate   Fair = minor rehabilitation required
Poor = major rehabilitation required   Very Poor = replace or dispose

5. Laboratory Site and Facility Plans

If INEEL infrastructure is to remain viable throughout its current mission, the capital projects identified and discussed in the *INEEL Infrastructure Long-Range Plan*, the *INEEL Infrastructure Project Capital Needs*, and the *Optimizing the INEEL Infrastructure* report must be approved, funded, and completed. These plans describe the mission requirements, project priorities, forecast of construction projects, realignment/reduction of INEEL infrastructure liability, new buildings, upgrades, and maintenance for all INEEL buildings, structures, and systems based on anticipated need.

It is critical to note that currently approved INEEL capital projects alone will not bring the INEEL infrastructure up to required support levels nor maintain it adequately to support programs to the end of their mission.

Continued inadequate funding will gradually impair the INEEL's ability to meet its mission objectives and will ultimately result in environmental, safety, health, and operational issues that will have to be addressed at the expense of programmatic goals. However, based on the infrastructure's current state of repair, approved General Plant Project and Line-Item Construction Project funds, and historical and projected levels of required maintenance, infrastructure degradation is not expected to significantly impact INEEL operational success during the FY 2002–2006 planning period. The forecast condition assessment in 2006, relative to today with just level (*Target*) funding and reflecting the projected effect of the footprint reduction initiative, is provided in Figure 12.

Target, budgeted, and proposed funding levels provide infrastructure support as follows:

- *Target.* Supports approved Line-Item Construction Projects, planned minimum safe caretaker and essential services, General Plant Projects, the INTEC Cathodic Protection Line-Item Construction Project, the Sitewide INEEL Information Network Line-Item Construction Project, the INEEL Restoration/Optimization Line-Item Construction Project, and the INEEL High-Voltage Equipment Replacement Line-Item Construction Project.

- *Budgeted*. Supports additional INTEC infrastructure, waste management, and spent nuclear fuel General Plant Projects.
- *Proposed*. All infrastructure needs would be met.

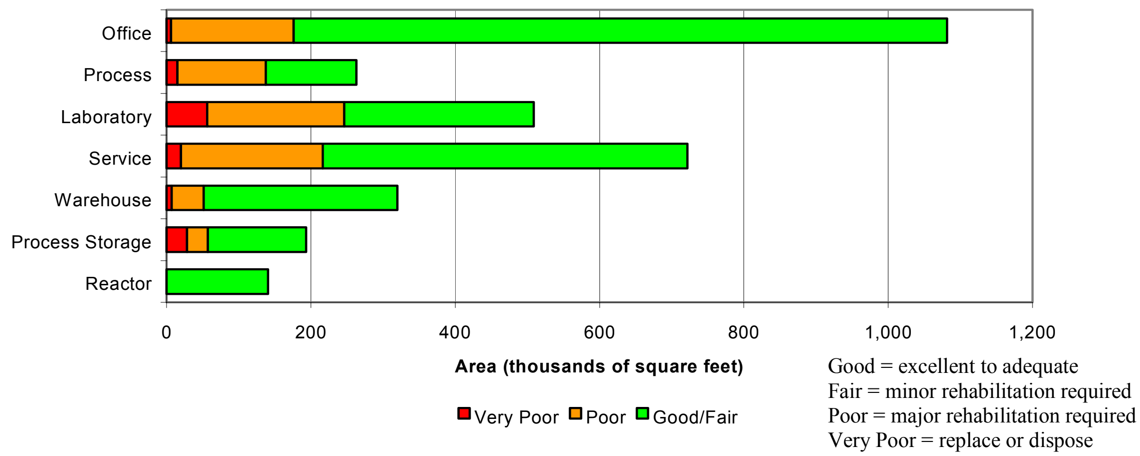


Figure 12. Condition of active INEEL buildings in 2006, assuming no change in current targeted level funding.

If infrastructure funding is not sufficient to support INEEL missions, plans will be updated on an annual basis to reflect current needs, and DOE will be advised of the impact of a gap in funding. Figure 13 shows just the gap in infrastructure FY 2002–2006 funding requirements and the currently suggested target funding. A balanced prioritizing process is provided in the *INEEL Infrastructure Long-Range Plan* and is used to annually address any funding shortfalls.

The new SGL and the Consolidated Laboratory Facility are cornerstones of the laboratory's future. Line-item construction funding for these two critical projects will be aggressively pursued. These facilities would support development of sound technical bases to ensure the success of the laboratory's environmental restoration mission and long-term stewardship, and are important to new missions and initiatives.

The SGL, located in Idaho Falls, will allow the INEEL to examine and understand processes that control the movements and interactions of subsurface contaminates. The Consolidated Laboratory Facility co-located at INTEC and in Idaho Falls would provide the equipment and capability needed to develop, test, scale up, and demonstrate the new treatment and disposal preparation processes needed to remediate the radioactive waste stored at INTEC. This facility will also include a component called the Subsurface Science Initiative—High-Level Laboratory, composed of two laboratories that support the SGL (i.e., the high-gamma laboratory and the geocentrifuge laboratory). These labs support work with radiation levels higher than would be allowed in Idaho Falls. The Consolidated Laboratory Facility also includes a component that would reside in leased space in Idaho Falls. The Idaho Falls component contains DOE's Radiological and Environmental Sciences Laboratory and other INEEL support laboratories.

The INTEC Consolidated Laboratory Facility would comprise approximately 85% operational support laboratories and 15% R&D laboratories. The leased facilities in Idaho Falls would consist of the Radiological and Environmental Sciences Laboratory at 51%, operational support laboratories at 31%, and R&D laboratories at approximately 18%.

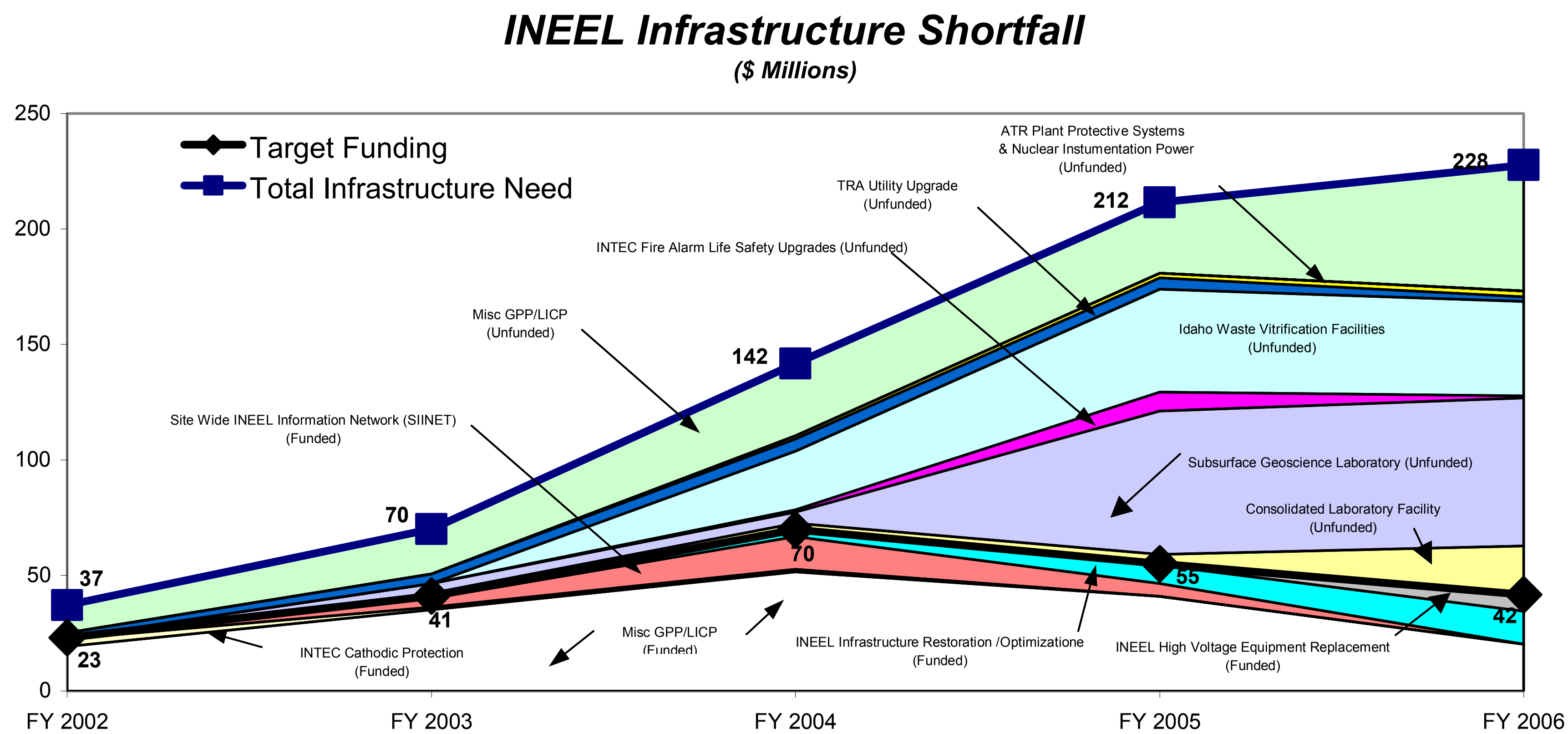


Figure 13. INEEL infrastructure funding shortfall.

Pending project approval and funding authorization, the SGL is scheduled to go online in FY 2007 and the Consolidated Laboratory is scheduled to be operational by FY 2009. Based on present planning assumptions, both facilities will be required beyond 2035.

If the INEEL is unable to obtain capital funding via available methods to support these projects, nontraditional funding alternatives such as third-party financing or special congressional allocations may be pursued. If funding is not obtained for the SGL, there will be no mesoscale subsurface research at the INEEL, and only limited subsurface research will be conducted in the proposed University of Idaho/Idaho State Center for Science and Technology facility (a portion is scheduled to be leased by the INEEL) and other existing laboratories, both at the IRC and site facilities. With no funding approved for the Consolidated Laboratory Facility, operations would continue within existing failing facilities, with no consolidation or operations and maintenance savings being realized. These facilities will be used until they are no longer safe to operate, and then work would be delayed, emergency funding would have to be obtained, or alternative methods for completing the work would have to be identified and pursued.

INEEL infrastructure must be managed to functionally and cost-effectively support completion of the environmental restoration mission and subsequent transition to new missions. Infrastructure management activities at the INEEL center on identifying mission-critical infrastructure needs while reducing the overall scope and cost of the INEEL's infrastructure. As detailed in the *INEEL Infrastructure Long-Range Plan*, excess facilities (and accompany support costs) will be eliminated. Useable buildings, structures, and utilities can be transitioned from environmental restoration support to new missions support, as they become available. Some new buildings and utilities will be required to replace aged infrastructure that is at an unacceptable state of degradation, or to provide unique capabilities.

The proposed Ten-Year Facility Optimization and Closure Plan delineates the INEEL's revised approach to addressing the infrastructure impacts of its changing mission needs and funding limitations. Appendix F shows the funding requirements, timing, life-cycle cost savings, and mission need associated with this optimized approach.

Detailed INEEL Sitewide and area-specific infrastructure health assessment and forecasting information is presented in the *INEEL Infrastructure Long-Range Plan*. Recommendations resulting from the assessments in that report include:

- Obtain funding and implement identified infrastructure optimization capital projects, beyond those currently approved, by demonstrating how those projects will prevent infrastructure deterioration and provide required program support at a reduced cost
- Focus more resources on the systematic analysis of INEEL utilities and distribution systems and related distribution system health to area space condition and program needs
- Systematically analyze INEEL maintenance application, costs, and plans to relate application of maintenance to system health, area space condition, and capital project plans
- Develop INEEL infrastructure need scenarios beyond those required by EM-funded work, and consider those scenarios when making new construction, facility upgrade, closure, and infrastructure optimization decisions.

The INEEL annually performs life-cycle analyses of its mission needs and determines its capital and maintenance funding requirements. Life-cycle asset management includes estimating the point in time when a component will fail and then scheduling maintenance or replacement before failure occurs. This practice minimizes irreversible loss of infrastructure. Life-cycle asset management consists of three major elements: maintenance, capital upgrades, and disposal.

Life-cycle planning doesn't necessarily focus on the useful life of the infrastructure. Instead, it concentrates on mission life cycles. For instance, if a particular mission is expected to outlast the building that houses it, then the mission work will be relocated or that building has to be considered for upgrades or replacement. So, development of a life-cycle capital plan begins with mission timelines and then knowledge of the infrastructure's current condition. Local inputs are subsequently applied and combined with generic historic data about relocation alternatives, replacements, and upgrades. This approach is the basis for analyzing and planning infrastructure capital needs.

The key general-purpose-facilities focus at the INEEL is maintaining the infrastructure in a safe and viable condition. There are several hundred pieces of general purpose capital equipment, over 50 general plant projects, and over 15 line-item construction projects identified through FY 2006 that would address health and safety deficiencies, environmental issues, and mission-need requirements.

Tables 19 and 20 reflect the construction projects' infrastructure capital funding requirements through FY 2006 in the *INEEL Infrastructure Long-Range Plan*. Funding for these projects is based on the availability of overall EM funding for a specific fiscal year and where these projects fall in relation to other EM priorities. The high-priority EM line-item construction projects are:

- INTEC Cathodic Protection
- Sitewide INEEL Information Network
- Consolidated Laboratory Facility
- Subsurface Geosciences Laboratory
- INTEC Fire Alarm System
- Idaho Waste Vitrification Facilities.

The high-priority NE and DOE Naval Reactors Program construction projects are:

- TRA Utility Upgrades
- ATR Plant Protective System and Nuclear Instrumentation Power.

6. Space Management

The INEEL Infrastructure Program maintains a sophisticated Geographical Information System for use in space allocation and personnel and equipment location. The information in this system is available to all INEEL employees on the intranet, but is primarily used by the organizations responsible for personnel relocations and services (telephone, computer networking, etc.). The personnel relocation rate at the INEEL is currently at 17% per year (other than when affected by circumstances such as contractor changes). This is well below industry standards for government facilities (26%).

Plans are currently under way to modify the existing cost model for occupying and maintaining INEEL facilities. The plan will allocate space cost, based on square feet used, to ensure adequate resources for facilities and to create an incentive for space conservation, thus reducing the associated costs.

Table 19. Major construction projects—summary ($K)[a].

MAJOR CONSTRUCTION PROJECT SUMMARY	R&D Specific	TEC *	FY 2002	FY 2003	FY 2004 ($000's)	FY 2005	FY 2006
Funded Construction							
Line Item Construction Projects			11,069	8,203	19,097	15,620	21,401
General Plant Projects			12,073	32,956	50,792	39,489	20,336
Total Funded Construction			23,142	41,159	69,889	55,109	41,737
Budgeted Construction							
Line Item Construction Projects			0	0	0	0	0
General Plant Projects			8,850	4,300	3,800	115	115
Total Budgeted Construction			8,850	4,300	3,800	115	115
Total Funded and Budgeted **			31,992	45,459	73,689	55,224	41,852
Proposed Construction							
Line Item Construction Projects ***			2,020	9,574	41,579	132,072	154,904
General Plant Projects			3,120	15,010	26,513	24,332	31,045
Total Proposed Construction			5,140	24,584	68,092	156,404	185,949
Total Funded/Budgeted/Proposed ****			37,132	70,043	141,781	211,628	227,801

GENERAL PURPOSE CAPITAL EQUIPMENT SUMMARY	R&D Specific	TEC	FY 2002	FY 2003	FY 2004 ($000's)	FY 2005	FY 2006
Funded General Purpose Capital Equipment							
Funded General Purpose Capital Equipment			10,184	10,469	10,469	10,763	10,763

* Total Estimated Cost GPPs = TEC; LICPs = TEC.
** Included in the INEEL EM Compliance Driven Requirements Summary, as a segment of (a) Total DOE Effort and
(a) Total DOE Effort and
(b) General Purpose/Program Capital Equipment, General Plant Projects, General Purpose Facilities, and Program Construction.
*** Line Item Construction Projects listed under the Proposed Construction funding category are those projects that have not had Cirtical Decision (CD0) approval. (Mission Need)
**** Total Funded, Budgeted, and Proposed funding information is contained in Project Data Sheets (PDS), Project Engineering Design (PED) PDS, Bechtel BWXT Idaho, LCC Internal Report, "INEEL Projects Five-Year Plan," INEEL/INT-2000-01560, dated November 2000, and the individual Programs estimates of funding profiles in advance of the FY 2003 Budget Call.

a. Table 19 reflects construction funding as it appears in the FY 2001 Infrastructure Long-Range Plan.

Table 20. Major construction projects.

SITEWIDE INFRASTRUCTURE (EW)	R&D Specific	TEC ($000's)	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Funded (Target) Construction							
Health Physics Instrumentation Laboratory		12,763	2,970	0	0	0	0
Sitewide INEEL Information Network		24,276	650	3,884	14,275	5,467	0
INEEL Infrastructure Restoration/Optimization		71,890	0	1,000	2,997	7,954	14,201
INEEL High-Voltage Equipment Replacement		16,068	0	0	0	700	7,200
SW General Plant Projects*			2,755	9,832	20,559	21,249	10,620
Total Funded (Target) Construction			6,375	14,716	37,831	35,370	32,021
Budgeted (Compliance) Construction							
Sitewide General Plant Projects*			0	0	0	0	0
Total Budgeted (Compliance) Construction			0	0	0	0	0
Total Funded and Budgeted			6,375	14,716	37,831	35,370	32,021
Proposed Construction							
Subsurface Geoscience Laboratory	Yes	165,000	0	4,000	4,800	62,000	64,000
Flood Control Upgrades		8,696	0	0	0	833	1,604
Sitewide General Plant Projects*			3,120	3,404	7,285	6,937	18,303
Total Proposed Construction			3,120	7,404	12,085	69,770	83,907
Total Funded/Budgeted/Proposed			9,495	22,120	49,916	105,140	115,928

INTEC INFRASTRUCTURE (EW)	R&D Specific	TEC	FY 2002 ($000's)	FY 2003	FY 2004	FY 2005	FY 2006
Funded (Target) Construction							
Electrical and Utility Systems Upgrade			448	0	0	0	0
INTEC Cathodic Protection System Expansion		6,000	3,256	1,119	1,125	0	0
INTEC General Plant Projects*			2,091	10,697	15,774	7,118	1,382
Total Funded (Target) Construction			5,795	11,816	16,899	7,118	1,382
Budgeted (Compliance) Construction							

Table 20. (continued).

	R&D	TEC	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
INTEC General Plant Projects*			1,800	0	0	0	0
Total Budgeted (Compliance) Construction			1,800	0	0	0	0
Total Funded and Budgeted			7,595	11,816	16,899	7,118	1,382
Proposed Construction							
Consolidated Laboratory Facility		80,070	0	1,236	2,739	4,069	21,064
INTEC Fire Alarm Life Safety Upgrades		10,100	0	0	930	8,219	951
INTEC Administrative Support Facility		16,327	0	0	0	3,945	10,000
INTEC General Plant Projects*			0	10,395	17,555	16,502	12,342
Total Proposed Construction			0	11,631	21,224	32,735	44,357
Total Funded/Budgeted/Proposed			7,595	23,447	38,123	39,853	45,739

	R&D	TEC	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
HIGH-LEVEL WASTE (EW) *	**Specific**		($000's)				
Funded (Target) Construction							
High-Level Waste General Plant Projects			2,307	3,372	5,851	4,963	1,850
Total Funded (Target) Construction			2,307	3,372	5,851	4,963	1,850
Budgeted (Compliance) Construction							
High-Level Waste General Plant Projects			0	0	0	0	0
Total Budgeted (Compliance) Construction			0	0	0	0	0
Total Funded and Budgeted			2,307	3,372	5,851	4,963	1,850
Proposed Construction							
Idaho Waste Vitrification Facilities		1,039,502	0	0	25,363	44,580	40,898
High-Level Waste General Plant Projects			0	0	0	0	0
Total Proposed Construction			0	0	25,363	44,580	40,898
Total Funded/Budgeted/Proposed			2,307	3,372	31,214	49,543	42,748

Table 20. (continued).

	R&D	TEC	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
WASTE MANAGEMENT (EW)	**Specific**		($000's)				
Funded (Target) Construction							
WM General Plant Projects			641	1,000	0	0	0
Total Funded (Target) Construction			641	1,000	0	0	0
Budgeted (Compliance) Construction							
WM General Plant Projects			1,734	4,300	3,800	115	115
Total Budgeted (Compliance) Construction			1,734	4,300	3,800	115	115
Total Funded and Budgeted			2,375	5,300	3,800	115	115
Proposed Construction							
WM General Plant Projects			0	0	0	0	0
Total Proposed Construction			0	0	0	0	0
Total Funded/Budgeted/Proposed			2,375	5,300	3,800	115	115
SPENT NUCLEAR FUEL (EW/EX)	**Specific**		($000's)				
Funded (Target) Construction							
Spent Nuclear Fuel General Plant Projects			0	4,914	4,156	3,494	3,039
Total Funded (Target) Construction			0	4,914	4,156	3,494	3,039
Budgeted (Compliance) Construction							
Spent Nuclear Fuel General Plant Projects			5,316	0	0	0	0
Total Budgeted (Compliance) Construction			5,316	0	0	0	0
Total Funded and Budgeted			5,316	4,914	4,156	3,494	3,039

Table 20. (continued).

	R&D	TEC	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Proposed Construction							
Spent Nuclear Fuel Dry Storage Project Storage and Transfer Cell Expansion		241,800	0	0	0	0	5,725
Spent Nuclear Fuel General Plant Projects			0	0	0	0	0
Total Proposed Construction			0	0	0	0	5,725
Total Funded/Budgeted/Proposed			5,316	4,914	4,156	3,494	8,764

	R&D	TEC	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
NUCLEAR ENERGY (AF)	**Specific**		($000's)				
Funded Construction							
Test Reactor Area (TRA) Fire & Life Safety Improvements		15,446	2,080	0	0	0	0
TRA Electrical Utility Upgrade		7,709	1,665	2,200	700	1,499	0
TRA General Plant Projects			1,772	358	1,777	1,240	1,415
Total Funded Construction			5,517	2,558	2,477	2,739	1,415
Budgeted Construction							
TRA General Plant Projects			0	0	0	0	0
Total Budgeted Construction			0	0	0	0	0
Total Funded and Budgeted			5,517	2,558	2,477	2,739	1,415
Proposed Construction							
TRA Utility Upgrade		19,700	2,020	4,338	5,347	4,926	1889
TRA Support Systems Upgrades		*18,000 - 20,400	0	0	1,000	1,500	5,173
TRA Administration Building		15,900	0	0	0	0	1,000
TRA General Plant Projects			0	0	0	0	0
Total Proposed Construction			2,020	4,338	6,347	6,426	8,062
Total Funded/Budgeted/Proposed			7,537	6,896	8,824	9,165	9,477

* Rough Order of Magnitude for the TRA Systems Upgrades is between $18,000K and $20,400K.

Table 20. (continued).

NAVAL REACTORS (AJ)	R&D	TEC	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
	Specific		($000's)				
Funded Construction							
ATR General Plant Projects			2,507	2,783	2,675	1,425	2,030
Total Funded Construction			2,507	2,783	2,675	1,425	2,030
Budgeted Construction							
ATR General Plant Projects			0	0	0	0	0
Total Budgeted Construction			0	0	0	0	0
Total Funded and Budgeted			2,507	2,783	2,675	1,425	2,030
Proposed Construction							
ATR Plant Protective Systems & Nuclear Instrumentation Power		6,000	0	0	1,400	2,000	2,600
ATR General Plant Projects			0	1,211	1,673	893	400
Total Proposed Construction			0	1,211	3,073	2,893	3,000
Total Funded/Budgeted/Proposed			2,507	3,994	5,748	4,318	5,030
Total Funded Construction			23,142	41,159	69,889	55,109	41,737
Total Budgeted Construction			8,850	4,300	3,800	115	115
Total Proposed Construction			5,140	24,584	68,092	156,404	185,949
			37,132	70,043	141,781	211,628	227,801
Total Funded/Budgeted/Proposed [Summary]			37,132	70,043	141,781	211,628	227,801

7. Excess Facilities

DOE has committed to clean up its inactive, contaminated nuclear facilities and noncontaminated support facilities at the INEEL. An established facility disposal program oversees the decontamination and decommissioning of those facilities in accordance with DOE guidelines and within budget and schedule constraints (see Table 21). The Decontamination and Decommissioning Program reduces surplus facility risks associated with residual radioactive and/or hazardous materials through removal and/or stabilization activities. The determination of whether a building or structure will be converted to another use or undergo decontamination and decommissioning depends on the building's level of contamination, age, condition, and need for the facility.

Table 21. Funding distribution for disposition of INEEL noncontaminated and contaminated facilities ($K).

Program	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
Noncontaminated Facility Disposal	0	0	0	0	0	0
Contaminated Facility Deactivation	1,731	4,773	4,872	7,431	6,687	25,494
Contaminated Facility Disposal	2,060	2,555	2,627	2,636	2,562	12,440
Total	3,791	7,328	7,499	10,067	9,249	37,934

Since it began in 1977, the INEEL Decontamination and Decommissioning Program has reduced infrastructure costs at the laboratory by more than $177 million. The program has been responsible for removing 130 buildings/structures, 33 component systems, 17 nuclear reactor related facilities/systems, 109 underground storage tanks, and closing three RCRA facilities. These removal and closure actions eliminated the radiological and hazardous material source terms, and the associated source term risks. As a result, the overall Sitewide risk profile was reduced. The Decontamination and Decommissioning Program prioritizes its work activities with methods that consider the associated risks. Currently, more than 167 excess facilities and structures at the INEEL will require disposition to mitigate the potential hazards. These facilities and structures are prioritized per their risks stemming from the associated hazards. Table 21 summarizes funding levels scheduled for remediation of contaminated and noncontaminated facilities through FY 2006. Details about the laboratory's Facility Disposal Initiative are contained in the *INEEL Infrastructure Long-Range Plan.*

8. Energy Management

The INEEL Energy Management Program realizes cost savings through energy efficiency. Since 1985, energy management efforts have resulted in an average cost savings of approximately $1 million per year. Over this same period, the Energy Management Program has won programmatic funding of approximately $10 million for projects and studies.

A technical staff of certified energy managers is maintained to identify cost-saving opportunities for operations and obtain programmatic funding to accomplish projects. Other energy management activities include measuring and reporting energy use and greenhouse gas emission data, and performing other energy efficiency activities as required by the Federal Energy Management Program. Measuring actual energy use enables the energy managers to identify inefficient systems and to track the impact of energy projects.

The Federal Energy Management Program steers energy management activities at all DOE facilities. The Federal Energy Management Program Office negotiates a 2-year Performance Agreement with DOE-ID for activities specific to the INEEL that will enable DOE to meet the orders complexwide. The current INEEL Energy Management Performance Agreement includes planning and reporting, water conservation, Energy Star building qualification, Energy Savings Performance Contract, sustainable design, and energy conservation activities.

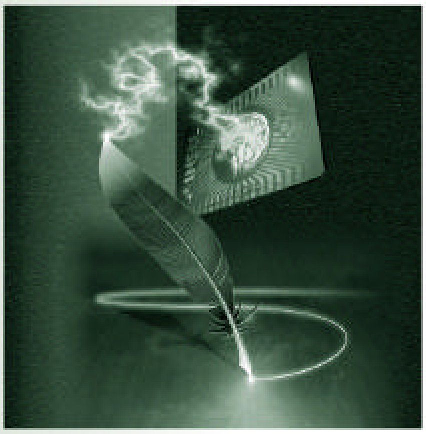
The INEEL has implemented its first Energy Savings Performance Contract. This project upgraded and replaced lighting and replaced transformers in the INEEL Research Center, providing $90,000 in energy savings per year. In accordance with the performance agreement, larger energy savings opportunities will be identified for other facilities at the laboratory.

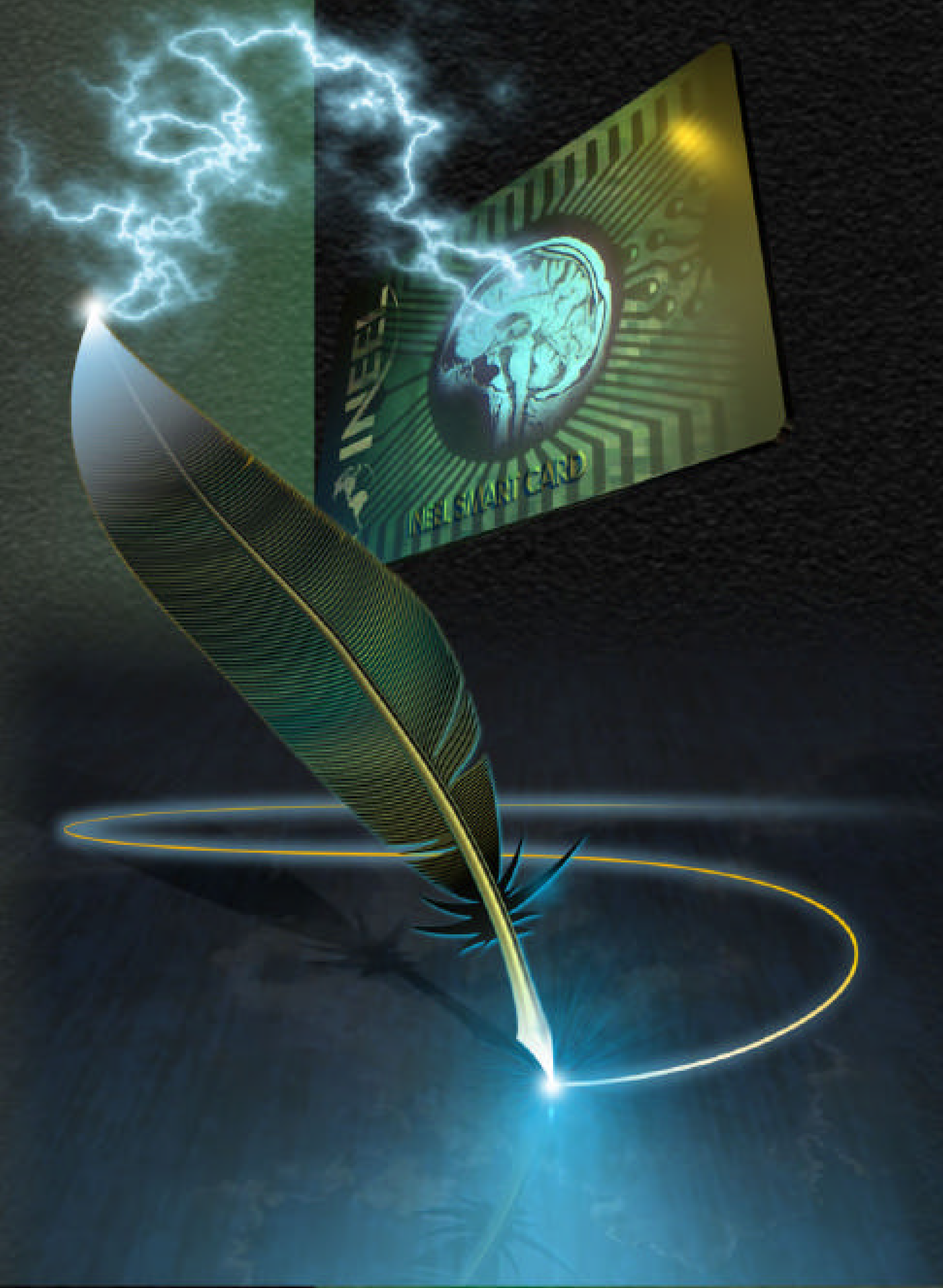
A sustainable design program at the INEEL has also been initiated. Energy managers work with Pollution Prevention, Affirmative Procurement, and Architectural Engineering Design to incorporate sustainable design (i.e., green building, recyclable materials, renewable energy, efficient systems) into new design through planning, checklists, procedures, and training.

The energy conservation goals of the performance agreement are accomplished by modifying buildings and systems per funding availability. The Energy Management Program also encourages employees to conserve resources and works with facility managers to operate buildings efficiently. Technical assistance is also provided on new building design and to outside agencies when applicable.

Traditional energy management activities and emerging technologies will be employed to improve INEEL systems. Executive and DOE orders suggest increased attention to renewable and alternate fuel applications. The laboratory's 526 buildings are a potential demonstration/validation test bed for new energy technologies.

Resource Projections





Digital Security

DOE's objective of ensuring the security of its nuclear materials, facilities and information assets is being met, in part, through the INEEL's digital signature technology. Developed for managing and shipping nuclear waste, the White House award-winning INEEL "smart card" represents one of the most complex digital signature systems in use today.

VI. RESOURCE PROJECTIONS

Tables 22 through 31 reflect only management and operation contractor projections and do not include DOE-ID. Projections are based on key planning assumptions located in Section III.A of this document.

Projections reflect Safeguards and Security operations moving from indirect to direct funding in FY 2001. Corporate-funded R&D is included in the Work-for-Others private industry projections.

The funding summary (Table 23) identifies an R&D projection using the 2000 Office of Science and Technical Information Report as the base, plus escalation, and a 5% growth each year beginning with FY 2001.

Direct-funded FTE information included in the resource tables (22 and 28) was derived from the business plan and reflects total FTEs associated with carryover plus new budget authority.

NOTE: RESOURCE TABLES DO NOT REFLECT FUNDING REQUIREMENTS FOR LABORATORY AND DIVISION INITIATIVES IDENTIFIED IN SECTIONS III AND IV. THE FOLLOWING RESOURCE TABLES REFLECT EXPECTED FUNDING AND FTE LEVELS BASED ON CURRENT BASELINES AND/OR ESTIMATES AS OF DECEMBER 31, 2001.

DUE TO THE TIMING OF THIS PLAN, RESOURCE PROJECTIONS CONTAINED IN THIS SECTION DO NOT REFLECT THE PRESIDENT'S FY 2003 BUDGET SUBMISSION TO CONGRESS OR POTENTIAL BUDGET IMPACTS RESULTING FROM THE EM TOP-TO-BOTTOM REVIEW.

Table 22. INEEL funding summary (does not include DOE-ID).

($ in Millions - BA)	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
OPERATING FUNDING							
DOE Effort							
DOE Effort	498.77	554.92	521.83	539.96	517.31	493.92	508.98
Subtotal DOE Effort	498.77	554.92	521.83	539.96	517.31	493.92	508.98
Work for Others							
Work for Others	90.70	94.87	100.75	97.13	110.89	120.67	123.78
Industry Work for Others	7.40	6.35	12.07	17.44	18.70	19.71	20.23
Subtotal Work for Others	98.10	101.22	112.82	114.57	129.59	140.38	144.01
Total Operating	596.87	656.14	634.65	654.53	646.90	634.30	652.99
Construction, Capital Equipment[a]							
Program Capital Equipment	4.24	2.28	9.18	7.27	7.08	7.18	7.49
Program Construction	25.00	2.62	10.63	17.18	4.91	6.59	16.35
General Purpose Facilities	6.16	2.20	8.40	10.70	15.80	5.80	-
General Plant Projects	5.88	3.20	2.80	9.80	20.50	21.20	10.60
General Purpose Capital Equipment	6.48	5.40	4.60	6.70	6.90	7.10	7.30
Subtotal Construction, Capital Equipment	47.76	15.70	35.61	51.65	55.19	47.87	41.74
TOTAL PROJECTED FUNDING	644.63	671.84	670.26	706.18	702.09	682.17	694.73
OSTI-Defined R&D[b]	197.10	216.68	238.21	258.62	280.79	304.85	330.98

a. Section VI Construction, Capital Equipment funding reflects EM prioritization numbers as of December 2001.

b. Data reflect the 2000 DOE Office of Science and Technical Information Report, plus escalation, and 5% growth each year (FY-01 through FY-06). Data of the DOE Office of Science and Technical Information for 2000 do not reflect Work-for-Others R&D of $27.6 million.

Table 23. LDRD funding ($ in millions based on 4% of total laboratory costs).

FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
$ 4.8M*	$23M	$21M	$25M	$25M	$25M	$25M

*The FY 2000 LDRD program did not include research funded by indirect costs derived from environmental management sources.

Table 24. INEEL personnel summary.

(Annualized FTEs)	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
DIRECT							
DOE Effort	3,600	3,595	3,415	3,278	3,124	2,842	2,780
Total DOE Effort	3,600	3,595	3,415	3,278	3,124	2,842	2,780
Work for Others	469	527	406	415	411	411	413
Total Operating	4,069	4,122	3,821	3,694	3,535	3,253	3,193
TOTAL DIRECT	4,069	4,122	3,821	3,694	3,535	3,253	3,193
TOTAL INDIRECT a.	2,400	2,252	1,700	1,600	1,600	1,600	1,600
TOTAL PERSONNEL	6,469	6,374	5,521	5,294	5,135	4,853	4,793

Note: These values are derived from estimated total FTEs as based in the business plan and reflects FTE restructure. (FTEs are calculations based on a model that takes into consideration personal leave, and other absences)

Table 25. Subcontracting and procurement—small and disadvantaged business.

($ in Millions)[a]	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Procurement from Small Business	122.00	120.00	120.00	107.00	108.50	108.50	108.50
Percent of annual procurement	72%	70%	70%	70%	70%	70%	70%
Procurement from Samll Disadvantaged	30.60	28.00	28.00	22.90	23.20	23.20	23.20
Percent of annual procurement	18%	15%	15%	15%	15%	15%	15%

a. Total dollars obligated in each fiscal year.

Table 26. Subcontracting and procurement.

($ in Millions Obligated)[a]	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Subcontracting and Procurement							
Universities	10.70	10.70	10.70	8.2	8.3	8.3	8.3
All others	177.00	177.00	177.00	135.4	137.2	137.2	137.2
Transfers to other DOE facilities	12.30	12.30	12.30	9.4	9.5	9.5	9.5
Total external subcontracts and procurement	200.00	200.00	200.00	153.00	155.00	155.00	155.00

a. Total dollars obligated in each fiscal year.

Table 27. Laboratory staff composition–2000.

Full and Part-Time Employees	Total	Ph.D.		MS/MA		BS/BA		Other	
		#	%	#	%	#	%	#	%
Professional Staff									
Scientists/Engineers	1579	197	12%	541	34%	827	52%	14	1%
Engineers									
Management and Administrative	1944	56	3%	226	12%	603	31%	1059	54%
Support Staff									
Technicians	558	0	0%	3	1%	42	8%	513	92%
All other	1316	0	0%	2	0%	47	4%	1267	96%
Total	5397	253	5%	772	14%	1519	28%	2853	53%

Table 28. Equal employment opportunity.

Occupational Codes		Total				Minority Total				White				Black				Hispanic				Native American				Asian/Pacific Islanders			
	Gender	M		F		M		F		M		F		M		F		M		F		M		F		M		F	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Official/Manager	350	293	84%	57	16%	12	3%	6	2%	281	80%	51	15%	1	0%	0	0%	10	3%	2	1%	0	0%	1	0%	1	0%	3	1%
Professional																													
Scientists/ Engineers	1569	1339	85%	230	15%	74	5%	23	1%	1265	81%	207	13%	8	1%	2	0%	21	1%	11	1%	10	1%	1	0%	35	2%	9	1%
Management/ Admin	1604	1135	71%	469	29%	52	3%	50	3%	1083	68%	419	26%	9	1%	2	0%	19	1%	20	1%	15	1%	12	1%	9	1%	16	1%
Technicians	558	405	73%	153	27%	24	4%	28	5%	381	68%	125	22%	3	1%	1	0%	9	2%	21	4%	8	1%	5	1%	4	1%	1	0%
Clerical	317	8	3%	309	97%	0	0%	33	10%	8	3%	276	87%	0	0%	2	1%	0	0%	19	6%	0	0%	7	2%	0	0%	5	2%
Craftsmen/Laborers	341	319	94%	22	6%	34	10%	5	1%	285	84%	17	5%	2	1%	0	0%	27	8%	4	1%	3	1%	1	0%	2	1%	0	0%
Service Workers/Operators	640	516	81%	124	19%	34	5%	18	3%	482	75%	106	17%	4	1%	2	0%	19	3%	12	2%	7	1%	3	0%	4	1%	1	0%
Apprentices	18	13	72%	5	28%	2	11%	0	0%	11	61%	5	28%	0	0%	0	0%	2	11%	0	0%	0	0%	0	0%	0	0%	0	0%
Total	5397	4028	75%	1369	25%	232	4%	163	3%	3796	70%	1206	22%	27	1%	9	0%	107	2%	89	2%	43	1%	30	1%	55	1%	35	1%

Table 29. Resources by major program.

($ in Millions-BA)	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
AA-Coal							
Operating	1.22	1.01	1.00	0.80	1.00	1.00	1.20
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.22	1.01	1.00	0.80	1.00	1.00	1.20
AB-Gas							
Operating	0.32	0.21	0.40	0.40	0.40	0.40	0.60
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.32	0.21	0.40	0.40	0.40	0.40	0.60
AC-Petroleum							
Operating	1.94	1.97	2.50	2.50	3.75	3.83	3.91
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.94	1.97	2.50	2.50	3.75	3.83	3.91
AF-Nuclear Energy Research and Development							
Operating	8.52	11.02	9.28	9.49	9.69	9.72	10.16
Capital Equipment	0	1.08	0	0	0	0	0
Construction	1.97	1.94	5.52	2.56	2.48	2.74	1.41
Subtotal	10.49	14.04	14.80	12.05	12.17	12.46	11.57
AJ-Naval Reactors							
Operating	50.01	50.16	50.90	52.00	53.09	54.21	55.34
Capital Equipment	0.24	0.53	0.6	0.5	0.51	0.52	0.53
Construction	-0.32	1.00	2.51	2.78	2.67	1.42	2.03
Subtotal	49.93	51.69	54.01	55.28	56.27	56.15	57.90
AT-Fusion Energy Sciences							
Operating	1.63	2.21	2.00	2.04	2.08	2.60	2.65
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.63	2.21	2.00	2.04	2.08	2.60	2.65
CD-Uranium Programs							
Operating	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.15	0	0.00	0.00	0.00	0.00	0.00
CN-Counterintelligence							
Operating	1.28	1.07	1.04	1.04	1.04	1.30	1.33
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.28	1.07	1.04	1.04	1.04	1.3	1.33
DC-Civilian Radioactive Waste R&D							
Operating	0	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0
DG-Donations, Gifts & Bequests							
Operating	0	0.08	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0.08	0	0	0	0	0
DP-Weapons Activities							
Operating	1.72	1.75	2.80	2.85	2.91	2.97	3.72
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.72	1.75	2.80	2.85	2.91	2.97	3.72
EB-Solar and Renewable Resource Technologies							
Operating	1.94	4.93	3.80	3.88	3.96	4.50	4.59
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.94	4.93	3.8	3.88	3.96	4.50	4.59

Table 29. (continued).

ED-Industrial Sector							
Operating	1.74	4.81	1.5	1.53	1.56	1.60	2.25
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.74	4.81	1.50	1.53	1.56	1.6	2.25
EE-Transportation Sector							
Operating	3.25	2.84	3.50	3.57	3.65	4.5	4.59
Capital Equipment	0.30	0.26	0.00	0.00	0.00	0.00	0.00
Construction	0	0	0	0	0	0	0
Subtotal	3.55	3.10	3.50	3.57	3.65	4.50	4.59
EL-Federal Energy Management Program							
Operating	0.04	0.025	0.05	0.05	0.05	0.05	0.05
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.04	0.025	0.05	0.05	0.05	0.05	0.05
EN-Indian Energy Resources Program							
Operating	0	0.003	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0.003	0	0	0	0	0
EW-Environmental Restoration and Waste Management (Defense)							
Operating	383.37	394.55	369.22	384.99	357.97	329.70	338.63
Privatization	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Purpose Capital Equipment	9.88	5.52	13.18	13.47	13.47	13.76	14.26
Construction	22.89	5.36	13.80	32.34	36.06	29.43	23.51
Subtotal	416.14	405.43	396.20	430.80	407.50	372.89	376.40
EX-Environmental Restoration and Waste Management (Non-Defense)							
Operating	4.82	1.44	0.26	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	12.50	0	0	0	0	0	0
Subtotal	17.32	1.44	0.26	0	0	0	0
FA-Field Operations							
Operating	0	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0
FS-Field Security							
Operating	0	32.08	35.60	35.60	35.60	35.60	35.60
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	32.08	35.6	35.6	35.6	35.6	35.6
GA-Fissile Materials Disposition							
Operating	0.38	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.38	0	0	0	0	0	0
GC-Nonproliferation and Verification Research and Development							
Operating	1.72	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.72	0.00	0.00	0.00	0	0.00	0.00
GD-Nuclear Safeguards and Security							
Operating	1.6	2.20	1.76	1.76	1.76	1.80	1.83
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.6	2.2	1.76	1.76	1.76	1.8	1.83
GG-Worker and Community Transition Program							
Operating	-0.01	5.00	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	-0.01	5	0	0	0	0	0

Table 29. (continued).

GJ-Arms Control and Nonproliferation							
Operating	0.94	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.94	0.00	0	0	0	0.00	0
HA Environment, Safety & Health							
Operating	0.00	0.10	0.00	0.00	0.00	0.00	0.00
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0.10	0	0	0	0.00	0
HC-Environmental, Safety & Health (Non-Defense)							
Operating	0.75	0.44	1.60	1.60	1.60	1.60	1.63
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.75	0.44	1.60	1.60	1.60	1.60	1.63
HD-Environmental, Safety and Health (Defense)							
Operating	0.13	0.15	0.50	0.50	0.50	0.50	0.50
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.13	0.15	0.50	0.50	0.50	0.50	0.50
IN-Intelligence							
Operating	0.87	0.92	0.30	0.30	0.30	0.30	0.30
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.87	0.92	0.30	0.30	0.30	0.30	0.30
KB-Nuclear Physics							
Operating	0	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0
KC-Basic Energy Sciences							
Operating	2.54	2.37	3.25	3.32	3.39	3.46	4.50
Capital Equipment	0.30	0.29	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	2.84	2.66	3.25	3.32	3.39	3.46	4.50
KK-Office of Nuclear Energy							
Operating	0	0.02	0.20	0.20	0.20	0.21	0.21
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0.02	0.20	0.20	0.20	0.21	0.21
KP-Biological and Environmental Research							
Operating	1.76	1.44	2.50	2.55	2.60	2.66	2.72
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	1.76	1.44	2.50	2.55	2.60	2.66	2.72
KX-Office of Energy Res Prog Direction							
Operating	0.00	0.04	0.00	0	0.00	0.00	0.00
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0.04	0.00	0.00	0.00	0.00	0.00
NN-Defense Nuclear NonProliferation							
Operating	0.00	3.18	0.00	0	0.00	0.00	0.00
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	3.18	0.00	0.00	0.00	0.00	0.00
NP-New Production Reactors							
Operating	-0.52	-0.53	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	-0.57	0	0	0	0	0
Subtotal	-0.52	-1.1	0	0	0	0	0
PE-Policy Analysis and Systems Studies							
Operating	0.07	0.06	0.11	0.11	0.11	0.12	0.12
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.07	0.06	0.11	0.11	0.11	0.12	0.12

Table 29. (continued).

SO-Office of Security and Emergency Management							
Operating	0.22	0.30	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.22	0.3	0	0	0	0	0
TA-National Energy Information Sys (NEIS)							
Operating	0	0.02	0.00	0.00	0.00	0.00	0.00
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0.02	0.00	0.00	0.00	0.00	0.00
TR-Scientific and Engineering Training and Development							
Operating	0.13	0.17	0.17	0.17	0.17	0.17	0.18
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.13	0.17	0.17	0.17	0.17	0.17	0.18
VM-International Nuclear Safety & Cooperation/HEU Transparency Implementation							
Operating	0	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0
VR-Federal Energy Regulatory Commission							
Operating	-0.002	-0.001	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	-0.002	0.00	0	0	0	0	0
WB-In-House Energy Management (IHEM)							
Operating	0	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0.29	0	0	0	0	0
Subtotal	0	0.29	0.00	0.00	0	0.00	0
WM-General Administration-Contractual Services							
Operating	0.02	0.08	0.06	0.06	0.06	0.06	0.07
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	0.02	0.08	0.06	0.06	0.06	0.06	0.07
40-Other Federal Agencies							
Operating	81.82	82.07	91.85	82.89	96.35	105.82	108.61
Capital Equipment	0	0.00	0	0	0	0	0
Construction	0	0.00	0	0	0	0	0
Subtotal	81.82	82.07	91.85	82.89	96.35	105.82	108.61
82-Rec. Transfers (Other DOE Fac.)							
Operating	26.22	28.86	27.53	28.65	29.87	31.06	32.3
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	26.22	28.86	27.53	28.65	29.87	31.06	32.3
WPR-Work for Others (Includes Non-AFP)							
Operating	16.26	19.17	20.97	31.68	33.24	34.56	35.40
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Subtotal	16.26	19.17	20.97	31.68	33.24	34.56	35.40
TOTAL FOR PROGRAMS	644.6	671.9	670.3	706.2	702.1	682.2	694.7

Table 30. Personnel by secretarial officer.

(Annualized FTEs)	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Office of Counter Intelligence (CN)							
Operating	6	7	6	6	6	6	7
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Counter Intelligence (CN)	6	7	6	6	6	6	7
Assistant Secretary for Defense Programs (DP)							
Operating	8	6	8	8	8	8	8
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Assistant Secretary for Defense Programs (DP)	8	6	8	8	8	8	8
Assistant Secretary for Energy Efficiency and Renewable Energy (EE)							
Operating	36	39	31	31	31	32	32
Capital Equipment	0	0	0	0	0	0	0
Construction	2	0	0	0	0	0	0
Total Assistant Secretary for Energy Efficiency and Renewable Energy (EE)	38	39	31	31	31	32	32
Assistant Secretary for Environment, Safety, and Health (EH)							
Operating	7	5	7	7	7	7	7
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Assistant Secretary for Environment, Safety, and Health (EH)	7	5	7	7	7	7	7
Assistant Secretary for Environmental Restoration and Waste Management (EM)							
Operating	2,814	2,890	2,417	2,214	2,094	1,864	1,837
Privatization	0	0	0	0	0	0	0
General Purpose Capital Equipment	4	6	4	5	5	5	5
Construction	140	115	117	154	137	105	84
Total Assistant Secretary for Environmental Restoration and Waste Management (EM)	2,958	3,011	2,538	2,373	2,236	1,974	1,926
Assistant Secretary for Fossil Energy (FE)							
Operating	19	16	18	18	19	19	19
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Assistant Secretary for Fossil Energy (FE)	19	16	18	18	19	19	19
Office of Intelligence (IN)							
Operating	2	5	2	2	2	2	2
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Intelligence (IN)	2	5	2	2	2	2	2
Office of Management and Administration (MA)							
Operating	2	1	2	2	2	2	2
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Management and Administration (MA)	2	1	2	2	2	2	2
Office of Fissile Materials Disposition (MD)							
Operating	2	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Fissile Materials Disposition (MD)	2	0	0	0	0	0	0
Office of Nuclear Energy (NE)							
Operating	405	48	27	30	30	30	29
Capital Equipment	0	0	0	0	0	0	0
Construction	15	11	10	9	9	6	5
Total Office of Nuclear Energy (NE)	420	59	37	39	39	36	34

Table 30. (continued).

Office of Nonproliferation and National Security (NN)							
Operating	40	12	9	9	9	9	9
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Nonproliferation and National Security (NN)	40	12	9	9	9	9	9
Office of Naval Reactors							
Operating	0	329	347	343	340	337	334
Capital Equipment	0	1	1	1	1	1	1
Construction	0	4	16	16	16	10	10
Total Director of Office of Navel Reactors (NR)	0	334	364	360	357	348	345
Director for Office of Policy (PO)							
Operating	1	1	1	1	1	1	1
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Director of Office of Policy (PO)	1	1	1	1	1	1	1
Office of Federal Energy Regulatory Commission (RC)							
Operating	1	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Federal Energy Regulatory Commission (RC)	1	0	0	0	0	0	0
Office of Civilian Radioactive Waste Management (RW)							
Operating	1	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Civilian Radioactive Waste Management (RW)	1	0	0	0	0	0	0
Office of Science (SC)							
Operating	33	29	30	30	30	31	31
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Science (SC)	33	29	30	30	30	31	31
Office of Security and Emergency Management (SO)							
Operating	2	15	342	342	332	323	314
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Security and Emergency Management (SO)	2	15	342	342	332	323	314
Office of Worker and Community Transition (WT)							
Operating	0	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Office of Worker and Community Transition (WT)	0	0	0	0	0	0	0
Other DOE Facilities							
Operating	61	57	21	51	45	45	45
Capital Equipment	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0
Total Other DOE Facilities	61	57	21	51	45	45	45
Department of Energy Roll-up							
Operating	3,439	3,458	3,267	3,093	2,956	2,715	2,675
Privatization	0	0	0	0	0	0	0
Capital Equipment	4	7	5	6	6	6	6
Construction	158	130	143	179	162	121	99
SUBTOTAL DEPARTMENT OF ENERGY ROLLUP[a,b]	3,600	3,595	3,415	3,278	3,124	2,842	2,780
(Annualized FTEs)	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**
WORK FOR OTHERS							
National Science Foundation							
Nuclear Regulatory Commission	56	33	24	24	24	24	24
Department of Defense	303	373	294	294	294	294	295
Department of Health and Human Services							
National Aeronautics & Space Administration	4	5	3	3	3	3	4
Environmental Protection Agency	2	2	2	2	2	2	2
Other Federal Agencies:							
Department of the Interior	0	1	0	0	0	0	0
Department of Transportation	7	5	7	7	7	7	7
Other Federal Work	6	5	5	5	5	5	5
Department of Justice							
Private Industry	41	44	38	50	48	48	49
Services (60)	35	48	27	22	20	20	20
CRADAs (65)	14	12	7	9	8	8	8
TOTAL WORK FOR OTHERS	469	527	406	415	411	411	413
INDIRECT PERSONNEL	2,400	2,252	1,700	1,600	1,600	1,600	1,600
TOTAL PROGRAM FTEs[a]	6,469	6,374	5,521	5,294	5,135	4,853	4,793

Note: Values are derived from estimated total expenditures as based in business plan.

Table 31. Funding by secretarial officer.

($ in Millions - BA)	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Office of Counter Intelligence (CN)							
Operating	1.28	1.07	1.04	1.04	1.04	1.30	1.33
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Counter Intelligence (CN)	1.28	1.07	1.04	1.04	1.04	1.30	1.33
Assistant Secretary for Defense Programs (DP)							
Operating	1.20	1.22	2.80	2.85	2.91	2.97	3.72
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	-0.57	0.00	0.00	0.00	0.00	0.00
Total Assisstant Secretary for Defense Programs (DP)	1.20	0.65	2.80	2.85	2.91	2.97	3.72
Assistant Secretary for Energy Efficiency and Renewable Energy (EE)							
Operating	6.97	12.61	8.85	9.03	9.22	10.65	11.48
Capital Equipment	0.30	0.26	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.29	0.00	0.00	0.00	0.00	0.00
Total Assistant Secretary for Energy Efficiency and Renewable Energy (EE)	7.27	13.16	8.85	9.03	9.22	10.65	11.48
Assistant Secretary for Environment, Safety, and Health (EH)							
Operating	0.88	0.69	2.10	2.10	2.10	2.10	2.13
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Assistant Secretary for Environment, Safety, and Health (EH)	0.88	0.69	2.10	2.10	2.10	2.10	2.13
Assistant Secretary for Environmental Restoration and Waste Management (EM)							
Operating	388.19	428.07	405.08	420.59	393.57	365.30	374.23
Privatization	0.00	0.00	0.00	0.00	0.00	0.00	0.00
General Purpose Capital Equipment	9.88	5.52	13.18	13.47	13.47	13.76	14.26
Construction	35.39	5.36	13.80	32.34	36.06	29.43	23.51
Total Assistant Secretary for Environmental Restoration and Waste Management (EM)	433.46	438.95	432.06	466.40	443.10	408.49	412.00
Assistant Secretary for Fossil Energy (FE)							
Operating	3.48	3.19	3.90	3.70	5.15	5.23	5.71
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Assistant Secretary for Fossil Energy (FE)	3.48	3.19	3.90	3.70	5.15	5.23	5.71
Office of Intelligence (IN)							
Operating	0.87	0.92	0.30	0.30	0.30	0.30	0.30
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Intelligence (IN)	0.87	0.92	0.30	0.30	0.30	0.30	0.30
Office of Management and Administration (MA)							
Operating	0.15	0.33	0.23	0.23	0.23	0.23	0.25
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Management and Administration (MA)	0.15	0.33	0.23	0.23	0.23	0.23	0.25
Office of Fissile Materials Disposition (MD)							
Operating	0.38	0.00	0.00	0.00	0.00	0.00	0.00
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Fissile Materials Disposition (MD)	0.38	0.00	0.00	0.00	0.00	0.00	0.00
Office of Nuclear Energy (NE)							
Operating	58.68	11.02	9.28	9.49	9.69	9.72	10.16
Capital Equipment	0.24	1.08	0.00	0.00	0.00	0.00	0.00
Construction	1.65	1.94	5.52	2.56	2.48	2.74	1.41
Total Office of Nuclear Energy (NE)	60.57	14.04	14.80	12.05	12.17	12.46	11.57

Table 31. (continued).

($ in Millions - BA)	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
Office of Nonproliferation and National Security (NN)							
Operating	4.26	3.20	0.20	0.20	0.20	0.21	0.21
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Nonproliferation and National Security (NN)	4.26	3.20	0.20	0.20	0.20	0.21	0.21
Deputy Administrator for Naval Reactors							
Operating	0.00	50.16	50.90	52.00	53.09	54.21	55.34
Capital Equipment	0.00	0.53	0.60	0.50	0.51	0.52	0.53
Construction	0.00	1.00	2.51	2.78	2.67	1.42	2.03
Total Deputy Administrator for Naval Reactors	0.00	51.69	54.01	55.28	56.27	56.15	57.90
Director for Office of Policy (PO)							
Operating	0.07	0.06	0.11	0.11	0.11	0.12	0.12
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Director of Office of Policy (PO)	0.07	0.06	0.11	0.11	0.11	0.12	0.12
Office of Civilian Radioactive Waste Management (RW)							
Operating	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Civilian Radioactive Waste Management (RW)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Office of Science (SC)							
Operating	5.93	6.02	7.75	7.91	8.07	8.72	9.87
Capital Equipment	0.30	0.29	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Science (SC)	6.23	6.31	7.75	7.91	8.07	8.72	9.87
Office of Security and Emergency Management (SO)							
Operating	0.22	2.50	1.76	1.76	1.76	1.80	1.83
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Security and Emergency Management (SO)	0.22	2.50	1.76	1.76	1.76	1.80	1.83
Office of Worker and Community Transition (WT)							
Operating	-0.01	5.00	0.00	0.00	0.00	0.00	0.00
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Office of Worker and Community Transition (WT)	-0.01	5.00	0.00	0.00	0.00	0.00	0.00
Other DOE Facilities							
Operating	26.22	28.86	27.53	28.65	29.87	31.06	32.30
Capital Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Other DOE Facilities	26.22	28.86	27.53	28.65	29.87	31.06	32.30
Department of Energy Roll-up							
Operating	498.77	554.92	521.83	539.96	517.31	493.92	508.98
Privatization	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Program & General Purpose Capital Equipment	10.72	7.68	13.78	13.97	13.98	14.28	14.79
Construction	37.04	8.02	21.83	37.68	41.21	33.59	26.95
SUBTOTAL DEPARTMENT OF ENERGY ROLLUP[a]	546.53	570.62	557.44	591.61	572.50	541.79	550.72
($ in Millions - BA)	**FY 2000**	**FY 2001**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**	**FY 2006**
WORK FOR OTHERS							
Nuclear Regulatory Commission	8.13	5.21	5.00	5.00	5.00	5.00	5.00
Department of Defense	70.51	73.00	82.70	73.67	86.95	96.33	99.03
National Aeronautics & Space Administration	0.62	1.18	0.81	0.82	0.86	0.87	0.90
Environmental Protection Agency	0.39	1.00	0.51	0.52	0.54	0.55	0.56
Other Federal Agencies:							
Department of the Interior	0.07	0.53	0.08	0.08	0.09	0.09	0.09
Department of Transportation	1.14	0.39	1.49	1.52	1.58	1.62	1.65
Other Federal Work	0.98	0.75	1.26	1.28	1.33	1.36	1.38
Private Industry	7.40	6.35	12.07	17.44	18.70	19.71	20.23
Services (60)	6.31	11.59	6.31	10.10	10.31	10.53	10.76
CRADAs (65)	2.55	1.22	2.59	4.14	4.23	4.32	4.41
TOTAL WORK FOR OTHERS	98.10	101.22	112.82	114.57	129.59	140.38	144.01
TOTAL PROGRAM FUNDING	644.63	671.84	670.26	706.18	702.09	682.17	694.73

Appendixes

INEEL at work

Carbon Sequestration

DOE's objective of limiting the environmental impact of energy use requires development of better technologies to remove and manage excess carbon dioxide – a potentially problematic greenhouse gas – from industrial process and exhaust streams. INEEL research is exploring gas control through membrane and centrifugal separation, geological sequestration and bioconversion.

Appendix A

INEEL Selected Collaborations

Appendix A

INEEL Selected Collaborations

Table A-1. INEEL collaborations with DOE laboratories, universities, and private industry enhance capabilities to support DOE missions.

Partner	Title	Description	DOE Mission Area
Pacific Northwest National Laboratory (PNNL)	Advanced Tensiometer	Demonstration of INEEL-developed technology for monitoring water movement in the vadose zone at the PNNL Hydrology group's Buried Waste Test Facility.	Environment
National Renewable Energy Laboratory (NREL)	Air-Cooled Condensers	INEEL and NREL collaboration in modeling and demonstration of advanced concepts to improve the heat exchange efficiency of air-cooled condensers for geothermal binary power plants.	Energy
Oak Ridge National Laboratory (ORNL)	Arrow-PAK Macroencapsulation – Accelerated Site Technology Deployment Project	INEEL collaborated to deploy this system at ORNL. The Mixed Waste Focus Area (MWFA) supported deployment for stabilization of heterogeneous wastes removed from disposal trenches at the Hanford site.	Environment
NETL	Barometrically Enhanced Remediation Technology	NETL Industrial Program technology deployed at INEEL Radioactive Waste Management Complex's Subsurface Disposal Area.	Environment
ORNL	Beneficial Reuse of Contaminated Scrap Metal	INEEL and ORNL collaborated to develop process to melt refine contaminated scrap metal.	Environment
NETL	Bioprocessing High-Sulfur Crudes	INEEL, NETL, UOP (formerly Union Oil and Petroleum) and Texaco collaboration to explore bio-processing of high-sulfur crude at critical fluid conditions using an enzymatic reactor.	Energy
ORNL	Buried Waste Integrated Demonstration	INEEL and ORNL collaborated in development and demonstration of a Remote Excavation System and Rapid Transuranic Monitoring Laboratory.	Environment
Sandia National Laboratory (SNL)	Center for Thermal Spray Research	INEEL and SNL are contributing members of this consortium based at the State University of New York – Stony Brook	Science and Technology

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
Hanford, ORNL, PNNL, UOP Inc.	Cesium Removal Using Crystalline Silicotitanate	INEEL collaborated with PNNL, ORNL, Hanford, and UOP Inc., to develop technology.	Environment
Boise Cascade, BWX Technologies	CFD Modeling, Shape Optimization and Feasibility Testing of Advanced Black Liquor Nozzle Designs	Development and demonstration of advanced black liquor nozzle designs to improve the energy efficiency of recovery boilers for the forest products industry.	Energy
Argonne National Laboratory (ANL)	Characterization of Remote-Handled Waste Drums Using Gamma Spectrometry Combined with Acceptable Knowledge	INEEL and ANL collaborated to develop this system for characterization of Experimental Breeder Reactor II fuel examination waste.	Environment
ORNL	Chemical Analysis Automation	INEEL and ORNL collaborated on hardware and data interpretation software for this system.	Environmental Programs
Pacific Gas & Electric (PG&E) So. Cal Edison	Compressed Natural Gas/Liquefied Natural Gas Fueling Station	INEEL and PG&E, and So. Cal Edison established a memorandum of understanding to demonstrate a CNG Liquefier and a CNG/LNG fueling station in California.	Energy
NREL	Condensation of Mixed Working Fluids	INEEL and NREL collaboration on this Geothermal Technologies Program effort.	Energy
International Process Services, Inc.	Mixed refrigerant	International Process Services, Inc. and INEEL collaboration to develop advanced refrigeration technologies with mixed refrigerant.	Energy
ORNL, Timken Steel, Univ. of British Columbia	Controlled Thermo-Mechanical Processing of Tubes and Pipes for Enhanced Manufacturing and Performance	Development of an intelligent process control system for a new innovative integrated tube mill at Timken Steel.	Energy
University of California at Berkeley, Alcoa	Coolant Characteristics and Control in Direct Chill Castings of Aluminum	Fundamental study of coolant behavior and development of strategies to control cooling rate during the direct chill casting of aluminum ingots.	Energy
SNL	Cross Borehole Electromagnetic Imaging	This SNL-developed technology was demonstrated at the INEEL's Subsurface Disposal Area.	Environment
ORNL, Savannah River Site (SRS)	Crossflow Filtration	ORNL and INEEL collaborated with SRS to develop this technology. The INEEL has demonstrated this technology on actual INEEL high-level waste.	Environment
University of Idaho	Cyber Security	Collaborating with the University of Idaho in cybersecurity.	National Defense

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
DOD, Department of Energy Office of Science and Technology (DOE-OST), Environmental Protection Agency (EPA) Dupont, General Electric, Novartis Zeneca, DOW, Geosyntec	DNAPL Bioremediation	Reciprocal information and technical support for DNAPL Bioremediation activities through DOE representation in the Remediation Technologies Development Forum consortium.	Environment
ORNL	Dual Arm Work Platform	This INEEL-developed technology was deployed during decommissioning of the CP-5 Reactor. INEEL and ORNL collaborated to develop this system that was deployed at ANL.	Environment
NREL	Electric Vehicle Field Operations Program	INEEL and NREL jointly conduct the Field Operations Program. The primary activity is testing advanced technology. Vehicles Technologies include pure electric, internal combustion engines using alternative fuels such as natural gas and hydrogen, and hybrid electric. The hybrid electric vehicles include fuel cell and internal combustion engines. The pure electric vehicles include new classes of small vehicles that the original equipment manufacturers are using to meet California Air Resource Board Mandates.	Energy
U.S. Advanced Battery Consortium	High-Power Batteries	Testing and analysis of high power batteries for hybrid vehicles	Energy
ANL, SNL, LBNL	Advanced technology development for lithium ion batteries	Analysis and diagnostic tools to overcome life and performance limitations of lithium ion battery chemistry	Energy
NETL	GammaCam™ Radiation Imaging System	Technology demonstrated through the INEEL Large-Scale Demonstration and Deployment Project and deployed through the Accelerated Site Technology Deployment Integrated D&D project.	Environment
NREL, SNL	GeoPowering the West	INEEL collaboration with NREL and SNL to provide educational outreach for geothermal electric and direct-use opportunities and technologies.	Energy

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
NETL	Geopressured Reservoirs	INEEL and NETL collaboration to develop, test, and validate an integrated conceptual model for the formation of pressure seals and the accumulation of hydrocarbons near the seal.	Energy
NREL	Geothermal Program	INEEL and NREL collaborate on Energy Systems tasks in the Geothermal Program. These tasks which include development of low-cost field instrumentation for emissions, corrosion and fouling monitoring, off-design operations, and improved materials are directed towards improving the efficiency and reducing costs of geothermal electric power production.	Energy
PNNL, SRS, Western Environmental Technology Office, Univ. of South Carolina, Utah State, VX Oprotronics	HANDS-55	This is an automated system used to open 55-gallon waste drums, inspect, sort and segregate non-compliant items and repackage them to the appropriate waste stream. This system will be deployed at SRS in FY 2003. This project is sponsored by the Mixed Waste Focus Area and the EM-50 Robotics Crosscut Program.	Environment
PNNL, SRS	High-Activity Waste Forms and Processes	INEEL, PNNL, and SRS are collaborating on the development of flowsheets for immobilization of high-activity radioactive waste.	Environment
NETL	Improved Water Flooding	INEEL, University of Wyoming, and NETL collaboration in developing a more complete understanding of the relationship between brine composition, temperature, and crude oil properties on wetability and its effects on oil recovery.	Energy
Amalgamated Research, Inc.	Industrial Membrane Filtration and Short-Bed Fractal Separation System	Development of a new pretreatment system for removing suspended solids via integration of a hybrid membrane filtration system for purification, short-bed chromatographic separation and new ion exchange technology.	Energy
ANL	Innovative Grout (In Situ Stabilization)	This INEEL-developed technology was demonstrated at ANL and ORNL.	Environment
ORNL	Innovative Grout (In Situ Stabilization)	This INEEL-developed technology was demonstrated at ANL and ORNL.	Environment

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
NREL	Institute of Electrical and Electronic Engineers Interconnect standard for distributed power	Institute of Electrical and Electronic Engineers Interconnect standard for distributed power	Energy
American Foundrymen's Society, Utah State University, Tennessee Technological University	Integrated Cupola Control	Development and demonstration of an integrated intelligent industrial sensing and control system for the foundry cupola.	Energy
ORNL	Integrated D&D – Accelerated Site Deployment Project	INEEL and ORNL collaborated to demonstrate and deploy the Oxy-Gasoline Torch and the Personal Ice Cooling System.	Environment
NETL	Large Downhole Seismic Sensor Array	INEEL and industrial partners collaborate in developing a more economic, higher-fidelity, three-component subsurface, seismic survey system to enhance the industries ability to collect and interpret seismic data.	Energy, Environment
SNL	Laser Assisted Arc Welding	INEEL is collaborating with ORNL and SNL to develop a novel laser-assisted arc welding process for the steel industry.	Science and Technology
Hanford, ORNL, SRS	Light-Duty Utility Arm	Collaborated on design and procurement of Light-Duty Utility Arms for Hanford, INEEL, ORNL, and Savannah River sites. Also included technical interchange on design of gripper and waste sampler designs.	Environment
ORNL, PNNL, SRS	Low-Activity Waste Forms	INEEL, ORNL, PNNL, and SRS are collaborating on the development of flowsheets for immobilization of low-activity radioactive wastes resulting from high-level waste treatment and tank closure.	Environment
NETL	Low-Sulfur Cat-Cracked Gasoline	INEEL collaboration with industrial partners to lower the sulfur content of cat-cracked gasoline using an innovative sulfur interception reaction mechanism.	Energy
ANL	Membrane-Supported Particle-Bound Ligands for Cesium Removal	This ANL-developed process was demonstrated at INEEL's Remote Analytical Laboratory and deployed at Test Area North.	Environment
PNNL, SRS	Membrane-Supported Particle-Bound Ligands for Cesium Removal (Empore)	The INEEL, SRS, and PNNL worked together in developing and demonstrating this technology.	Environment

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
NETL	Microbially Enhanced Oil Recovery	INEEL collaboration with Phillips Petroleum to investigate the production and application of surfactants produced from agriculture waste products and their beneficial use to recover oil.	Energy
University of Idaho, J. R. Simplot, Advanced Power Technologies, Baker Process, Inc.	Mine Compatible Laser Analysis Instrument for Ore Grading	Development and demonstration of a robust instrument for the real-time, in-situ analysis of ore during the extraction process.	Energy
ORNL	Modified BROKK Demolition Machine with Remote Console	ORNL and INEEL collaborated to modify and deploy this system to remotely demolish deactivated facilities. Integration of ORNL Compact Remote Operator Console with INEEL deployed BROKK BM 250 Demolition Machine.	Environment
ORNL	Multidetector Analysis System	INEEL and ORNL collaborated to validate detector performance.	Environment
PNNL	Multimetal Continuous Emissions Monitor	MWFA supported demonstration of Massachusetts Institute of Technology-developed continuous emission monitors (CEM) at PNNL.	Environment
SNL	Nuclear Regulatory Commission Human Reliability Systems	INEEL and SNL collaborated to develop and implement techniques for human error rate prediction.	Science and Technology
SNL	OST Robotics Crosscut	INEEL and SNL jointly developed products including the Internal Duct Characterization System, Chemical Analysis Automation, and the Robotics and Intelligent Machines Critical Technology Roadmap.	Environment
ANL, Fernald	Oxy-Gasoline Torch	Technology demonstrated through the INEEL Large-Scale Demonstration and Deployment Project and deployed through the Accelerated Site Technology Deployment Integrated D&D project.	Environment
PNNL, Private Vendor, SRS	Passive Soil Vapor Extraction	System enhancements to technology developed by SRS, PNNL, and private vendor demonstrated at INEEL's Subsurface Disposal Area.	Environment
SNL	Performance Assessment for Disposal of INEEL Spent Nuclear Fuel	INEEL and SNL collaborated to develop this performance assessment to support future disposal decisions.	Environment
NETL	Pipe Explorer™ Surveying System	NETL Industrial Program technology demonstrated at the INEEL's Idaho Nuclear Technology and Engineering Center.	Environment

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
PNNL	Planar In Situ Vitrification	Collaboration with PNNL and private vendor in treatability studies for deployment of in situ vitrification (ISV) for stabilization of underground tanks at INEEL's Test Area North.	Environment
NETL	Pore Pressure Prediction	INEEL collaboration to determine the applicability of mud pulses as a downhole seismic source for look ahead of the bit pore pressure collection	Energy
NETL	Portable Analyzer for Chlorinated Compounds	NETL Industrial Program technology deployed by INEEL ER program for monitoring of well-head gas vapor.	Environment
Case New Holland	Precision Agriculture	Development of autonomous vehicle technology for the agriculture industry.	Energy
NETL	Pulsed Gamma Neutron Activation Analysis System for the Assay of RCRA Metals in Mixed Waste	NETL Industrial Program technology supported by the INEEL-managed Mixed Waste Focus Area.	Environment
ORNL	Reduced Access Characterization System	INEEL-configured system was demonstrated at ORNL	Environment
SNL	Remote Control Monitoring of Nuclear Materials	INEEL and SNL collaborated to demonstrate remote monitoring of special nuclear materials at ANL-W.	Environment, Energy
ORNL	Remote Viewing System	INEEL and ORNL collaborated on the development of viewing systems used during the Light-Duty Utility Arm deployments.	Environment
PNNL	Resonant Sonic Drilling	Deployment of PNNL-enhanced commercial technology for placement of boreholes for characterization of INEEL's Subsurface Disposal Area (Pit 9).	Environment
NETL	Robotic Tank Inspection End Effector	NETL Industrial Program technology deployed using the INEEL Light-Duty Utility Arm in Idaho Nuclear Technology and Engineering Center High-Level Waste Tank WM-188.	Environment
NETL, PNNL	Robotic Tank Inspection End Effector	Collaboration to demonstrate and deploy technology.	Environment
Carnegie Mellon University, Joy Mining Machinery, Consol, Inc.	Robotics Technology for Improved Mining Productivity	Deployment of sensors and advanced control architectures on underground mining equipment.	Energy

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
SNL	Segmented Gate System	This SNL-developed technology was deployed at INEEL's Waste Reduction Operations Complex/Power Burst Facility (WROC/PBF) Area.	Environment
Idaho Department of Water Resources, Idaho Wheat Commission, Inland Northwest Research Alliance (INRA)	Selective Harvest of Higher Value Wheat Straw Components	Development of a system to preprocess and pretreat wheat straw to make a more desirable feedstock for combustion and for straw-thermoplastic composite production.	Energy
ORNL	Small Pipe Characterization System	This INEEL-developed system was demonstrated by the ORNL Robotics Technology Assessment Facility	Environment
SNL	Spent Nuclear Fuel Cost Analysis and Risk Tool	INEEL's National Spent Nuclear Fuel Program and SNL collaborated to develop this tool for safe and timely management of spent nuclear fuel.	Environment
University of California at Irvine, Colorado School of Mines, Alcoa, Pechiney, Inductotherm	Spray Rolling Aluminum Strip	Development of spray rolling technology for the aluminum industry.	Energy
PNNL, University of Arizona	Stabilization of High-Salt Waste using Sol Gel Process	MWFA treatability study using process developed by PNNL and University of Arizona.	Environment
ANL	Stabilization using Phosphate-Bonded Ceramics	This ANL-developed process demonstrated for stabilization of waste experimental flyash.	Environment
NETL	Surface Acoustic Wave/Gas Chromatography System for Trace Vapor Analysis	NETL Industrial Program technology deployed by INEEL ER program for routine monitoring of well-head gas vapor.	Environment
Idaho State University	The Idaho Accelerator Center (IAC)	INEEL is involved with LDRD and programmatically funded work at the IAC. Work being performed under 5-year Memorandum of Understanding between Idaho State University and DOE-ID.	National Defense
PNNL	Thermal Denitration	INEEL and PNNL collaborated to develop this technology to condition low-activity waste for immobilization.	Environment
University of Utah, Barrick Goldstrike Mines, Kennecott Copper, Process Engineering, Inc.	Three-Dimensional Simulation of Charge Motion in Semi-autogenous Grinding and Ball Mills for Energy Efficiency	Development and demonstration of an accurate predictive model for the calculation of energy consumption of high-capacity, semiautogenous grinding mills.	Energy

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
ANL, Fernald	Track-Mounted Shear/Crusher	Technology deployed through the Accelerated Site Technology Development Integrated D&D project.	Environment
Hanford, ORNL	Transuranic Nondestructive Analysis	Technical support of transuranic nondestructive analysis activities at the Hanford Waste Reduction and Processing facility.	Environment
PNNL	Transuranic Extraction and Strontium Extraction Systems	INEEL and PNNL information exchange in respective high-level waste programs.	Environment
NETL	Ultraclean Fuels – Alkylation	INEEL and Marathon Ashland collaboration to test supercritical regeneration of fouled solid-acid alkylation catalysts.	Energy
NETL	UltraClean Fuels – Ceramic Membrane Reactor	INEEL collaboration with ITN Energy Systems to develop a single reactor that combines separation of oxygen from air and partial oxidation of hydrocarbons.	Energy
NETL	Vision 21 – Hydrogen Separation Membrane	INEEL collaboration with ITN Energy Systems to develop a ceramic membrane that selectively allows hydrogen to diffuse through the membrane for use in advancing Fischer-Tropsch processes.	Energy
NETL	Vortex Tube Design & Demonstration for CO_2 Separation	INEEL collaboration to develop an improved CO_2 sequestration module using vortex tubes and a scrubbing solution.	Energy
NETL	Waste Inspection Tomography	NETL Industrial Program technology deployed at the INEEL's Stored Waste Examination Pilot Plant.	Environment
ANL	X-Ray Fluorescence Spectrometry for Real-Time Monitoring of Slag Phase	This ANL-developed system was demonstrated during operation of the Plasma Hearth Process at the INEEL.	Environment
NREL	Yellowstone Park Bechler Entrance Solar Project	INEEL and NREL are providing design assistance for a photovoltaic power system for the Yellowstone National Park Bechler entrance	Energy
University of Iowa, U.S. Geological Survey, DOE-ORNL, and Idaho State University	Fossil Energy Bioresearch	Collaborative research efforts at each institution to further the understanding of microbial carbon sequestration and improved fossil energy recovery and utilization	Environment and Energy

Table A-1. (continued).

Partner	Title	Description	DOE Mission Area
NREL	Interconnect Standards Development	INEEL and NREL collaborate on the development of standards for the interconnection of distributed power generation sources to regional and national electric power transmission grids. Consistent standards are needed to lower the cost of interconnection and to ensure the reliability of the transmission grid.	Energy
MTI	Diesel Auto Thermal Reforming	INEEL collaboration with MTI to demonstrate large stationary hydrogen production platform	Energy
University of California at Irvine	Development and Demonstration of Advanced Tooling Alloys for Molds and Dies	Development and demonstration of advanced tooling alloys for molds and dies that take metallurgical advantage of the rapid solidification benefits of the INEEL's Rapid Solidification Process Tooling technology.	
Colorado State University, North American Die Casting Association	Integration of Rapid Solidification Process Tooling with Rapid Prototyping for Die Casting Applications	Development of hardware and software for the integration of the INEEL's Rapid Solidification Process Tooling technology with commercial rapid prototyping technology.	Energy
Iowa State University, University of Idaho, CNH Global	Multi-component Harvesting Equipment for Inexpensive Sugars from Crop Residues	Development and demonstration of agricultural harvesting equipment for cost-effective separation of crop residues for producing inexpensive sugars for bioenergy/bioproduct applications	Energy

Appendix B

Current INEEL Programs

Appendix B
Current INEEL Programs

Below is a brief description of current Idaho National Engineering and Environmental Laboratory (INEEL) programs, categorized by the four Department of Energy (DOE) mission areas. Also included are examples of the INEEL's Laboratory-Directed Research and Development (LDRD) and Technology Transfer programs.

Environmental Programs

In its role as DOE's lead Environmental Management (EM) laboratory, the INEEL manages or co-manages the DOE Office of Science and Technology's (EM-50) Research and Development (R&D) Environmental Restoration, Waste Management, Spent Nuclear Fuel, and High-Level Waste programs.

EM Science and Technology Program

The INEEL serves EM-50 through managing national programs and supporting R&D for INEEL/DOE operations.

Management of National Programs

EM-50 programs managed by the INEEL include:

- Transuranic and Mixed Waste Focus Area
- EM Science
- Accelerated Site Technology Deployment
- Robotic and Intelligent Machines (Mixed Waste Division)
- Nuclear Materials Focus Area.

These R&D programs support EM throughout the DOE complex. Addressing and resolving technology needs associated with completing the DOE cleanup mission, these programs range from basic science to technology development, demonstration, and deployment. The INEEL also performs directed R&D for EM-50. Examples of ongoing directed research include waste immobilization, characterization, and handling of transuranic wastes; decommissioning and decontamination technologies; safe storage of spent nuclear fuel; nondestructive assay for Resource Conservation and Recovery Act (RCRA) metals in mixed waste, transuranic waste transportation and repackaging, subsurface contamination technology deployments, bioremediation R&D, high-level waste treatment, tank farm sampling technologies, and decontamination and decommissioning (D&D) large-scale demonstration. Below are examples of EM-50 technology development projects.

Modified BROKK Demolition Machine with Remote Control

The Modified BROKK Demolition Machine with Remote Console enhances the capabilities of a commercially available BROKK BM 250 demolition machine by the addition of an INEEL-developed remote viewing system and fiber optic control tether. The BROKK machine and INEEL-developed viewing system controls are integrated using the Oak Ridge National Laboratory developed Compact

Remote Operator Console. The Modified BROKK Demolition Machine with Remote Console extends the utility of the BROKK demolition machine to applications where exposure to radiological, chemical, or industrial hazards precludes line-of-sight operations by allowing operators view the work area and control the BROKK machine from a remote console.

Two INEEL areas, Robotics and Deactivation, Decontamination and Dismantlement, and sister laboratory Oak Ridge National Laboratory worked together to test and demonstrate the modified BROKK Demolition Machine with remote console at the INEEL Security Training Facility D&D Project (Experimental Organic Cooled Reactor). This demonstration is an example of how robotics is helping the INEEL and DOE in the D&D area to:

- Reduce hazards to people
- Reduce secondary waste
- Improve productivity by reducing cost and increasing operator efficiency
- Reduce technical risk by gradually introducing new technologies, thus allowing greater acceptance of more sophisticated technologies.

The two DOE laboratories developed the project 3 months ahead of schedule and under budget.

Enhanced Bioremediation at Test Area North

Under the Environmental Restoration Program, the enhanced bioremediation project at TAN is successfully remediating the trichloroethylene plume in the deep fractured rock. The bacterial processes developed at the laboratory will break down the trichloroethylene into the harmless constituents ethene and ethane. The enhanced bioremediation technology replaces a much less effective "pump-and-treat" approach. With this technology deployment, remediation time is greatly reduced due to faster degradation of the trichloroethylene; no secondary waste streams are generated because the contaminants are transformed or immobilized in place; worker exposure is reduced compared to the "pump and treat" technologies; and the estimated life-cycle cost savings is $14 million.

The "Fractured Rock Science Team" and WAG 1 project developed a multidisciplinary approach to understanding and remediating the subsurface environment. Researchers from the laboratory, other national laboratories, and universities used basic geochemistry and microbiology to characterize the aquifer and demonstrate that certain existing microbial communities degrade trichloroethylene. Methanotrophic bacteria, those that degrade methanol, are abundant in the subsurface at TAN. These bacteria can also degrade trichloroethylene. Other microbes in the TAN subsurface use phenol as a source of energy by employing certain enzymes to break open and degrade the chemical ring. These same enzymes can also degrade trichloroethylene. The researchers determined that these microbes exist in higher concentrations close to the injection well and are present at least a kilometer distant.

Advanced Tensiometer

The advanced tensiometer developed by the Integrated Earth Science Department now measures soil water potential at several locations. Soil water potential, an important variable in soil water and chemical transport, indicates how tightly water is held by soil or rock and is related to moisture conditions in the soil. Conventional mechanical tensiometers used to measure soil tension are limited by their design to shallow depths. The advanced tensiometer was demonstrated at various locations including the INEEL and PNNL. After several successful demonstrations, advanced tensiometers were deployed at:

- Oak Ridge National Laboratory Bear Creek Drainage
- Savannah River Site E-Area disposal trenches
- RWMC Subsurface Disposal Area (WAG 7).

The advanced tensiometer deployed at INEEL's RWMC site enabled water and contaminant movement model calibration for the deployment area.

Portable Isotopic Neutron Spectroscopy

The INEEL Nuclear Technology and Engineering Center Remediation project required a way to identify the contents of discarded gas cylinders before they could be removed from a buried waste site. The project turned to an INEEL product known as Portable Isotopic Neutron Spectroscopy to avoid the time-consuming and potentially dangerous task of manually sampling the containers. This product is a portable piece of equipment, which scans a suspect container by using gamma ray spectra induced by neutrons to identify the elements in container materials without having to open the container.

The technology had been used successfully to characterize old military bunkers and abandoned artillery shells, but have never been used in an environmental application until called on to help characterize old gas cylinders at a buried waste site near INTEC.

Integrated Waste Tracking System

The Integrated Waste Tracking System is used to manage radioactive and hazardous waste throughout the entire lifecycle from waste declaration to disposal. This includes the tracking of waste during generation, treatment, storage, transport, and disposal. The system provides all information necessary for facilities to properly manage and demonstrate inventory compliance with the Resource Conservation and Recovery Act (RCRA) regulations, DOE Order 435.1, State permits, and facility-specific Safety Analysis Report requirements. As a platform-independent, client-server and Web-based, inventory and compliance system, the Integrated Waste Tracking System has been proven as a successful tracking and reporting tool to meet the needs of both operations and management.

With data-driven functionality, client and Web-based reporting, and remote access, the Integrated Waste Tracking System provides a high level of flexibility in the management of waste for any facility.

Environmental Systems Research and Analysis Program

The INEEL conducts environmental research under the Environmental Systems Research portion of the Environmental Systems Research and Analysis Program. This program is a directed research program to strengthen the INEEL's long-term science base and solve complex DOE problems. During FY 2001 the program was modified significantly to reflect INEEL major initiatives of which two, Subsurface Science and Advanced Waste Management Solutions reflect major EM concerns. The Environmental Systems Research and Analysis Program's subsurface science activity includes the following.

Mesoscale Investigations of Vadose Zone Carbon Cycles

Long-term stewardship of DOE lands requires understanding the fate of contaminants released to the vadose zone by past waste disposal practices. The soil-zone carbon cycle is integral to this understanding, as it links soil moisture, microbial activity, soil water pH buffering, and retardation of contaminants. The laboratory will conduct studies to define constitutive and thermodynamic relations between soil moisture, carbon dioxide, and contaminant transport. Key relations will be microbial activity and wetted surface area as a function of soil moisture content, and thermodynamic relations between adsorbed and dissolved species as a function of pH and carbon dioxide concentration. A flow-through centrifuge will be used in laboratory experiments to measure hydraulic properties to establish parameters for constitutive relations. Batch and automated titrator experiments will develop thermodynamic parameters for adsorption. The INEEL will test hypotheses with data collected from mesoscale columns where coupled processes can be studied simultaneously. Validated hypotheses will be included in predictive computer models that can support decision-making for operations.

"Next Generation" Predictive Models of Vadose Zone Flow and Transport

The laboratory's long-term goal is to develop new algorithms for predicting flow and transport based on chaos theory or a solution from complex systems theory (cellular automata, artificial neural networks, etc.). New algorithms will advance understanding of fundamental physical and hydrological multiscale processes needed for defining the constitutive relations of vadose zone fate and transport modeling. This work will lead to the next generation of models for vadose zone flow and transport and will address a variety of DOE needs relating to effective and efficient characterization, monitoring, prediction, remediation, and restoration of contaminated sites.

In the short-term, the goal is to collect data sets of sufficient quality to demonstrate and prove that the conventional approach used to formulate predictive vadose zone models is in many cases flawed because subsurface environments are complex entities in the strict mathematical sense (INEEL Subsurface Science Initiative, 2000). The inappropriate use of deterministic conceptual models of the subsurface has led to great uncertainty in transport calculations and has created problems in selecting final remediation strategies at several DOE sites. A new conceptual model of vadose zone transport is needed. In the vadose, the nonlinear feedback between a host of parameters (e.g., moisture content, hydraulic conductivity, spatial variability, hysteresis, etc.) must be recognized in order to make significant improvements in the ability to *reliably* predict contaminant transport. By recognizing the inherent reality that vadose zone flow and transport exhibit chaotic behavior, the new algorithms will significantly improve the ability to determine what is predictable about the flow and transport behavior and thus could have a significant effect on the regulatory process.

A series of coupled laboratory, small field-scale, and computer experiments to achieve three overarching goals during the 3-year project are proposed:

- Characterize the causes and controls of nonideal behavior in vadose zone flow and transport, including the nonlinear feedback among variables

- Develop generalizations, categorize common characteristics, and define associative relationships that lead to emergent patterns in real-world vadose zones

- Generate a *new* conceptual model of vadose zone transport that accounts for feedback between transport variables and an alternative mathematical approach that better represents the effects of uncertainty and nonideal behavior in vadose zone transport.

Spatial and Temporal Characterization of the Vadose Zone

This 3-year project coordinates interdisciplinary research at INEEL to improve our understanding of processes that affect contaminant transport and to develop tools for using this knowledge to accurately predict and monitor the movement and transformation of contaminants in the vadose zone. Four hypotheses are suggested for testing. Task 1 will develop tools to interpret vadose zone flow and to examine chemical concentration characterization. Task 2 will apply INEEL exfiltrometer to describe the spatial variability of unsaturated hydraulic properties. Task 3 will discuss the incorporation of soil physical measurements to better constrain the geophysical inversion problem. Task 4 will suggest an approach to identify the mechanisms and evaluate the effects of enhanced infiltration at the soil surface (through ponding at topographic lows) and within the subsurface (funnel flow caused by heterogeneities at the sediment/basalt interface) on contaminant transport in the subsurface.

Geomicrobiology of Subsurface Environments

This project investigates relationships between bulk-scale (g-Kg or ml-L) biological, chemical, and physical heterogeneities in the subsurface to allow development of predictive knowledge of contaminant fate and transport. Microorganisms are the primary agents of geochemical change in the subsurface, and these changes mediate transport phenomena. This research integrates microbial transport and partitioning with the effects of metabolic transformation of contaminant compounds, the importance of wettability of aquifer materials in contaminant degradation and distribution and the effect that microorganisms play in that process, and the determination of how key aquifer chemical constituents can structure significant microbial communities. Endpoint applications of this work include remediation of contaminated geologic media at DOE sites and facilities nationwide and industrial sites throughout the world, as well as agriculture, mining, resource recovery (energy), aquifer contamination, and waste disposal.

Interfacial Processes Controlling Fate and Mobility of Actinides, Fission Products, and Other Contaminants

This research is designed to evaluate equilibrium and reversibility under conditions of variable contaminant contact time, hydration, colloid content, and ligand complexation. The objective is to determine when it may be important to include nonideal chemical interactions in order to account for contaminant transport in porous media. The project will attempt to correlate nonideal behavior with analysis of chemical speciation as a function of time and space. This correlation will not only help to develop fundamental understanding of nonideal behavior, but should be a valuable tool in deciphering the history of in-place contaminants and approaches to remediation (changing mobility or inducing chemical transformation). The project will use advanced surface speciation determination approaches based on secondary ion mass spectrometry instrumentation unique to INEEL and solution phase speciation strategies based on optical and mass spectrometric techniques. The research is designed to run for three years, which will allow evaluation of equilibrium and reversibility over time scales relevant to subsurface processes.

Correlation of speciation with equilibria and reversibility will enable mobility results and causes at the bench scale to be directly compared with larger-scale observations. The approach will overcome key deficiencies relating to understanding equilibria and reversibility, which is required if improvements in modeling ability are to be realized. Concurrent development of advanced speciation methods will result in approaches broadly applicable to characterization of widely ranging contaminated environmental and waste form materials.

Waste Management Science

Nondestructive Assay

The overall objective of this program is to conduct basic and applied research that will lead to advancements in the science of nondestructive assay (NDA), as a major tool to support INEEL and DOE complexwide programs. This is a multifaceted program wherein several aspects of NDA technology are being pursued in parallel. The proposed scope includes basic research into the physics of fission, developing advanced data acquisition and analysis methods directed toward high count rate applications, developing radiation transport calculation methods adapted to more accurately interpret NDA data, developing prototypical assay units, and conducting field demonstration experiments. The application areas that will benefit from this research are characterization of spent nuclear fuel, characterization of contact-handled and remote-handled transuranic waste, in situ characterization of buried nuclear waste, field surveys of D&D and RCRA sites, detection of contraband and nuclear smuggling, and industrial process control.

Nuclear Structure Research

The INEEL and DOE require accurate NDA methods to identify, quantify, monitor, and remediate waste. In particular, there is a need to identify and assay the contents of mixed/low-level/transuranic waste and to locate and characterize subsurface contaminants and objects. This project addresses these issues and assists in enhancing INEEL's basic science culture and it's partnering collaborative efforts with universities and other national laboratories. This is being accomplished by focusing on the following four key research areas:

- Identifying and providing radionuclide decay data needed to support INEEL environmental/waste, spent fuel, and reactor operations missions
- Developing improved, faster, and less costly methods of fissile assay for drums, boxes, and waste disposal sites containing transuranic waste via prompt gamma rays from (alpha,n) and (alpha,p) reactions
- Measuring inelastic and capture gamma-ray production rates for neutron interrogation and prompt gamma neutron activation analysis so that Monte Carlo codes can more accurately reflect actual physical processes
- Developing calculational methods to support the first three areas.

This research will increase understanding of microbiologically induced corrosion and how it effects the stability of spent nuclear fuel.

The plan is to implement newly developed techniques that can spatially discriminate specific electrochemical channels, and to correlate positional information with the presence or absence of a biological component. This is imperative to providing definitive evidence for biocorrosion. The laboratory will focus on the problem of transferring spent nuclear fuel from interim wet storage to vented dry storage. In particular, the INEEL will address issues relating to desiccation, radionuclide sequestration within biofilms, and aerosol formation. The success of this proposal will be measured by how it addresses each of the aforementioned Site Technology Coordination Group needs.

Environmental Restoration Program

The Environmental Restoration Program is responsible for remediating all of the laboratory's contaminated sites in accordance with CERCLA and the FFA/CO. The INEEL was placed on the National Priorities List in 1989. In 1991, DOE, EPA, and Idaho signed the FFA/CO under CERCLA to ensure that environmental hazards associated with contaminant releases are identified and remediated. Currently, 389 release sites and 307 contaminated facilities have been identified. Activities associated with High-Level Waste and nuclear operations are co-located with some of the identified release sites and contaminated facilities. Consequently, remediation and/or facility decontamination and dismantlement schedules depend on completion of those projects.

In the last decade, INEEL has completed 21 environmental investigations. Three additional investigations are in progress. To date, eight of ten comprehensive Records of Decision have been signed.

The remedial investigations and feasibility studies continue for the RWMC, INTEC tank farm, and Snake River Plain Aquifer.

The INEEL is divided into 10 WAGs composed of 98 Operable Units (OUs). INEEL WAGs are described in Appendix C.

The laboratory will complete ongoing remediation activities in three of the 10 INEEL WAGs by FY 2006. Long-term groundwater pump-and-treat operations will continue through 2025 at TAN (WAG 1). Cap construction and long-term monitoring and maintenance will continue at the Idaho Nuclear Technology and Engineering Center WAG 3. Two sites at the Test Reactor Area co-located with operational facilities will be remediated in 2035 after operations are completed. The Transuranic Waste Pits and Trenches (WAG 7) Project has significant remediation work to complete after FY 2006. D&D of surplus facilities will continue through 2044.

Under the Environmental Restoration Program, the enhanced bioremediation project at TAN is successfully remediating trichloroethylene contamination in the deep-fractured rock. The one-year study is the largest bioremediation test of its kind in the United States. The bacterial processes, developed at the INEEL, will break down the trichloroethylene into the harmless constituents ethene and ethane. This technology is replacing a much less effective “pump-and-treat” approach.

The laboratory D&D Program dispositions surplus facilities located at TAN, TRA, INTEC, CFA, Power Burst Facility (PBF), Auxiliary Reactor Areas (ARAs), and the reactor experimental areas located near the RWMC. While D&D at Argonne National Laboratory-West and the Naval Reactors Facility (NRF) is accomplished by a separate effort, the INEEL D&D Program does interface with Argonne and NRF D&D Programs to share technology and planning. Of INEEL’s original 45 surplus, contaminated facilities, 27 have been decommissioned to date. In the last 4 years the D&D Program has demolished more than 100 buildings and structures. Over 200 INEEL facilities are scheduled to undergo some type of D&D in the next decade.

D&D Program activities for surplus facilities encompass radiological, chemical, and physical characterization; decision analyses, which guide the selection of preferred D&D alternatives; detailed project planning for D&D performance and disposition of waste streams; and establishment and maintenance of project documentation. In addition, the D&D Program addresses the requirements for surveillance and maintenance of contaminated surplus facilities. The INEEL’s D&D Program includes:

- Surveillance and maintenance of contaminated surplus facilities waiting for decommissioning
- Implementing a structured decommissioning program in compliance with legal requirements
- Conducting cost-effective and priority-based decommissioning activities on a long-term basis
- Identifying and making available surplus materials, equipment, facilities, and property for potential reuse.

Examples of INEEL environmental restoration technology and development needs include in situ debris characterization for partial retrieval, in situ treatment of volatile organic compound-contaminated groundwater in saturated and unsaturated deep-fractured rock, pretreatment of explosives-contaminated soil for biological remediation, and instrumentation to precisely locate subsurface utilities and stainless steel piping.

Waste Management Programs

The INEEL's Waste Management Waste Programs provide the leadership to treat, store, and dispose of radioactive, hazardous, and industrial wastes generated or stored at the laboratory in a safe, cost-effective, and environmentally sound manner. The program manages waste types including:

- Transuranic and transuranic-contaminated mixed waste
- Low-level and mixed low-level waste
- Hazardous waste
- Industrial/sanitary waste.

The INEEL's activities center on managing waste from previous, current, and future operations to avoid further contamination that may impact human health, safety, or the environment. Each of the INEEL's major waste streams is managed with aggressive waste minimization, treatment, storage, and disposal practices. Packaging and transportation services are provided to ensure the safe and compliant transportation of all site-generated waste. Environmental monitoring of waste management facilities is provided to ensure that the performance of waste management activities does not result in impacts to the environment and is in compliance with applicable rules, regulations, and permits.

Transuranic-contaminated wastes are stored at the RWMC. The INEEL is currently retrieving, characterizing, certifying, and shipping waste to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. As of October 1, 2001, over 817 m^3 of transuranic waste has been shipped to WIPP. Additional characterization and transportation capabilities have been implemented to achieve the necessary levels of throughput to meet the Settlement Agreement milestone. By December 31, 2002, a total of 3100 m^3 of waste will be shipped to WIPP.

Construction of the Advanced Mixed Waste Treatment Facility was initiated in August 2000. The facility is a privatized facility that will begin transuranic waste characterization and treatment operations in 2003 to ship the remaining stored contact-handled transuranic waste to WIPP by a target date of December 31, 2015, and no later than December 31, 2018, to meet Settlement Agreement milestones.

Capabilities to retrieve, characterize, certify, and transport stored remote-handled transuranic waste to WIPP are currently being developed. Shipment of remote-handled transuranic waste to WIPP will be completed no later than December 31, 2018.

Hazardous wastes are shipped to commercial treatment and disposal facilities as the waste is generated. Hazardous waste is only stored for the purpose of accumulating sufficient quantities for shipment. Industrial and sanitary wastes are collected onsite and routinely disposed at the CFA landfill.

Spent Nuclear Fuel

Spent Nuclear Fuel activities at INEEL are performed under two programs: the National Spent Nuclear Fuel Program and the INEEL Spent Nuclear Fuel Program. Each program supports the mission of safe storage and ultimate disposition of DOE spent nuclear fuel, supporting different objectives to meet that mission. The National Spent Nuclear Fuel Program addresses DOE nationwide issues and coordinates the DOE approach to ensuring ultimate DOE spent nuclear fuel disposition. The INEEL Spent Nuclear Fuel Program manages the spent nuclear fuel operations and ensures safe storage at the INEEL and Fort St. Vrain in Colorado.

National Spent Nuclear Fuel Program. INEEL supports the DOE Office of Nuclear Material and Spent Fuel as the lead laboratory for the National Spent Nuclear Fuel Program in accordance with the Settlement Agreement between the State of Idaho, DOE, and the U.S. Navy. This program performs research and provides technology solutions and guidance to DOE sites managing spent nuclear fuel for safe fuel handling, characterization, storage, transportation, and disposal. In addition, the National Spent Nuclear Fuel Program is directly responsible for including DOE spent nuclear fuel in the proposed national repository system. It also provides the analyses and research necessary to ensure DOE spent nuclear fuel is addressed during the repository license application process.

The National Spent Nuclear Fuel Program addresses common research and technology development needs identified by the DOE spent nuclear fuel sites to support them in accomplishing their mission and objectives. Examples of the spent nuclear fuel technology development work include an advanced nondestructive assay system to validate spent nuclear fuel characterization data and a transportation cask system and standardized canister to store and transport more than 250 types of DOE fuel. Other examples include remote welding and nondestructive examination for quality verification of spent nuclear fuel canister closure welds and advanced neutron absorbers to address criticality safety under long-term storage conditions. The program also performs materials analysis, spent nuclear fuel release rate studies, and chemical reactivity evaluations of uranium metal spent nuclear fuel.

The program coordinates and integrates issue resolution to prepare disposition of DOE spent nuclear fuel. It also retains quantitative isotopic and other characterization information on all DOE spent nuclear fuel types. The program provides quality assurance certification of the DOE complex spent nuclear fuel programs through the following:

- Total system performance assessment of DOE spent nuclear fuel on the repository design
- Design basis event analysis of repository preclosure safety basis events
- Criticality analysis of DOE spent nuclear fuel in the repository over the license period
- Guidance to the DOE sites in preparing their spent nuclear fuel to meet the repository acceptance criteria
- Release rate testing to verify the DOE spent nuclear fuel performance used in the various analyses.

INEEL Spent Nuclear Fuel Program. The Spent Nuclear Fuel Program's role is to safely manage, store, prepare, and dispose of all DOE-owned spent nuclear fuel assigned to the INEEL by 2035 in accordance with the Settlement Agreement. This role includes conditioning, characterizing, and packaging, as required. The laboratory's spent nuclear fuel inventory includes spent nuclear fuel presently at the INEEL and at Fort St. Vrain in Colorado, spent nuclear fuel that will be received from DOE and commercial research reactors, and spent nuclear fuel received from foreign countries. The INEEL's strategy for spent nuclear fuel is as follows:

- Resolve existing vulnerabilities associated primarily with storage of spent nuclear fuel in outdated underwater storage facilities
- Prepare and store INEEL-assigned spent fuel in consolidated, onsite, interim dry storage
- Prepare spent fuel for offsite disposal at a monitored retrievable storage facility or federal repository.

Ongoing activities include:

- Safe and efficient operation of the existing spent nuclear fuel storage facilities, while transferring all spent nuclear fuel from the underwater storage facilities and consolidating it at two INEEL dry storage sites (INTEC and Test Area North).

- Receipt of spent nuclear fuel from foreign research reactors and domestic sources in accordance with the Records of Decision.

- Construction of additional dry storage and packaging under Nuclear Regulatory Commission licenses, to prepare and package the spent nuclear fuel in a road ready condition for shipment out of Idaho.

- Development of the appropriate technologies, spent nuclear fuel information, and program systems for the INEEL spent nuclear fuel inventory.

- Safe and efficient operation of the Fort St. Vrain spent nuclear fuel storage facility in Colorado.

High-Level Waste Program

The High-Level Waste Program was formed to manage, treat, store, and dispose of DOE radioactive liquid waste, high-level solid (calcine) waste, contaminated mixed debris, and high-efficiency particulate air (HEPA) filters stored at INTEC. The High-Level Waste Program's mission is the ultimate disposition of DOE radioactive liquid waste, high-level solid (calcine) waste, contaminated mixed debris, and HEPA filters according to legal and regulatory requirements. The program's planning, scheduling, and execution of technology development, projects, and activities comply with the *Site Treatment Plan*, Notice of Noncompliance Consent Order, and Settlement Agreement and will comply with the future Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (High-Level Waste Environmental Impact Statement) Record of Decision. The program actively interfaces with other INEEL organizations as required to integrate activities and to develop technologies, processes, and facilities to meet required goals and milestones.

The strategy of the High-Level Waste Program is to manage waste at INTEC in a safe, regulatory compliant, and cost-effective fashion. Additionally, particular attention will be given to pollution prevention measures and stakeholder acceptance of elements of the strategy. The specific strategy for INEEL's future management of high-level waste depends upon the High-Level Waste Environmental Impact Statement and subsequent Record of Decision. A specific treatment or series of treatments will be selected and implemented based on the Record of Decision. The end objective is to treat all INEEL high-level waste so that it is ready to be moved out of Idaho for disposal by 2035.

The specific strategy for managing sodium-bearing waste is to continue the operation of the tank farm to store the waste. The liquid waste volume continues to be reduced by evaporation with the High-Level Liquid Waste Evaporator and Process Equipment Waste Evaporator, and operation of the Liquid Effluent Treatment and Disposal facility. Volume reduction is necessary to cease use of the pillar and panel vaulted tanks by 2003 and the rest of the tanks by 2012, as well as the eventual closure of the existing tank farm. Liquid waste minimization for the processes mentioned, as well as for debris treatment and filter leach, is essential to this effort. Newly generated liquid waste will not be accepted in the tank farm after 2005. The process selected by the High-Level Waste Environmental Impact Statement Record of Decision will treat the remaining liquid waste.

All the liquid high-level waste once stored in the tank farm at INTEC has been calcined and placed in storage in the Calcined Solids Storage Facilities. Calcine will continue to be stored in these facilities, which provide safe, efficient, and easily monitored storage. The decision on the final disposition of the calcine will be discussed in the High-Level Waste Environmental Impact Statement Record of Decision, but the final treatment decision will likely be deferred until approximately 2006, when additional decision-making data will be available.

The High-Level Waste Program has an extensive research and technology development program to develop and demonstrate technologies in support of the High-Level Waste Environmental Impact Statement. Ongoing efforts include development and testing of sodium-bearing waste stabilization systems; chemical and sorbent separations technologies; glass formulation and melter technology development for calcine treatment; and tank inspection, heel sampling, and immobilization processes. The program's R&D will result in the deployment of selected treatment processes necessary to disposition the high-level waste materials.

Energy

Nuclear

Nuclear and Radiological Sciences

INEEL is a leading laboratory in basic nuclear and radiological science research and applications. Both DOE and non-DOE customers request the expertise and assistance of the INEEL's nuclear scientists to address critical situations (e.g., the 1999 Japanese nuclear criticality accident, safety analysis of Russian reactors, etc.). The laboratory chairs the international working group in radiation metrology and leads U.S. participation in the International Atomic Energy Agency program on nuclear structure and decay data evaluation.

The Idaho Accelerator Center gives INEEL a special niche in applications of small electron and light-ion accelerators associated with nondestructive examination/nondestructive analysis (NDE/NDA) and medical techniques. INEEL and Idaho State University are collaborators in the center.

Highlights of INEEL nuclear and radiological science program are double-beta decay measurement, boron neutron capture therapy, and fusion safety. In collaboration with nationally and internationally renowned scientists, INEEL is preparing to measure double-beta decay in molybdenum. This is an opportunity for directly measuring the possible mass of the neutrino. If the mass is unequivocally demonstrated to be nonzero, the INEEL will yield important insights into the standard model of particle physics and the existence of so-called "dark matter" in the universe.

Key science accomplishments and their beneficiaries include:

- *Neutron Radiotherapy.* INEEL, in collaboration with other DOE laboratories, several major domestic and foreign universities, and other institutions, has a longstanding record of contributions to cancer research in fast-neutron external-beam radiotherapy and epithermal-neutron boron neutron capture therapy (BNCT). The laboratory is recognized worldwide for its research contributions and technology developments in computational and experimental neutron biophysics and dosimetry, accelerator- and reactor-based neutron source development and deployment, chemical synthesis of advanced boron neutron capture agents, and high-precision chemical analysis of boron uptake in tissue.

- *Portable Isotopic Neutron Spectroscopy.* INEEL developed the field-portable instrumentation used by DOE, DOD, and other organizations worldwide to perform nonintrusive chemical analysis of items such as chemical weapons.

- *Nuclear Fission Research.* INEEL researchers in collaboration with Argonne National Laboratory and Vanderbilt University performed fundamental studies of the nuclear fission process using large arrays of gamma detectors. This provides new information about the fundamental mechanics of the fission process on very short time scales, and it may lead to the discovery of additional very short-lived radionuclides resulting from fission. Practical applications of the techniques and hardware developed in this work include nondestructive assay and characterization of various types of spent nuclear fuel of interest to DOE, as well as nonintrusive examination of nuclear weapons for purposes of treaty verification.

- *Environmental Applications in the Mining Industry.* INEEL-developed field-portable equipment and techniques measure the surface-based composition of geological structures before disturbance and possible dispersal of undesirable natural constituents to the atmosphere. Current activities in this area are in collaboration with the phosphate mining industry.

Nuclear Reactor Design and Development

With over 50 years of experience in nuclear reactor and nuclear materials processing plant design, operations, and decommissioning, INEEL has internationally recognized expertise to conduct nuclear reactor R&D. In 1999, the laboratory was designated with Argonne National Laboratory as DOE's Co-Lead Laboratory for nuclear reactor research. Current reactor research focuses on Generation IV reactor technology and the technical issues associated with improved nuclear plant economics, safety, nonproliferation, and nuclear waste characteristics. The laboratory recently invented an innovative split-core design for the ultrahigh flux Advanced Neutron Source. INEEL design activities are being applied to the conceptual design of pebble bed and liquid metal reactors for Generation IV, as well as 21^{st} century naval reactors.

Nuclear Operations

INEEL nuclear operations, encompassing reactor operations and irradiation services, are based on a long tradition of safe and cost-effective operations for DOE and its predecessors.

- *Reactor Operations.* INEEL operates and maintains the Advanced Test Reactor (ATR), the world's largest test reactor, which delivers high thermal neutron flux and large test volumes for performing irradiation services. The ATR's particular design permits tailoring the power among its nine flux traps. A few months of ATR irradiation are equivalent to the effects of many years in other reactors.

  While the primary sponsor of the ATR is the Naval Reactors Propulsion program, additional R&D work is conducted for international sponsors—bi-axial creep of zirconium for Canada, welding repair technologies for irradiated metals for Japan, long-life irradiation of graphite structurals for Magnox reactors for the United Kingdom, and consultation on the HANARO test reactor for the Republic of Korea. The ATR has also been used for testing weapons-grade mixed-oxide fuel and for testing plutonium-238 dosimetry and pellets used in deep-space missions. Reactor operations are conducted in full compliance with DOE orders and safety requirements.

- *Irradiation Services.* A major benefit of ATR reactor operations is the production of radioisotopes for medical, industrial, environmental, agricultural, and research applications. ATR provides cobalt-60 for medical and defense use and one half of the nation's supply of iridium-192 for nondestructive testing of major structural weldments in bridges, pressure vessels, and ships.

  Gamma irradiation facilities in the ATR canal provide gamma irradiation services that simulate radiation fields encountered high in the atmosphere, outer space, nuclear reactors, and hot cells. The large test canister in the gamma facility can hold entire instruments or microprocessors.

Nuclear Safety and Regulatory Support

As a long-term leader in systems safety analysis and testing for the Nuclear Regulatory Commission, INEEL has made significant contributions to the scientific understanding and safety of the current generation of light-water reactors, which supply nearly 20% of the country's electrical generating capacity. This understanding has enabled many plants to pursue reductions in operations and maintenance costs, and has enabled them to economically compete with natural gas. They are highly regarded as investments by Wall Street. The laboratory's leadership and expertise in nuclear safety dates back to the establishment of INEEL and the subsequent construction and testing of 52 nuclear reactors. This capability was significantly enhanced through the Loss-of-Fluid Test (LOFT), Power Burst Facility (PBF), and RELAP5 code, and it has been maintained through ongoing support to the Nuclear Regulatory Commission. INEEL is continuing to strengthen its leadership through international programs with Taiwan, Korea, and Japan.

INEEL is internationally recognized for nuclear criticality safety leadership. It established and chairs the International Criticality Safety Benchmark Evaluation Working Group, an International Atomic Energy Agency-sanctioned group that manages the world database on experimental nuclear systems criticality safety information. The RELAP5 reactor safety code, developed and maintained at INEEL, is the leader in thermal-hydraulics analysis and is used by many organizations throughout the world.

In the area of experimental thermal-hydraulics, INEEL has the capability to conduct large- scale and high electrical power nuclear reactor safety experiments. The extensive and remote land areas available and INEEL operating infrastructure offer a special capability for conducting large-scale experiments that are potentially hazardous.

The laboratory is a leader in probabilistic risk assessment modeling of commercial nuclear power plants for the Nuclear Regulatory Commission. The laboratory has initiated many projects in risk-and performance-based regulation. It is active in related national and international committees and societies such as the American Society of Mechanical Engineers.

Since the 1970s, INEEL has provided safety expertise and scientific research to U.S. and international communities on issues fundamental to safety in fusion reactor systems. INEEL led the world community through the International Thermonuclear Experimental Reactor (ITER) program in (1) understanding and modeling volatilization of activation products, (2) measuring rates of chemical reactions between air and water and hot plasma-facing surface materials, and (3) measuring and modeling complex interactions between plasmas of hydrogen isotopes and plasma-facing materials. These are all critical to establishing safety performance in fusion facilities and have had a pronounced impact on the design of fusion reactors. INEEL has recently been chosen to ensure that future fusion reactors will meet their safety criteria.

Energy Sources and Production

Below are examples of programs in energy sources and production.

Renewable Energy and Power Technologies

The INEEL is one of the three lead laboratories for the DOE Geothermal Program and is responsible for the program's geoscience research component. The laboratory plays a leading role in understanding the flow of fluids in geothermal reservoirs as well as reservoir characterization and management. Researchers also identify, develop, and field test innovative methods to improve power output, increase efficiency, and reduce the cost of geothermal electric power plants. INEEL is the lead laboratory for engineering support to the DOE National Hydropower Program, for which it is applying its engineering expertise to challenging environmental issues such as fish mortality, impact on aquatic environments, water quality, and land use. New "fish friendly" turbines are being designed, built, and tested through partnerships with industry in the Advanced Hydropower Turbine System component of the national program. In response to DOD and DOE needs, INEEL applies its power system engineering expertise to current and developing distributed energy applications including low-head/low-power hydro, solar photovoltaic systems, and wind farm development. To support the new DOE R&D portfolio initiative Enhancing Energy Systems Reliability, the laboratory is providing engineering support to the electric power systems, natural gas systems as related to electric power systems, and secure energy infrastructure reliability thrust areas.

Fossil Energy

The INEEL Fossil Fuel Research Programs work with the public sector and industry to develop improved processes and engineered solutions to problems faced by the domestic petroleum industry (exploration, production, and refining), including environmental compliance, toxicity, corrosion, reduced well performance, offensive odors, and high operating costs. The laboratory is using current expertise to respond to the DOE R&D initiatives to increase natural gas infrastructure reliability for hydrogen and fuel cells, and the Vision 21 and Clean Fuels for the 21st Century Programs.

The laboratory has recognized expertise and active R&D programs in areas directly related to hydrogen production and use, including materials science, plasma technologies, biotechnology, fossil energy production, and alternative fuel transportation systems. INEEL is also developing improved techniques for analyzing seismic data to locate and characterize petroleum, natural gas, and hydrate deposits.

INEEL efforts to understand the origins of methane hydrates are well respected in the national laboratory system. The laboratory has made world-recognized contributions in understanding the behavior and role of microorganisms in the low-temperature, high-pressure environment where methane hydrates form. The methane hydrate area focuses on the characterization of methane hydrates in areas such as deposit formation, quantification, detection, and possible production schemes.

The laboratory is leading a project to develop a vortex tube contactor for bulk CO_2 separation from process gases with PG&E, Southern California Gas, British Petroleum Amoco PLC, and Purdue University. Another project, in collaboration with Los Alamos National laboratory, involves the development of high-temperature thermally optimized polymer membranes for more efficient separation of CO_2 from methane and nitrogen streams. Other collaborations are with the University of Colorado, Pall Corp., and Shell. The third project will enhance CO_2 emissions conversion efficiency by use of structured microorganisms and it also involves Montana State University and the University of Memphis.

The INEEL applies biotechnology and process engineering capabilities to perform research on enhanced production and utilization of fossil feedstocks, reduce energy usage, and reduce the environmental impacts of industrial processes. Biotechnology and other examples include microbially enhanced oil recovery, development of biocatalysts to convert hydrocarbons in coal to industrial products, development and demonstration of clean coal power technologies, enhanced carbon sequestration through biologically controlled processes, remediating hydrocarbon vapors from leaking fuel tanks, reducing the sulfur compounds and heavy hydrocarbon vapors associated with asphalt processing, biofiltration of nitrogen oxide compounds, and reducing volatile organics released by wood drying. These biotechnology capabilities also support the Environmental Programs mission.

Automotive & Transportation Technology

The INEEL is a DOE lead laboratory for advanced high-power energy storage testing and evaluation for both the Partnership for a New Generation of Vehicles and the Hybrid Vehicle Propulsion Programs of the United States Advanced Battery Consortium. The laboratory has developed and standardized the procedures for hybrid energy storage testing and data analysis, which are now used internationally by government and industry developers. It produced data identifying critical performance and life limitations vital to automotive company development schedules and identified critical technology barriers to be addressed by new research efforts within the DOE complex.

The laboratory's Transportation Center, with its diverse heavy vehicle fleet and infrastructure, tests the scale-up of R&D, alternative fuels, and maintenance. The Transportation Center has significant alternative fuels background including compressed and liquid natural gas, and electric vehicle battery testing. The laboratory has demonstrated expertise in technology areas that directly support the multi-agency 21st Century Truck Program such as diesel exhaust aftertreatment, shape optimization of fluid flow and heat transfer, applied materials, testing and analysis, economic analysis, and systems engineering. As a result, the Transportation Center can develop specific enabling technologies as well as integrate components and verify systems for performance, life, and cost to support future truck requirements. The fleet of 1,600 vehicles comprised of light vehicles, heavy trucks, and motor coach buses that use a variety of conventional and alternate fuels is operated and maintained at the INEEL.

Industrial & Material Technologies

The INEEL conducts collaborative R&D with industry and academia to address the technology development needs identified in industry roadmaps used by the DOE Office of Industrial Technologies Industries of the Future Program. This program is focused on improving the energy efficiency, quality, cost-effectiveness, and environmental stewardship of nine domestic industries, namely, steel, aluminum, metalcasting, mining, forest products, glass, chemical, petroleum and agriculture. Laboratory expertise and capabilities in advanced welding technology; intelligent process control systems; robotics and technology integration; sensors; separation chemistry and selective mass transport agents; biochemistry; advanced materials and materials processing (such as spray forming); structural/mechanical testing and analysis; and thermal processing are used to respond to competitive solicitations for industry cost-shared R&D proposals issued by DOE throughout the year in these nine industry areas.

One of the INEEL's Industries of the Future technology areas has been the agriculture program, which develops high-efficiency biomass production techniques that reduce the environmental and energy impacts of agriculture and improves yields for biomass-powered renewable energy systems, and industrial and food products

Building Energy Efficiency

Building energy efficiency activities at the INEEL couple building research projects with an Energy Management Program.

The INEEL is leading research projects in large-scale structural testing, energy use evaluations, and software development/verification for industrialized housing for the DOE Office of Building Technologies, the Department of Housing and Urban Development, and industry in collaboration with several universities. Researchers gather data on the performance of industrialized housing in variable environmental conditions (e.g. ultraviolet radiation, extreme temperatures and weather) and relate building performance and energy use. Findings are used to develop industry design tools to assess building durability and energy efficiency.

The Energy Management Program realizes cost savings for INEEL through energy conservation in the 500-plus buildings housing INEEL operations and employees. Certified Energy Managers survey buildings to identify energy-saving opportunities, track and report energy use, deploy standard and innovative technologies, and provide information on energy and water conservation and green house gas emissions to employees, other agencies, and the public. Since 1986, the Energy Management Program has accomplished numerous retrofit projects for laboratory buildings saving an average of $1 million annually. Additional information on the INEEL Energy Management Program can be found in Section V.E.6, Energy Management.

Crosscutting Program

The INEEL has many programs that crosscut disciplines and DOE mission areas. Within Energy Efficiency and Natural Resources, an example of an emerging crosscutting program is the Greater Yellowstone-Teton Systems Analysis Model Program. Targeting the geographic area in and around Yellowstone and Grand Teton national parks, this prototype program will encourage energy, environment, and science R&D that integrates what have traditionally been viewed as unconnected systems to achieve greater efficiency and less environmental impact. The program will include clean fuel infrastructure shared for transportation, heating, process loads, and distributed production.

National Defense

Below are examples of INEEL national security programs.

Advanced Threat Mitigation Systems

Advanced threat mitigation systems R&D at the INEEL consists of integrated threat defense and mitigation programs in chemical demilitarization and operations command and control for military applications; currency, explosives, chemical, biological, and other contraband materials detection for law enforcement and counterterrorism; nuclear-related environmental activities for multilateral and international initiatives; and advanced information management technologies for information, security, waste management, scientific simulation, and advanced military mission planning. Five R&D 100 awards over 12 years exemplify external recognition of INEEL's contribution to intelligence and national security.

The INEEL provides nonproliferation and intelligence R&D to reduce the threat of proliferation of weapons of mass destruction and their delivery systems. The DOE National Nuclear Security Administration is the largest source of nonproliferation R&D funding. Current R&D includes criticality safety, actinide solution stabilization, fission studies, and high-level waste studies. Funded by DOE national security programs and jointly operated by the INEEL and Idaho State University, the Idaho Accelerator Center is a scientific facility providing accelerator applications and low-power nuclear and optical physics. In FY 2000, INEEL and Argonne National Laboratory began supporting bilateral scientific collaboration with Russia through the newly established International Center for Environmental Safety. DOE and the Russian Ministry of Atomic Energy formed the center recognizing their common security and environmental goals.

INEEL national security military programs include R&D as well as production. The laboratory is the sole producer of M1 A1 Abrams tank armor packages for the U.S. Army. The Specific Manufacturing Capability's modeling and simulation capability and metal fabrication design and automation expertise are recognized national assets. INEEL is responsible for the deployment of advanced military mission planning systems, and command and control communications systems. The laboratory's Advanced Test Reactor supports specialized nuclear materials testing for multiple national security customers. INEEL chemical-weapons assessment program leverages the experience and expertise of the laboratory's science, technology, and operations programs. Based on the laboratory's engineering excellence and success adapting nonintrusive characterization technologies, the U.S. Army recognized the INEEL as its lead laboratory for Nonstockpile Chemical Weapons Material mobile assessment systems. The INEEL demilitarization program includes multiple projects in mobile and fixed chemical munitions assessment systems that ensure U.S. compliance with the Chemical Weapons Convention. With a growing customer need for integration services, INEEL is expanding its R&D support with new concepts in systems integration, international chemical and conventional munitions assessment, and first responder systems for nuclear, chemical, and biological materials counterterrorism.

The INEEL also conducts research and tests integrated systems and technologies for federal and regional law enforcement organizations. For example, the INEEL leads the application of information technologies as part of the Criminal Records Information Management Network (CRIMNET) in Idaho and the Colorado Justice Information Network. Law enforcement depends on information technology to improve information sharing across different operating systems and network infrastructures. INEEL law enforcement R&D projects include applications such as compact standoff detection systems for weapons, vehicles, and packages; rapid detection and treatment systems to protect air and water supplies; intelligent software to prevent and correct damage from system intrusions; and monitoring systems to identify active threats to or attacks on critical infrastructure. Other R&D for law enforcement counterterrorism programs include forensic science, information forensics and case management, and biosensors.

Advanced Technology Systems

The laboratory's Advanced Technology Systems R&D consists of nonproliferation and intelligence programs based on materials development and characterization; chemical and biological threat detection and analysis; nuclear material detection; intelligence tools and analysis; electrical systems and control infrastructure; and new areas of software engineering. DOE's national security programs rely on INEEL expertise in sensor development, engineered systems, computer security, software development and assessment, and systems modeling.

Advanced technology programs encompass information warfare, command and control, computer and network reliability, and communications and data protection for DOE, and multiple federal and nonfederal customers. INEEL deploys automated command and control systems with advanced cryptography. In collaboration with the University of Idaho, INEEL is designing and testing secure network communications with authentication protocols utilizing a formal methodology. Through a strategic alliance, the INEEL and the University of Idaho are expanding the laboratory's cybersecurity capability in the four areas identified by DOE: information assurance, intrusion detection, intrusion protection, and information forensics. The laboratory Visualization Team focuses on specialized technologies and applications to protect intelligence information during network communication.

As part of DOE's effort to counter weapons of mass destruction terrorism, INEEL's counterterrorism and law enforcement programs conduct research and technology development under Work-for-Others agreements with the departments of Justice, State, and Transportation. The laboratory received the National Institute of Justice Law Enforcement Technology Innovation Award for developing practical technologies for law enforcement officers.

Science

Specific examples of INEEL science research programs and capabilities follow.

Bioremediation

The INEEL conducts fundamental bioremediation research supported through the Natural and Accelerated Bioremediation Research Program of the Office of Biological and Environmental Research. The field-oriented research assesses the relationships between reactive surface area and groundwater flow in heterogeneous aquifer media and evaluates their influence on subsurface bioactivity and the migration of contaminants and other dissolved constituents in groundwater. Through the use of multiscale experiments and field observations, new approaches are being developed for the in situ measurement of the reactive surface area of aquifer media and more effective methods are being developed to translate the results of laboratory studies of biogeochemical processes to field-scale applications. The multi-institutional research is being conducted with materials from the pristine Oyster, Virginia, site and is developing needed fundamental understanding of subsurface processes required for developing more effective in situ remediation approaches for contaminated DOE sites.

Materials Sciences and Engineering

This program, which grew out of the older DOE Office of Basic Energy Sciences program in Engineering Research, comprises five existing programs and one pending. These programs represent the INEEL's support of the Division of Materials Sciences and Engineering's mission to:

- Extend the body of knowledge underlying current engineering practice so as to create new options for enhancing energy savings and production, prolonging useful equipment life, and reducing costs without degradation of industrial production and performance quality

- Broaden the technical and conceptual base for solving future engineering problems in the energy technologies.

The present INEEL programs are Topics in Thermal Plasma Processing of Materials, Modeling of Thermal Plasma Processes, Intelligent Control of Industrial Processes, and Elastic-Plastic Crack Propagation and Coupled Mode Nondestructive Evaluation Methods. The Crack Propagation research and Intelligent Control of Industrial Processes program have historically been managed in cooperation with the Massachusetts Institute of Technology. A pending program, previously funded, is Intelligent Control of Bioprocesses.

Microstructure and Properties of Multilayer Materials

This program is an outgrowth of two programs formally funded by the DOE Office of Basic Energy Sciences involving microstructure evolution in rapidly solidified powders and characterization of compositionally graded microstructures fabricated using powder methods. The INEEL is now investigating the relationship between microstructure and properties in functional gradient metal/ceramic multilayer materials. The goal is to quantitatively determine development of residual stress resulting from powder processing of a Ni-Al_2O_3 model system. The influence of constraint from interlayer interfaces on the constitutive properties is being determined from comparison of high-resolution phase-shifted Moiré interferometry and numerical simulation. The influence of elevated temperature powder processing on microstructure evolution within the particulate constituents is being determined using analytical transmission electron microscopy.

Center of Excellence for Synthesis and Processing Projects

In an ongoing collaboration, INEEL, Oak Ridge National Laboratory, and Lawrence Berkley National Laboratory are conducting research to determine whether a naturally occurring oxide scale is protective during high-temperature exposure. In collaboration with Brookhaven National Laboratory, the INEEL is examining the evolution of microstructure and magnetic properties of rare-earth permanent magnets. Structure/property relationships are being examined for ultrahigh-temperature silicide intermetallics in collaboration with Los Alamos, Oak Ridge, and Ames National Laboratories. Engineered inorganic polymer membrane materials are being developed in collaboration with Pacific Northwest National Laboratory.

Surface Ionization Mass Spectrometry

This program explores the topic of why a very few materials, when taken to elevated temperatures (800-1300°C), sublime substantial numbers of atomic or molecular ions rather than neutral atoms and molecules. The three main types of ion emitters identified to date are chemically reactive ion emitters, preformed ion emitters, and Saha-Langmuir ion emitters, listed in the order in which they can be scaled in intensity. Each of the higher-intensity ion-emission processes studied to date can be classified in one of these categories. Examples of each of these types of ion emitters are being studied to gain insights into the underlying mechanisms of ion emissions.

LDRD Program

Examples of selected INEEL LDRD projects follow:

Natural Attenuation as a Cleanup Method

Radionuclide and hazardous metal contaminants are present in the vadose zone and groundwater throughout the DOE complex. In situ immobilization of certain contaminants (i.e., divalent species) can occur naturally through co-precipitation in carbonate minerals. Simulating the native microbial community to generate chemical conditions that favor carbonate precipitation can accelerate the process. INEEL, in collaboration with the University of Toronto, has successfully demonstrated potential application of this technique to environmental cleanup efforts. Specifically, the testing has been able to characterize the ability of native microorganisms to hydrolyze urea, leading to alkaline conditions conducive to carbonate precipitation. Based on this testing, INEEL can now:

- Enrich, isolate, and characterize organisms that can hydrolyze urea

- Directly measure urea hydrolysis and apply results to isolates
- Quantitatively link urea hydrolysis to calcium carbonate mineral precipitation.

These results will have direct application to development of a subsurface cleanup technology that can be deployed in various vadose zone environments throughout the DOE complex. As an in situ process, natural attenuation may directly benefit the DOE cleanup efforts by eliminating secondary waste streams and minimizing worker exposure to hazardous materials and environments, when compared with traditional pump-and-treat technologies. In addition, it greatly reduces the need for the physical infrastructure that must be decontaminated and decommissioned after the cleanup project is completed, resulting in significant cost savings.

Microbial Stability of Subsurface Solidified Waste Media

Realistic data are needed on the biodegradation of subsurface solidified (e.g., cementitious) waste forms to satisfy NRC and DOE Order 435.1 requirements. Specifically, in 10 CFR 61 Part 56(b)(1), the NRC requires a basic understanding of the biodegradation characteristics of waste forms placed in subsurface disposal sites. Likewise, DOE M 435.1-1, Section IV.G(1)(d)(4), requires that low-level waste forms do not produce toxic gases or structurally fail due to radiolysis or biodegradation. DOE is actively developing and using immobilization technologies for long-term subsurface disposal of liquid/slurry radioactive and hazardous wastes. Since these technologies are mandatory to meet EPA and NRC regulations, biodegradation (i.e., microbial stability) data are needed for the resulting waste forms. The INEEL worked in parallel with Tuskegee University to develop a realistic, accelerated testing protocol for accurate evaluation of microbial-influenced degradation of solidified waste forms. Specifically, this development was focused on establishing methods that account for biofilm activity on the waste forms, which is not adequately considered in other existing accelerated test methods. The new microbial-influenced degradation test method developed at INEEL will now be applied to the grout waste forms planned for the tank waste that will be treated by the INEEL High-Level Waste Program. In addition, the biofilm data developed as a result of this work is directly applicable to the subsurface science efforts ongoing within the DOE complex, including INEEL.

Human-Machine Interfaces

The INEEL Human Factors Research Program is addressing the disparity between process-efficient technology and human learning/interaction. DOE is aware of the need to integrate human factors into design of its new environmental restoration, decontamination and decommissioning, and waste management systems, particularly with regard to dispositioning high-level waste, transuranic waste, spent nuclear fuel, and associated facilities. Congress, in a letter from the Senate Task Force on Manufacturing to the Secretary of Defense (November 5, 1997), urged that “the relationship between robotics and intelligent machines and the work force of the future should be . . . systematically explored.” A DOE effort has been initiated to examine the human-machine interface.

At INEEL, this research addresses the challenge that newer process control systems employ more advanced technologies that reduce human roles to system/process monitoring. But with these changes has come an unanticipated degradation in human performance. These degradations arise from a variety of sources including poor display of information, awkward controls, inadequate training, and most serious, the inability of operators to understand and intervene when needed. Human Factors research focuses on making the human-machine interfaces more natural, i.e., more in line with the way human logic drives human action. Accidents such as Chernobyl and the EXXON Valdez highlight the importance of human performance in complex, technological systems. Reducing the number of operator errors will become increasingly essential as technology becomes more automated. The laboratory test facility for the design, development, test, and evaluation of human-machine systems:

- Employs a distributed computing system based on a combination of Silicon Graphic and Intel Xeon platforms
- Provides multimodal and multimedia capabilities including 3-D video, 3-D audio, real-time interactive video, stereographic systems, eye-motion tracking, tactile input, immersive displays, and professional audio/video editing of data
- Allows distributed simulations and real-time collection and analysis of human performance data.

Testing has been conducted on human-machine interactions on distributed control and decision-making systems (versus central control systems), which are affecting many government agencies and industries. The research focused on integrating commercial off-the-shelf systems to evaluate the joint effects of new technology designed to support distance collaboration and centralized versus distributed work. In particular, the researchers wanted to determine the effects of distance collaboration on the situational awareness, workload, and decision-making quality of test subjects in a realistic command and control simulated environment. INEEL research is highly relevant to (a) future command and control applications for DOE and other national security customers, (b) the design of monitoring and surveillance systems used for operations at the laboratory, and (c) the design and evaluation of process control systems that will be developed for future nuclear power plant control rooms and peripheral control stations.

Neutron/Gamma Dosimeter

To accurately measure a radiation field, both gamma-ray and neutron amounts must be determined. Currently, no single device is commercially available that can accurately measure both radiation fields. Detection needs are met with two separate detectors, and these detectors are heavy, bulky, and difficult to carry around. Alternative detection methods include smaller detectors, but these have limited capability. INEEL has developed a neutron/gamma dosimeter based on a new measurement technique that uses two sensors made up of two isotopes: lithium-6 and lithium-7. This dosimeter also uses two small photomultiplier tubes to measure neutrons and gammas. Both lithium-6 and lithium-7 are equally sensitive to gamma radiation, but lithium-6 is also sensitive to neutrons. Neutron detection is identified by subtracting the amount of radiation recorded by the lithium-7 sensor from the amount recorded by the lithium-6 sensor. Benefits of this detector are multiple. It has the ability to measure gamma rays in 2 seconds and neutrons in 10 seconds, with results instantly shown on a liquid crystal display, including a total radiation reading. The detector can measure dose rates as low as 10 μR/hour. This neutron/gamma dosimeter provides the most accurate neutron measurement available today. It can be used in many applications, such as personnel monitoring at nuclear power plants, neutron radiation therapy, monitoring special nuclear materials, and detecting low-level neutrons in very high gamma-ray fields. The latter has a number of environmental applications, including in the waste management arena where detecting a small amount of plutonium is a problem for many radiation detectors because of strong gamma emissions.

Novel Human Molecular Identification

INEEL is partnering with Miragen, a biotechnology company in Irvine, California, to develop a low-cost, fast, easy-to-use, highly sensitive assay to replace current DNA testing methods. Using the new process, initial tests can identify an individual and illegal drug use at the same time. The new process costs less than one-tenth of what current procedures costs. This novel technology has important implications for DOE national security efforts, with specific potential application to the DOE Office of Nuclear Nonproliferation Forensics Initiative.

Miragen originally developed the Antibody Profile Assay used to identify an individual by a subset of normally occurring antibodies present in the body. Medicines or illnesses do not affect these antibodies, called Individual Specific Autoantibodies, and, with very few exceptions, the antibodies are stable across a person's lifetime—much like a fingerprint. While Miragen's Antibody Profile Assay met some needs, it was not human specific or sensitive enough to meet the parameters required in forensics work. INEEL researchers improved the assay by substituting a human-specific antibody in place of the protein the Miragen assay used. Incorporating a double label test into the process led to making a correct identification 91% of the time. While this success rate may seem high, it does not meet requirements for national security and other legal applications. Research will continue to identify ways to improve the assay results by testing the process against additional simulated crime scene situations. The goal is to establish statistical proof that the banding pattern is truly as unique to each person as a fingerprint. The validity of the assay has to be statistically proven before the test results will be widely accepted.

Mapping Extreme Environments and Regional Natural Resources for Significant Enzymes (Yellowstone-Teton Initiative)

Research in recent years shows that the thermal features of Yellowstone National Park are unequaled and contain microbiological diversity that has the potential for important scientific and economic impact. Cataloging and mapping microorganisms in extreme environments is of strategic importance. Understanding the fundamentals of this microbiological diversity and the hot springs "habitat" is crucial to being able to utilize and preserve this resource. INEEL is working with the National Park Service to develop an integrated relational database and geographic information system for mapping biodiversity data and associated geochemical and hydrological attributes in extreme environments. The prototype system, launched in FY-99, includes the data table architecture and input data, as well as integrated graphical user interface tools to provide map displays, query capabilities, and Internet file downloading. In addition, sampling protocols and new sampling methods were developed in FY-99 for this program. The data tables and associated geographical information in this system are the first of their kind intended for mapping microbial biodiversity in any environment. This database provides capabilities well beyond the traditional "lists" currently used for most inventories. This database will also be applicable to environments other than Yellowstone National Park. Presently, the database is being considered for use in INEEL watershed and land management activities.

This technology developed in the Yellowstone-Teton research project has potential application to DOE complex needs. There is a universal need for subsurface science and in situ remediation activities for data processing and bioinformatics infrastructure that facilitates the integration of microbiological data with geochemical, geographical, and temporal information. The INEEL's research project will lead to a database system that incorporates a regional or global coverage, as well as subsurface environments. This would support environmental restoration and long-term stewardship by allowing scientific investigators, operations personnel, and other stakeholders to use a single, comprehensive, up-to-date database accessible via the Internet. Such a capability would also allow stakeholders to assess changes in chemical contaminant, geochemical, and microbial profiles; monitor progress of remediation activities including any online, real-time data loggers; and access safety and emergency contact information.

Technology Transfer and Commercialization

The INEEL Technology Transfer and Commercialization Program operates as prescribed by several federal statutes and applicable DOE orders. Industry Focus Teams work closely with INEEL programs to identify and pursue technology commercialization and business development opportunities.

Each team is a matrix of laboratory personnel who possess interest, expertise, knowledge, and experience applicable to a specific target industrial market. The team is responsible for analyzing the needs of its assigned market, linking INEEL capabilities and technologies to the market needs, and developing strategies for meeting those needs. Input on decisions relating to intellectual property in the assigned industrial market is also provided by the Industry Focus Team.

The main contractual formats used for the transfer of technology at the INEEL are:

- CRADAs
- Work for Others
- Licensing of technology
- Formation of external entities (spin-off companies).

CRADAs

A CRADA is a cooperative agreement between the INEEL and at least one commercial entity that involves both parties contributing to the project. The INEEL Technology Transfer and Commercialization Program has negotiated 68 CRADAs over the last 5 years and is projecting to negotiate an additional 60 over the planning period. Recent examples are:

- Pacific Gas & Electric/Southern California Gas for liquefied natural gas: This CRADA will result in significant funding and in-kind work over a two-year period.
- Global Metal Technology, Inc. rapid solidification tooling process: This CRADA will result in significant funding over the next two years.

Work for Others

Work for Others agreements are used to work with industrial and non-DOE government entities. Under this approach, the external entity provides all of the funding for the project. Work-for-Others funding at the INEEL approached $100 million in FY 2000. A typical example is the work done for the Department of the Army at the SMC facility. This totaled in excess of $60 million in FY 2000.

A program to develop a diesel fuel reformer to feed hydrogen to fuel cells began in FY 2000. This is expected to provide about $4 million in funding over a 4- to 5-year period.

Licenses

A license is generally used when the technology at the INEEL is ready, or nearly ready, for commercial application. It gives an entity the right to use a technology but does not transfer title of the technology to the entity. Examples of recent licenses are:

- A Houston, Texas, firm licensed INEEL’s submergible, explosion-proof inspection crawler. The INEEL developed this technology for applications in DOE’s Waste Management and Environmental Remediation programs. The licensee is using the technology to inspect internal structures the petroleum industry’s process and storage systems. Estimated revenue from this contract is $1 million.

- INEEL has transferred a weld inspection technology to a private company under a license agreement. An ongoing CRADA between the INEEL and the company is facilitating the technology's further development. The laboratory estimates this contract to return $15 million over the next 5 years.

- An Idaho-based engineering firm has licensed the Concealed Weapons Detection System from the INEEL. This system allows law enforcement and security personnel to search people for concealed weapons and to identify the exact location of weapons. The estimated value of this contract is $1.1 million.

Spin-Off Companies

Spin-out businesses from the INEEL have the potential to strengthen and diversify the regional economy. Surveys of laboratory personnel have also shown that spin-outs are a significant recruiting tool for attracting scientific and engineering talent. Examples of companies under consideration for this program are:

- Northwind Environmental is an existing business in Idaho Falls. A technology developed at the INEEL for the in situ remediation of chlorinated hydrocarbons will be used as the basis for a new operating unit. The personnel at the INEEL that were responsible for the development of the technology will transfer to Northwind as part of the spin-out of the technology. Northwind will make the additional investment necessary to bring this important environmental technology to a commercial state.

- A new nondestructive examination technology will form the basis for another spin-out to be located in Idaho. The technology development will be done in the Idaho Falls area and the manufacturing will occur in the Boise area under present plans. This new firm will be backed by venture capital from a Boise-based venture capital firm.

Appendix C

University and Science Education Participants

Appendix C
University and Science Education Participants

Table C-1. University and science education participants.

	FY 1999			FY 2000			FY 2001			2005 Goals		
	Total	Minorities	Women	Total	Minorities	Women	Total	Minorities	Women	Total	Minorities	Women
PRECOLLEGE PROGRAMS												
Student Action Teams	121	8	50	108	14	53	37	3	13	100	20	50
Scholastic Tournament	930	0	232	960	0	240	940	4	336	990	2	247
Physics Day	4,000			5,715			4,625			5,000		
ROBO Challenge							145			180		
SNARF Camp	92			849	139	324	738	43	292	750	45	300
Teaming Teachers with INEEL	112	2	41	64	3	15	17	0	2	100	5	40
Preservice Teachers	8	0	5	7	0	5	2	0	2	20	5	10
Mars Workshop							20		12	30		
JASON	~500			4,000			5,000	500	2,500	30,000	300	15,000
Science & Engineering Expo							1,925			10,000		
Education Services							597			2,650		
Providing a Trusting Hand	22	22	17	17	17	13	6	6	6	6	6	6
Promoting a Successful Outcome				20	20	11	15	15	12	15	15	12
UNDERGRADUATE PROGRAMS												
Undergraduate	98	2	34	72	0	21	64	3	25	90	5	40
Computer Science Power Fellowship	18	1	6	22	1	10	12	0	4	20	3	7
Historically Black Colleges and Univ./Minority Inst.	4	4	1	8	8	2						
Office of Nuclear Energy							11	4	2	10	2	5
Energy Research Undergraduate Laboratory Fellowship	1	0	1	14	0	9	6	0	3	20	10	10
Experimental Program to Stimulate Competitive	2	2	2	0	0							
GRADUATE PROGRAMS												
Graduate	70	2	23	54	2	21	50	2	17	75	10	30
Oak Ridge Institute for Science and Education	2	0	0									
Postbaccalaureate	15	0	4	0	0	0	3	0	3			
Postmasters	4	0	1	2	0	0	2	0	0			
INRA Ph.D. Candidates							13	2	1	50	10	15
POSTGRADUATE PROGRAMS												
INRA Postdocs							6	1	2	50	10	15
Postdoctoral	18	1	8	11	1	3	12	3	5	50	10	15
FACULTY PROGRAMS												
University	37	5	6	20	1	1	19	1	2	25	3	5

Appendix D

INEEL WAGs

Appendix D

INEEL WAGs

For environmental restoration purposes, the Idaho National Engineering and Environmental Laboratory (INEEL) is divided into 10 Waste Area Groups (WAGs) (see Table D-1), composed of 98 Operable Units (OUs) grouped together based on similar contamination problems or geographic boundaries.

Table D-1. INEEL WAGs.

WAG 1, Test Area North (TAN)	WAG 6, Combined with WAG 10
WAG 2, Test Reactor Area (TRA)	WAG 7, Radioactive Waste Management Complex (RWMC)
WAG 3, Idaho Nuclear Technology and Engineering Center (INTEC)	WAG 8, Naval Reactors Facility (NRF)
WAG 4, Central Facilities Area (CFA)	WAG 9, Argonne National Laboratory-West (ANL-W)
WAG 5, Power Burst Facility (PBF)/Auxiliary Reactor Area (ARA)	WAG 10, All areas of the INEEL located outside the boundaries of other WAGs

The INEEL will complete ongoing remediation activities in three of the 10 WAGs by Fiscal Year (FY) 2006. Long-term groundwater pump-and-treat operations will continue through 2025 at WAG 1. Cap construction and long-term monitoring and maintenance will continue at WAG 3. Two sites at TRA co-located with operational facilities will be remediated in 2035 after operations are complete. The WAG-7 project has significant remediation work to complete after FY 2006. Decontamination and decommissioning (D&D) of surplus facilities will continue through 2044.

WAG 1. TAN Remediation

Mission. This project addresses the assessment and remediation of Test Area North (TAN), which encompasses the Technical Support Facility, Initial Engine Test Facility, Loss-of-Fluid Test Facility, and Water Reactor Research Test Facility. During the course of TAN's 50-year operating history, contaminants have been introduced into the environment through incidental releases and past waste management practices. Contaminants of concern include radionuclides, metals, polychlorinated biphenyls, and organics. Identification of organic contaminants in the groundwater at TAN resulted in the INEEL being listed on the National Priorities List (Superfund Site).

Scope. WAG-1 activities include characterizing any current or newly identified Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites and the cleanup of CERCLA sites as required by the OU 1-10 and 1-07B Records of Decision. Each of these projects previously evaluated a total of 94 potential release sites to determine whether they cause an unacceptable risk to human health or the environment.

Sites to be addressed include:

- *Buried tanks.* Tank content removal; decontamination of the tanks, if necessary; removal of the tanks, if necessary; isolation of associated pipes; and treatment or disposal of tank contents.

- *Soils contaminated with radionuclides.* Excavation and treatment and/or disposal of the contaminated soils.

- *Soils contaminated with metals.* Isolation of the contaminated soils using a soil cover.

- *Soil contaminated with petroleum.* Removal of contaminated soils followed by landfarming, if necessary.

- *Contaminated groundwater.* In situ bioremediation of the most contaminated groundwater zone, monitored natural attenuation of the least contaminated groundwater zone, and pump and treatment of the remainder of the contaminated groundwater plume.

Each of these sites may also be placed under institutional controls to include, for example, items such as fences and monitoring.

2006 End State. Environmental restoration will be completed through the OU 1-10 Comprehensive Remedial Investigation/Feasibility Study, OU 1-10 Record of Decision, and subsequent Remedial Design/Remedial Action activities. The exception will be OU 1-07B, which will continue groundwater treatment and ongoing long-range surveillance and maintenance activities. Also, liquid and sludge wastes removed from the TAN V-Tanks may be in long-term storage awaiting the availability of suitable disposal facilities. All known OU 1-10 cleanup actions will be completed, and the OU 1-07B cleanup action will provide containment of the contaminant plume while the aquifer undergoes active remediation. Surplus facilities currently in the Environmental Management Program will have been stabilized or demolished.

Final End State. Required long-range surveillance and maintenance activities at TAN will be ongoing. Long-term groundwater pump-and-treat operations will continue through 2026.

WAG 2. TRA Remediation

Mission. This project addresses the assessment and remediation of the Test Reactor Area (TRA), which is divided into 14 OUs based on the similar nature of the waste releases. The OUs consist of known and suspected releases from disposal ponds, waste lines, underground storage tanks, and other incidental releases from facility operations. Contaminants of concern include radionuclides, polychlorinated biphenyls, metals, and organics.

Currently, all waste release sites at WAG 2, except for OU 14, have been evaluated. The WAG-2 Remedial Investigation/Feasibility Study for OU 2-13 determined that eight of the sites at WAG 2 posed an unacceptable risk to human health and the environment and required remediation. Remediation of these low-level radioactive and/or hazardous substance release sites has been performed. This project directly supported completion of regulatory requirements with enforceable milestones defined in the INEEL Federal Facility Agreement and Consent Order (FFA/CO) and Idaho Settlement Agreement.

Scope. The scope of this project includes performing monitoring of the perched water and the Snake River Plain Aquifer below the TRA; performing a Track-2 investigation on new sites identified as

OU 2-14; and conducting operations and maintenance activities on those sites previously remediated under OU 2-13.

2006 End State. Soils in the TRA will be under institutional controls.

Final End State. Long-range surveillance and maintenance activities will be ongoing. It is anticipated that TRA facilities will remain in operation until at least 2035; therefore, remediation of contaminated soil in areas of active TRA operations will not be completed until TRA operations cease. Institutional controls in these areas have been invoked and will remain in place until remediation occurs.

WAG 3. INTEC Remediation

Mission. This project is to complete assessment, remedial design/remedial action cleanup, and long-term monitoring and maintenance at the Idaho Nuclear Technology and Engineering Center (INTEC), which includes facilities for spent nuclear fuel storage, a waste solidification facility and related waste storage bins, remote analytical laboratories, and a coal-fired steam generation plant.

WAG 3 potential release sites are divided into 14 operable units based on the nature of the potential release. These sites include contaminated pits, French drains, perched and aquifer water, percolation ponds, rubble piles, spills, storage areas, tanks, an injection well, and windblown areas. Contaminants of concern include radionuclides, metals, organics, and acids.

Remaining assessment activities include completion of two Remedial Investigation/Feasibility Study and associated Records of Decision documenting the decision process for remedy selection. Cleanup activities include the design and implementation of remedies selected to meet remedial action objectives established in the Record of Decision. Monitoring and maintenance will include activities required for long-term operation of the selected remedy and final project closeout, such as groundwater sampling and repairs to soil caps.

Scope. The scope of assessment activities include completing the OU 3-13 Comprehensive Remedial Investigation/Feasibility Study Proposed Plan and Record of Decision; OU 3-14 Tank Farm Soil Sites Remedial Investigation/Feasibility Study Scope of Work, Work Plan, and Report; and OU 3-14 Tank Farm Soil Sites Remedial Investigation/Feasibility Study Proposed Plan and Record of Decision. The INEEL will also provide technical support for all WAG-3 activities, including continued investigation of new units; conducting Remedial Design/Remedial Action scoping with DOE, EPA, and the State of Idaho; and preparing the preliminary Remedial Design/Remedial Action Scope of Work.

The scope of cleanup activities include completing the Remedial Design/Remedial Action Scope of Work; completing the Remedial Design/Remedial Action Work Plan; submitting the Preliminary Remedial Design, which will include the Sampling and Analysis Plan, Operations and Maintenance Plan, design drawings, and specifications; conducting procurement activities; completing the Environmental Safety and Health Plan; completing the Auditable Safety Analysis; performing remedial action construction activities at all OU 3-13 and 3-14 sites requiring cleanup; completing the Remedial Action Report; performing post-Record of Decision monitoring; and performing long-term remedy monitoring and maintenance. WAG 3 also includes development of the INEEL CERCLA Disposal Facility. This facility will be an engineered repository that will be used for the consolidation of contaminated CERCLA wastes from across the INEEL.

2006 End State. By 2006, all contaminated soil sites, except the tank farm and soil under buildings, will be remediated. Institutional controls will be in place for all WAG-3 sites by 2005. Monitoring and maintenance activities will continue beyond 2006. An interim action remedy will be implemented at the tank farm by 2002. The INEEL CERCLA Disposal Facility will be in operation, receiving and disposing of contaminated materials from across the INEEL.

Final End State—Resource Conservation and Recovery Act (RCRA) closure of the tank farm is planned to begin in 2009 and is expected to be completed before 2035. Facilities immediately adjacent to the tank farm are expected to be decontaminated and dismantled by 2044. A cap will be constructed over the tank farm. One hundred years of postremediation long-term monitoring and maintenance is assumed to maintain the cap and verify remedial actions. The INEEL CERCLA Disposal Facility will be closed by 2011.

WAG 4. CFA Remediation

Mission. This project covers the assessment, cleanup, and remediation of the Central Facilities Area (CFA), which consists of 13 OUs in and around CFA. The potential release sites comprise landfills, underground storage tanks, aboveground storage tanks, French drains, soil contamination areas, a sewage treatment plant, and disposal ponds. Field sampling has been completed. Contaminants of concern are radionuclides, organics, nitrates, and metals.

Currently, all waste release sites at WAG 4 have been evaluated, and the WAG-4 Remedial Investigation/Feasibility Study determined that three of the sites pose an unacceptable risk to human health and the environment and therefore must be remediated. Remediation of the low-level radioactive and/or hazardous substance release sites will reduce the contamination and associated risk to acceptable levels. This project directly supports completion of regulatory requirements with enforceable milestones defined in the INEEL FFA/CO.

Scope. Cleanup of CERCLA WAG-4 sites is governed by the INEEL FFA/CO, under which a Comprehensive Remedial Investigation/Feasibility Study for WAG 4 has been completed. The decision-making process for integrating of Environmental Restoration cleanup and facility operations is tied to the CERCLA Record of Decision, which included stakeholder participation. The remaining scope of cleanup activities includes preparation of the remedial design/remedial action work plans, performance of the remedial actions, and implementation of the operations and maintenance plan at five sites where contamination will be left in place. This includes groundwater monitoring, routine remedy review and maintenance, maintenance of institutional controls, and 5-year regulatory reviews.

2006 End State. By 2004, all known contaminated sites at WAG 4 will be remediated. Institutional controls will be in place for all WAG-4 sites by 2003. Monitoring, maintenance, and 5-year review activities, as required by the FFA/CO and CERCLA, will continue beyond 2006.

Final End State. Long-range surveillance and maintenance activities will be ongoing. Long-term activities include groundwater monitoring, soils analysis, air monitoring, moisture and organics monitoring in the vadose zone, maintenance and repair of institutional controls, and repair and filling in subsidences.

WAG 5. PBF/ARA Remediation

Mission. This project baseline summary addresses the assessment and cleanup of the Power Burst Facility (PBF)/Auxiliary Reactor Area (ARA) in accordance with the FFA/CO. Work at each OU includes assessment of the contaminants, either through field sampling and analysis, or a records search in what is called the Track-1 or Track-2 process. Depending on the outcome of the assessment, specific sites within the OU may require a risk assessment, with the results documented in a Remedial Investigation/Feasibility Study.

WAG 5 is divided into 13 OUs, which identify specific past or suspected contaminant releases. These OUs include potential sites located at or near the PBF/ARA and include all the Special Power Excursion Reactor Test facilities. The 13 OUs are in different stages of the process defined above. OU 5-12 has been designed to consider the comprehensive risk of all the WAG-5 sites and is intended to be the final Record of Decision for WAG 5.

Scope. Current planning includes evaluation of risks for the two remaining OUs, with Records of Decision being reached for all OUs, either separately or combined in the WAG-5 Comprehensive Remedial Investigation/Feasibility Study Record of Decision in FY 1999. This will result in remedial design(s)/remedial action(s) for any sites determined to present a risk to human health or the environment.

2006 End State. All investigations and remedial actions for WAG 5 will be completed.

WAG 7. RWMC Remediation

Mission. Assessment and cleanup activities at the Radioactive Waste Management Complex (RWMC) are necessary to evaluate the risk to human health and the environment and to remediate the site. Activities being conducted include field sampling of groundwater and vadose zone volatile organic compounds, Baseline Risk Assessment and Remedial Investigation of the site, fate and transport modeling of contaminants, Treatability/Feasibility Studies, Remedial Investigation/Feasibility Study report preparation, Proposed Plan and Record of Decision preparation, and Remedial Design/Remedial Action scoping and implementation. This project directly supports requirements of the FFA/CO that implements CERCLA for the assessment and remediation of the RWMC. Remedial action is being performed for OU 7-08, containing organic contamination in the vadose zone. Remedial action is complete for OU 7-12, Pad A, except for maintenance and monitoring requirements.

Scope. Waste disposed at the Subsurface Disposal Area includes mixed low-level radioactive waste and transuranic-contaminated mixed waste, all of which is contained in various forms and packages buried in the Subsurface Disposal Area. The assessment phase will investigate, characterize, and quantify the nature and extent of contamination. Routine monitoring of the groundwater, vadose zone, and Pad A is currently being performed in support of the Comprehensive Remedial Investigation/Feasibility Study. The cleanup phase will implement a remedial action alternative that achieves acceptable risk levels and meets Idaho, federal, and DOE applicable or relevant and appropriate requirements. Remedial actions will be performed for OU 7-08, which contains organic contamination in the vadose zone; OU 7-12, Pad A; and OU 7-13/14 and 7-10.

2006 End State. By 2006, routine and verification monitoring for groundwater pathways (OU 7-06), remedial action for organic contamination in the vadose zone (OU 7-08), and remedial action for the comprehensive pits and trenches (OU 7-13/14) will be in progress. The OU 7-13/14 Record of Decision will be signed, OU 7-13/14 Remedial Design activities will be under way, and excavation of a 20×20 ft area of Pit 9 will be complete under OU 7-10 Stage II.

Final End State. By 2020, retrieval and treatment of waste for OU 7-13/14 will be complete, treated transuranic waste will have been shipped to the Waste Isolation Pilot Plant for disposal, and other wastes will either be placed back in the SDA pits and trenches or disposed of at an engineered facility to be built at the Subsurface Disposal Area. By 2024, a cap will have been installed over the Subsurface Disposal Area and all D&D will be completed. A minimum of 100 years of post-remediation monitoring is expected to be required to help ensure the effectiveness of the WAG-7 remedial activities. All remediation activities for WAG 7 will be conducted under OU 7-13/14.

WAG 6 and WAG 10. Site Monitoring Area Remediation

Mission. This project covers the assessment and remediation of both WAG 6 and 10. WAG 6 consists of the Experimental Breeder Reactor and Boiling Water Reactor Experiment areas. Both the Experimental Breeder Reactor and the Boiling Water Reactor areas have been decommissioned. The Experimental Breeder Reactor is now a National Historic Landmark, open to the public. The Boiling Water Reactor Experiment area housed five different reactors, which were dismantled or moved, and only monitoring takes place in the area. WAG 10 includes miscellaneous surface sites, liquid disposal, and unexploded ordnance areas throughout the INEEL. It also includes regional Snake River Plain Aquifer and site ecological concerns relating to the INEEL that cannot be addressed on a WAG-specific basis. The release sites have been grouped into two OUs based on the nature of the potential release.

Scope. This project includes completing the OU 10-04 and OU 10-08 Comprehensive Remedial Investigation/Feasibility Study, Record of Decision, and Remedial Decision/Remedial Action per the FFA/CO. It also includes implementing long-term INEEL surveillance, maintenance, and monitoring per the OU 10-04 and OU 10-08 Records of Decision. Completing these activities supports the goal of removing the INEEL from the National Priority List Superfund Site.

2006 End State. All OU 10-04 and OU 10-08 assessment activities will be complete. Records of Decision for both OU 10-04 and OU 10-08 will be in place. Remedial Design/Remedial Action activities for both OU 10-04 and OU 10-8 will be under way. Long-term site groundwater, ecological, and institutional controls monitoring will be ongoing.

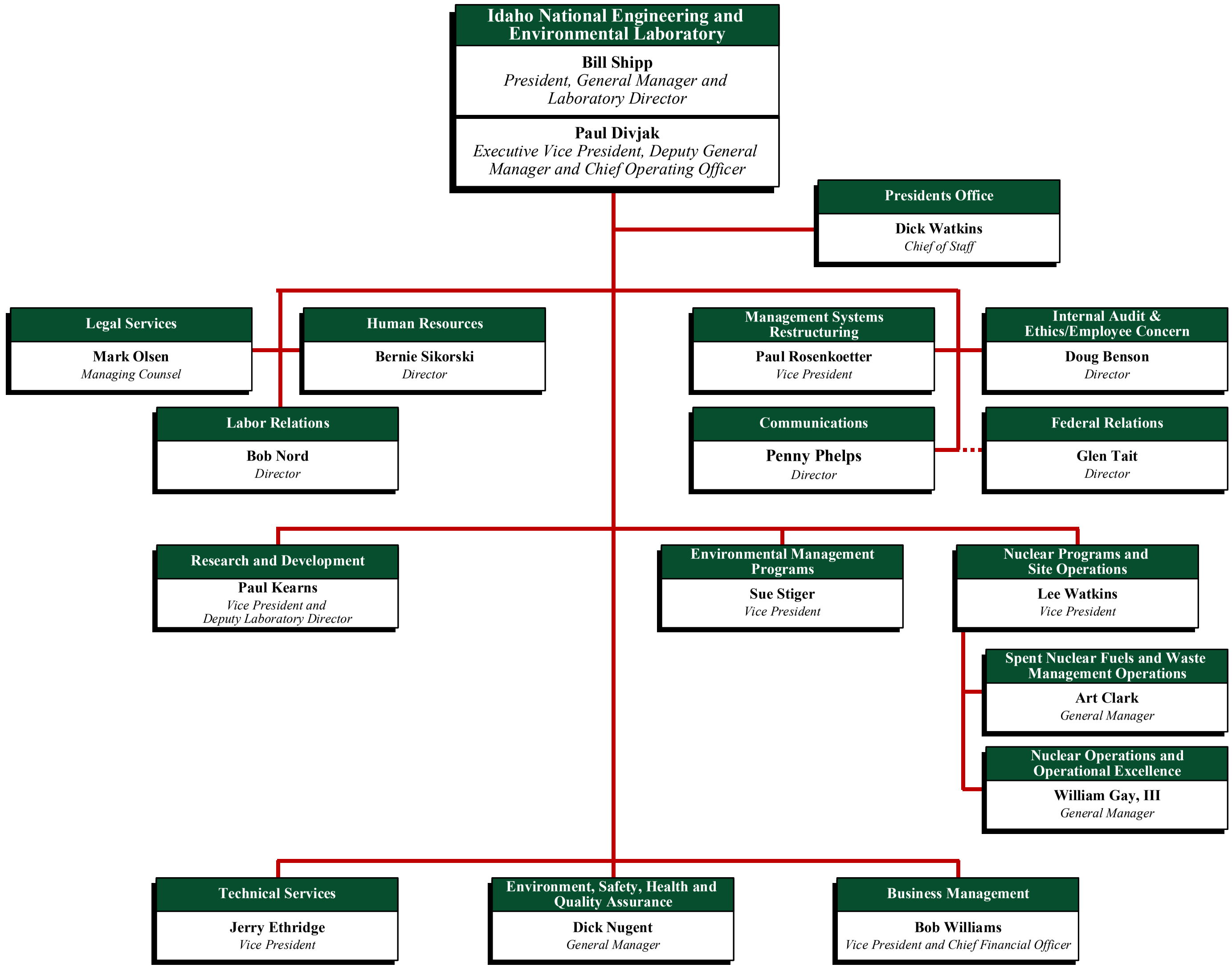
Final End State. Long-term groundwater, ecological monitoring, and institutional controls will continue.

Appendix E

INEEL Organization Chart

Appendix E

INEEL Organization Chart



Appendix F

Facility Optimization and Closure Plan

Appendix F
Facility Optimization and Closure Plan

The proposed Ten-Year Facility Optimization and Closure Plan delineates the Idaho National Engineering and Environmental Laboratory's (INEEL) revised approach to addressing the infrastructure impacts of its changing mission needs and funding limitations. Table F-1 shows the funding requirements, timing, life-cycle cost savings, and mission need associated with this optimized approach.

Table F-1. Proposed Ten-Year Facility Optimization and Closure Plan.

Proposed Facility	Estimated Completion Date	Preliminary Total Projected Cost (TPC)	Number of Facilities Closed	New Facility Life-Cycle Cost Savings	Proposed Fund Source	Primary Facility Use	Description of Mission Need
Consolidated Laboratory Facility at the Idaho Nuclear Technology and Engineering Center (INTEC)	2008	$80M	13 (186K ft^2)	$164M	DOE Office of Environmental Management (EM)	Lab	The INEEL infrastructure supports specific missions in the areas of hazardous-waste storage, treatment, remediation, and disposal; spent nuclear fuel storage and disposal; packaging and shipping of waste forms to permanent sites; and R&D in wastes, nuclear reactors, and scientific technologies.
Consolidated Laboratory Facility at Idaho Falls (IF)	2008	$20M (lease only)	(part of above)	(part of above)	Lease	Lab	(see above)
Bonneville Technical Center (geocentrifuge component of the Subsurface Geoscience Initiative)	2002	0	0	0	Corporate Funded R&D	Lab	The objective of the Geocentrifuge Facility, Corporate-Funded R&D is to procure a geocentrifuge and develop supporting facilities at the INEEL for conducting geotechnical testing and contaminant transport studies. This capability includes a 2-m radius geocentrifuge and laboratory support for conducting experiments and modeling of complex geological, geochemical, biological, and hydrological processes that influence subsurface behavior of contaminants. This capability is being developed to address pressing Department of Energy (DOE) and INEEL research needs in areas such as fluid and colloid movement in the vadose zone, and movement and long-term stability of engineered caps and barriers. In addition, the facility will be available

Table F-1. (continued).

Proposed Facility	Estimated Completion Date	Preliminary Total Projected Cost (TPC)	Number of Facilities Closed	New Facility Life-Cycle Cost Savings	Proposed Fund Source	Primary Facility Use	Description of Mission Need
							to Bechtel Corporate to conduct seismic and geotechnical engineering studies such as static and soil liquefaction tests, and to other national laboratory, university, and industry users.
Center for Science and Technology (component of the Subsurface Geoscience Initiative)	2004	$17.2M	0	0	State of Idaho	Lab	Center for Science and Technology, being developed by the Inland Northwest Research Alliance (INRA), is a laboratory and office facility intended to support collaborative research among academic and INEEL scientists. The facility is planned for 2003 and will be located at University Place in Idaho Falls. The center will bring important physical and intellectual resources to bear on the Subsurface Geosciences Initiative and will function as the initiative's home until the SGL is completed.
Subsurface Geosciences Laboratory (SGL) Line Item	2007	$170M TPC $165M Total Estimated Cost (TEC)	0	0	EM	Lab	The SGL will foster research that will provide critical understanding of fate and transport of contaminants in the subsurface. The laboratory will house advanced subsurface research including mesoscale experiments. Because of their size (in some cases exceeding 1,000 m^3) and complexity, and the need to use actual DOE contaminants, mesoscale experiments require specialized facilities that currently do not exist in the DOE complex. Mesoscale experiments link traditional laboratory experiments with field-scale observations. Traditional

Table F-1. (continued).

Proposed Facility	Estimated Completion Date	Preliminary Total Projected Cost (TPC)	Number of Facilities Closed	New Facility Life-Cycle Cost Savings	Proposed Fund Source	Primary Facility Use	Description of Mission Need
							laboratory experiments focus on controlled studies of single processes or individual mechanisms, while field-scale experiments are obtained under uncontrolled real-world conditions, which impede determination of the underlying processes. Mesoscale experiments typically consist of large and flexible, but controlled, test sites that allow determination of the underlying processes and thereby provide an improved understanding of subsurface contaminant fate and transport. The SGL will provide specialized facilities to conduct experiments involving the following: • Evaluation of coupled processes affecting fate and transport of contaminants in subsurface media. Evaluation of coupled process requires large areas for experimentation. Understanding of coupled processes is critical to developing validated field-relevant predictive models. • Use of contaminants, tracers, and microorganisms that would be prohibited in a field experiment. Past experiments using surrogates rather than real contaminants have not provided the critical information needed to make effective cleanup decisions.

Table F-1. (continued).

Proposed Facility	Estimated Completion Date	Preliminary Total Projected Cost (TPC)	Number of Facilities Closed	New Facility Life-Cycle Cost Savings	Proposed Fund Source	Primary Facility Use	Description of Mission Need
Test Reactor Area (TRA) Administration Building	2008	$17.2M	8	$2.8M	DOE Office of Nuclear Energy, Science, and Technology (NE)	Office/ support	The existing TRA administration functions are done from many buildings through TRA. Many of the buildings are old and have safety and health deficiencies. The facilities are in poor condition and will not support the TRA mission over the next 30 to 50 years. Many of these facilities require extensive upgrades, while others are scheduled for destruction and removal in the near future. Feasibility studies show that the most efficient and cost-effective mitigation of these problems is the construction of a new consolidated TRA administration building.
Restoration of Remaining Mission Critical Infrastructure (see 10 subprojects below)	2009	$79M	0	$106M	EM	Utilities/ support	These projects propose to upgrade INEEL mission-critical infrastructure to facilitate meeting mission needs and to reduce overall long-term facility capital upgrade and maintenance costs at the INEEL. The Infrastructure Restoration/Optimization Project will concentrate on upgrading only those remaining facilities, structures, and utilities that are mission critical or needed to support mission-critical activities to reduce the gap between projected outyear funding allocations and funding needs.

Table F-1. (continued).

Proposed Facility	Estimated Completion Date	Preliminary Total Projected Cost (TPC)	Number of Facilities Closed	New Facility Life-Cycle Cost Savings	Proposed Fund Source	Primary Facility Use	Description of Mission Need
Subproject 1. Central Facilities Area (CFA) Substation High-Voltage Bus Upgrade		2M of 79M					The high-voltage insulators and strain bus at the Scoville Substation are more than 50 years old, well beyond their normal life expectancy of 30 years.
Subproject 2. INTEC-606 Service Building/Powerhouse Electrical, Mechanical, and Roof Upgrades		5M of 79M					The facility is over 40 years old and needs additional electrical, mechanical, and structural upgrades to reach its projected end of life in 2035.
Subproject 3. INTEC Utility Demineralization Upgrade		1.6M of 79M					The system lacks adequate hangers, expansion joints, and protection from water hammer. Because of this, major leaks erupt frequently. This creates safety issues and high maintenance costs and poses probable impacts to high-level waste and spent nuclear fuel programmatic operations.
Subproject 4. INTEC Emergency Communications Upgrade		15M of 79M					The existing system is made up of two separate older designs that have been modified over the years. Noncompliance and the lack of direct occupant notification for most INTEC buildings are serious concerns.
Subproject 5. INTEC Potable Water Upgrades		.4M of 79M					The INTEC-663 facility has several potable water source/line noncompliance problems that present safety and health concerns.
Subproject 6. INTEC Fire Alarm Safety Upgrade		12M of 79M					The system must be updated to maintain a safe worker environment and to ensure that INTEC's mission is not jeopardized.
Subproject 7. INEEL		30M of 79M					This project replaces or upgrades 20- to

Table F-1. (continued).

Proposed Facility	Estimated Completion Date	Preliminary Total Projected Cost (TPC)	Number of Facilities Closed	New Facility Life-Cycle Cost Savings	Proposed Fund Source	Primary Facility Use	Description of Mission Need
High-Voltage Equipment Replacements							50-year-old major electrical equipment on the site electrical distribution system. Failure of these components will result in loss of electrical power to critical facilities onsite.
Subproject 8. INEEL Road System Upgrade		8M of 79M					Specific INEEL roads are essential to the movement of radioactive waste and spent nuclear fuel shipments. Periodic upgrading of these transportation avenues is critical to maintaining capability in meeting state milestones and for safe shipments of these hazardous materials.
Subproject 9. Modify INTEC Facilities to Accommodate Crafts and Warehouse Move from CFA		2M of 79M					Investing in upgrades at INTEC will result in overall cost reductions for the INEEL's infrastructure budget.
Subproject 10. INEEL Research Center Upgrades		3M of 79M					Corrosive fumes in the IF-603 fume hood exhaust system caused considerable deterioration to the mild steel ductwork. Repairs are frequently required. The heating, ventilating, and air conditioning system in the IF-602 office building is not capable of satisfying the heat load, and the repair parts for the air handlers are no longer available. Furthermore, the electrical distribution system is operating at capacity, has no room for growth, and does not meet current electrical codes and standards.

Appendix G

Acronyms

Appendix G

Acronyms

ANL	Argonne National Laboratory
ARA	Auxiliary Reactor Area
ATR	Advanced Test Reactor
BBWI	Bechtel BWXT Idaho, LLC
BNCT	boron neutron capture therapy
BWXT	BWX Technologies, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	*Code of Federal Regulations*
CI	INEEL Counterintelligence
CNG	compressed natural gas
CRADA	Cooperative Research and Development Agreement
CRIMNET	Criminal Records Information Management Network
CST	Center for Science and Technology
D&D	decontamination and decommissioning
DNAPL	dense nonaqueous phase liquid
DOD	Department of Defense
DOE	Department of Energy
DOE-HQ	DOE Headquarters
DOE-ID	DOE Idaho Operations Office
DOI	Department of Interior
DOT	Department of Transportation
DS	Digital Signal Level
EE	Energy Efficiency and Renewable Energy Office of DOE

EM	Environmental Management Office of DOE
EML	Environmental Management Laboratory
EMS	Environmental Management System
EPA	Environmental Protection Agency
ESAAB	Energy System Acquisition Advisory Board
ESH&QA	Environment, Safety, Health, and Quality Assurance
ESnet	Energy Sciences Network of DOE
EXT	external
FE	Fossil Energy Office of DOE
FFA/CO	Federal Facility Agreement and Consent Order
FTE	full-time equivalent
FY	fiscal year
HEPA	high-efficiency particulate air
HQ	headquarters
ICES	International Center for Environmental Safety
IN	Intelligence Office of DOE
INEEL	Idaho National Engineering and Environmental Laboratory
INRA	Inland Northwest Research Alliance
INT	internal
INTEC	Idaho Nuclear Technology and Engineering Center
IRC	INEEL Research Center
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
ISSM	Integrated Safeguards and Security Management
ITER	International Thermonuclear Experimental Reactor
LANL	Los Alamos National Laboratory

LDRD	laboratory-directed research and development
LLC	Limited Liability Company
LNG	liquefied natural gas
LOFT	Loss-of-Fluid Test
LTS	Long-Term Environmental Stewardship
MACT	Maximum Achievable Control Technology
NASA	National Aeronautics and Space Administration
NDA	nondestructive analysis *or* nondestructive assay
NDE	nondestructive examination
NE	Nuclear Energy, Science, and Technology Office of DOE
NETL	National Energy Technology Laboratory
NRC	National Research Council
NRF	Naval Reactors Facility
OC	optical carrier level
OIT	Office of Industrial Technologies of DOE
ORNL	Oak Ridge National Laboratory
OTT	Office of Transportation Technologies of DOE
OU	Operable Unit
PBF	Power Burst Facility
PG&E	Pacific Gas and Electric
PLC	Public Limited Company
PNNL	Pacific Northwest National Laboratory
PRA	probabilistic risk assessment
R&D	research and development
R2A2	roles, responsibilities, accountabilities, and authorities
RCRA	Resource Conservation and Recovery Act

RELAP5	Reactor Excursion and Leak Analysis Program, Version 5
RESL	Radiological and Environmental Sciences Laboratory
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SAPHIRE	Systems Analysis Programs for Hands-on Integrated Reliability Evaluation
SC	Science Office of DOE
SCDAP	Severe Core Damage Analysis Package
SciDAC	Scientific Discovery through Advanced Computing
SDA	Subsurface Disposal Area
SGL	Subsurface Geosciences Laboratory
SIINET	Sitewide INEEL Information Network
SMC	Special Manufacturing Capability
SRTC	Savannah River Technology Center
SSI	Subsurface Science Initiative
START	Strategic Arms Reduction Treaties
TAN	Test Area North
TRA	Test Reactor Area
UHF	ultrahigh frequency
VHF	very high frequency
VPP	Voluntary Protection Program
WAG	Waste Area Group
WIPP	Waste Isolation Pilot Plant
WROC	Waste Reduction Operations Complex

Appendix H

Cited Documents

Appendix H

Cited Documents

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U.S. Department of Energy National Laboratory
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INEEL/EXT-02-00307