Nuclear Energy Research
Advisory Committee

April 28, 2004

The Honorable Spencer Abraham
Secretary of Energy
Washington, D.C. 20585

Dear Mr. Secretary:

As Chairman of the Nuclear Energy Research Advisory Committee (NERAC), it is my pleasure to forward to you with this letter a copy of the January 16, 2003, *Report of the Infrastructure Task Force of the DOE Nuclear Energy Research Advisory Committee.*

The Task Force's most important conclusions are that:

- It is significant and important to have designated a lead laboratory for nuclear energy research and development;
- The funding at the Idaho Site, given the lead lab status is clearly insufficient;
- Certain facilities (*e.g.*, the Fuel Processing Facility) that have lost their missions or for which significant maintenance challenges exist should be abandoned; and
- If Idaho Site facilities are to be used for specific proposed missions, *e.g.*, Advanced Fuel Cycle Initiative, Generation IV Reactors, and other nuclear energy programs beyond 2010, resources must be provided at appropriate levels.

The most important recommendations are:

- The Federal commitment to nuclear energy needs to be restated and reinforced by the White House and other senior Administration officials.
- For the Administration to go forward with "nuclear energy beyond 2010" the lead lab site at Idaho requires an immediate and significant increase in funding to, *e.g.*, clear up maintenance backlog and make key facilities mission ready.
- University participation (faculty and students) should be a basic element of research and development in "nuclear energy beyond 2010."
- Some facilities should be shut down or not considered for further development including the uncompleted Fuel Processing Facility. There may be others such as the Flourinel Dissolution Process Cell.
- New facilities will probably be needed for the purposes of "nuclear energy beyond 2010." This may include a source of fast neutrons, among others. In this regard, the Task Force recommends a specific study on the need for steady and fast neutron facilities in the United States. This study should consider accessibility of existing support facilities.
- To optimize the use of resources, the Task Force strongly recommends use of facilities beyond the Idaho Site but in the United States (*e.g.,* Argonne National Laboratory-East, Oak Ridge, and Savannah River) and international sites in the Geneneration IV partner countries.
- As the lead nuclear energy laboratory, the Idaho National Engineering and Environmental Laboratory should establish an external review process for laboratory activities.

The full NERAC accepted the Task Force's report at its last meeting on November 4, 2003. In forwarding the accepted report to you, NERAC wants also to convey its recommendation, reflected in the following statement:

Recognizing that:

- **The environmental cleanup at Idaho National Engineering and Environmental Laboratory has many obstacles;**
- **The NERAC Infrastructure Task force and the Office of Nuclear Energy, Science and Technology's Ten-Year Plan for Idaho National Laboratory (INL) has identified significant long-delayed facility improvements; and**
- **To make INL the leading nuclear energy laboratory, as is the DOE goal;**

NERAC urges the Department of Energy not to link INL funding to Office of Environmental Management cleanup funding decreases, but to provide INL the substantial funding that will be necessary to achieve the goal of an outstanding laboratory.

To continue where this study left off, NERAC has created a Subcommittee on Nuclear Laboratory Requirements that will assist NERAC in identifying what characteristics, capabilities, and attributes a world-class nuclear laboratory would possess. This effort will help the Department achieve its objective of making INL the leading nuclear energy laboratory in the world within ten years of its inception. The Subcommittee will deliver its report by the end of fiscal year 2004. We will provide our recommendations on the findings of the Nuclear Laboratory Requirements Subcommittee as soon as the full committee has had an opportunity to review them.

Thank you for your continued support for NERAC activities and careful consideration of NERAC recommendations.

Sincerely,

William F. Martin
Chairman

Enclosure

cc: Dr. John Ahearne, NERAC
Mr. William D. Magwood, IV, DOE/NE
Mr. Mark Roth, DOE/NE

REPORT

of the

INFRASTRUCTURE TASK FORCE

of the

DOE NUCLEAR ENERGY RESEARCH ADVISORY COMMITTEE

January 16, 2003

EXECUTIVE SUMMARY

On October 1, 2002 the DOE Nuclear Energy Research Advisory Committee was asked to provide specific, focused updates to its *Nuclear Science and Technology Infrastructure Roadmap* and review the specific issues at the DOE key nuclear energy research and development (R&D) laboratories. This activity was assigned to a five-member Infrastructure Task Force (ITF). After receiving extensive written materials from DOE, the Idaho Nuclear Engineering and Environmental Laboratory (INEEL) and Argonne National Laboratory-West (ANL-W), on November 6-8, 2002 the ITF visited the Idaho site and received briefings and tours of the INEEL and ANL-W facilities. INEEL and ANL-W have provided updated facility descriptions that will be incorporated by DOE staff, with ITF review, into a revision of the *Roadmap*.

On January 7-8, 2003 the ITF met in Albuquerque, NM to complete preparation of this Report. Detailed Conclusions and Recommendations of the ITF are found in Sections IV and V, respectively, of the Report. The most important conclusions are:

- ITF believes it is significant and important to have designated a lead laboratory for nuclear energy research and development.
- The funding at the Idaho site, given the lead-lab status is clearly insufficient.
- ITF notes that there are certain facilities, e.g., the Fuel Processing Facility, that have lost their missions and/or for which significant maintenance challenges exist. These facilities should be abandoned.
- ITF observes that if Idaho site facilities are to be used for the proposed missions, e.g., Advanced Fuel Cycle Initiative, Generation IV Reactors and other nuclear energy programs beyond 2010, resources must be provided at appropriate levels.

The most important recommendations are:

- Given events since the *National Energy Strategy* was issued, the ITF believes that the federal commitment to nuclear energy needs to be restated and reinforced by the White House and other senior administration officials.
- For the Administration to go forward with "nuclear energy beyond 2010" the lead lab site at Idaho requires an immediate and significant increase in funding to, e.g., clear up maintenance backlog and make key facilities mission ready.
- ITF recommends that university participation (faculty and students) be a basic element of research and development in "nuclear energy beyond 2010".
- Some facilities should be shut down or not considered for further development. In our view this includes the uncompleted Fuel Processing Facility (FPF) that we recommend be abandoned. There may be others such as the Flourinel Dissolution Process Cell (FDP).
- New facilities will probably be needed for the purposes of "nuclear energy beyond 2010". We believe this might include a source of fast neutrons, among others. In this regard ITF recommends a specific study on the need for steady and

fast neutron facilities in the U.S. This study should consider accessibility of existing support facilities.

- In order to optimize the use of resources we strongly recommend that use of facilities beyond the Idaho site but in the U.S. (e.g. ANL-E, Oak Ridge, and Savannah River) and international sites in the Gen IV partner countries.
- Given the designation of INEEL as the lead nuclear energy laboratory, ITF recommends that INEEL establish an external review process for laboratory activities.

The ITF appreciates the support and candor of the INEEL and ANL-W staffs during our visit and in their responses to our request for additional information. We also appreciate the support of DOE staff in the preparation of the update to the *Nuclear Science and Technology Infrastructure Roadmap*. As stated in the Report, there are significant challenges to be met for INEEL to truly become the lead DOE Laboratory for nuclear energy research and development.

DOE NERAC Infrastructure Task Force Report

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I. INTRODUCTION

In a letter from William D. Magwood, IV to Professor James J. Duderstadt, dated October 1, 2002, Mr. Magwood requested that the DOE Nuclear Energy Research Advisory Committee provide specific, focused updates to its *Nuclear Science and Technology Infrastructure Roadmap* and review the specific issues at the DOE key nuclear energy research and development (R&D) laboratories. At the NERAC meeting of September 30-October 1, 2002, Dr. Duderstadt assigned this review to an Infrastructure Task Force (ITF) made up of the following members:

Robert L. Long, Chair, Nuclear Stewardship, LLC
Michael L. Corradini, University of Wisconsin-Madison
Jose L. M. Cortez, University of Texas Pan American
Warren F. Miller, Jr., Los Alamos National Laboratory
Allen L. Sessoms, Harvard University

In the letter from Mr. Magwood to Dr. Duderstadt, the ITF was asked to:

- Update the roadmap and review the specific issues at the key DOE nuclear energy research and development laboratories.
- Advise concerning the maintenance, upgrade and new construction needs of DOE laboratory infrastructures.
- Focus the first activity on the Idaho National Engineering and Environmental Laboratory (INEEL), including Argonne National Laboratory-West (ANL-W), as DOE's lead nuclear energy laboratory. Once this activity is completed, DOE will request that NERAC review other sites of interest.
- Assess the current state of the facilities at INEEL and ANL-West and analyze the infrastructure gaps that could prevent DOE from conducting R&D in key nuclear technology areas over the next decade.
- Consider both existing and emerging R&D needs,

  Nuclear Power 2010
  Nuclear energy beyond 2010, e.g., the Gen IV Initiative
  Related work on advanced fuel cycle initiatives
  Radioisotope and reactor systems for space applications

- Consider availability of facilities and capabilities elsewhere when making final recommendations.
- Complete initial report by end of calendar year 2002.

The ITF began the process immediately with a review of various documents provided by DOE, INEEL and ANL-W. On November 6-8, 2002, the ITF visited INEEL and ANL-W to receive extensive briefings and tours of facilities. After receiving additional information the ITF met in Albuquerque, NM on January 7-8, 2003 to complete our review and prepare this Report.

This Report provides the results of the ITF review. Section II describes the process underway by DOE staff, with ITF review, to update the *Nuclear Science and Technology Infrastructure Roadmap.* Section III summarizes the ITF review of the INEEL and ANL-W infrastructures. And sections IV and V present the ITF conclusions and recommendations.

II. UPDATE OF THE NUCLEAR SCIENCE AND TECHNOLOGY INFRASTRUCTURE ROADMAP

The first draft of the *Nuclear Science and Technology Infrastructure Roadmap* was completed in December 1998. The *Roadmap* documented a detailed analysis of the Nation's nuclear research and development (R&D) infrastructure in which likely science and technology requirements through the year 2020 were compared to existing facility capabilities. A subsequent revision, issued in March 2000, added additional analyses that considered such factors as facility staffing requirements, evolving missions, schedules, costs, and facility capacities.

The ITF has, as a result of its evaluation of the Idaho site, generated substantial new information for inclusion in the next update of the *Roadmap.* In particular, new facility descriptions were developed for both INEEL and ANL-W nuclear facilities. Additionally, the site Laboratories provided the ITF with detailed assessments of programmatic needs and likely facilities to meet those needs. Both the new facility descriptions and the needs/facilities assessment have been provided to DOE for inclusion in the next revision of the *Infrastructure Roadmap*. Additionally, ITF analyses of staffing requirements should be reflected in the *Roadmap* and are provided for inclusion in its next update.

Finally, the ITF recommends that a broader revision of the *Roadmap* be undertaken to bring it up to date. There have been numerous changes to the DOE facilities and missions in the past three years that should be included in the *Roadmap*. Even without a more general reassessment of the complex, the new data generated by the ITF warrants a revision of the *Roadmap* that should be made and submitted to the NERAC soon after publication of this Report.

III. REVIEW OF INEEL AND ANL-W INFRASTRUCTURE

A. Overview of Site and Facilities

1. General Description

The Idaho National Engineering and Environmental Laboratories (INEEL) and the Argonne National Laboratories-West (ANL-W) are large research and development centers located in southeast Idaho, near Idaho Falls in a valley between the Grand Teton and Sawtooth Mountain ranges. Argonne-West is located on an 800-acre tract within INEEL, about 35 miles west of Idaho Falls.

The INEEL consists of eight major facility areas scattered across an 890-square-mile area typically referred to as the "site." The ninth area includes several laboratories located approximately 30 miles east in the city of Idaho Falls.

The Test Area North (TAN) consists of facilities for handling, storage, examination, and research of spent nuclear fuel. TAN also houses the Specific Manufacturing Capability Project, which makes armor packages for Army tanks.
The Test Reactor Area (TRA) is one of the world's most sophisticated materials testing complex and has extensive facilities for studying the effects of radiation on materials, fuels, and equipment. The Advanced Test Reactor (ATR) is located in the TRA.

The Idaho Nuclear Technology and Engineering Center (INTEC) provides safe interim storage for government-owned spent nuclear fuels. INTEC currently develops new approaches and technologies to prepare spent fuel and other nuclear materials for eventual disposal in a national repository. It also is the center for the INEEL's High-Level Waste treatment program.

The Central Facilities Area (CFA) houses many technical and support services including monitoring and calibration laboratories, fire protection, medical services, warehouses, vehicle and equipment pools, and bus operations.

The Waste Reduction Operations Complex/Power Burst Facility (WROC/PBF) is housed in an area formerly used for reactor operations. WROC/PBF provides safe treatment, storage, and recycling of the INEEL's radioactive, mixed, and industrial/commercial wastes.

The Radioactive Waste Management Complex (RWMC) studies the strategies for waste storage, processing, and disposal. Some 32,000 drums containing waste are safely stored at this facility.

The Naval Reactors Facility (NRF) is the birthplace of the U.S. Nuclear Navy. NRF receives and examines Naval spent fuel, and works together with other INEEL facilities to continually improve nuclear propulsion systems

The INEEL Research Center (IRC) is located in Idaho Falls, and is INEEL's primary research complex with activities in the areas of fundamental and applied R&D in science and engineering areas critical to national and DOE missions.

The facilities of ANL-W are predominantly contained within a fenced area of about 90 acres. The only exception is the Transient Reactor Test Facility, which is located about a mile away. ANL-W is devoted mainly to R&D on nuclear technology.

At ANL-W current primary missions are the use of electrometallurgical techniques to treat driver and blanket assemblies from the Experimental Breeder Reactor-II (EBR-II) and the development of technologies for deactivating other sodium-cooled reactors. In addition to Nuclear Energy, Science and Technology, DOE programs using ANE-W

facilities include Environmental Management, Defense Nuclear Nonproliferation, and Defense Programs.

The EBR-II has now been shut down and defueled. It is serving as a demonstration facility for the development of deactivation methods applicable to other nuclear power plants. One key technological issue is treating EBR-II spent fuel to stabilize it from a mixed hazardous waste to a final form that will meet the requirements of a geologic repository. This problem is being addressed at the Fuel Conditioning Facility (FCF), where sodium is being removed from inside the EBR-II fuel and where the spent fuel will be converted from a mixed hazardous waste to a stable metallic and mineral waste form. A second technological issue is processing large quantities of contaminated sodium into a nonreactive waste form for disposal. A third issue is development and implementation of a safe process for controlled reaction of sodium remaining in the reactor's primary system following the draining operation.

The Transient Reactor Test Facility (TREAT) is not currently operating, but the facility is being used to conduct various nondestructive-assay experiments with irradiated materials in containers and shielding casks.

The Zero Power Physics Reactor (ZPPR), now in standby status, was used for physics testing of new reactor core designs. The facility includes a large fuel storage vault that provides state-of-the art storage for special nuclear materials.

The Fuel Manufacturing Facility (FMF), previously used to fabricate fuel for the EBR-II, has completed manufacturing of stainless steel subassemblies for replacement purposes in the defueling of EBR-II.

ANE-W houses about 690 persons. The site includes approximately 70 buildings having 600,000 gross square feet of floor space. Most of the buildings and other infrastructure were originally built during the mid to late 1960s but have since been upgraded and expanded.

2. Maintenance Backlog

Because most building and facility infrastructure systems have a useful-life expectancy of 25-35 years, many ANL-W and INEEL facilities constructed in the 1950s and 1960s now require upgrading or replacement. This aging of facilities has caused the accumulation of a large inventory of needed revitalization. Furthermore, as costs related to space continue to escalate — notably heating, cooling, lighting, and maintenance — effective use of that space has become increasingly important.

The major programmatic facilities at the two laboratories have been well maintained, and all are projected to have useful lives of 15 years or more. General purpose facilities have been maintained with limited funds in a workable state of repair by giving priority to jobs critical or necessary to prevent much more costly future repairs.

However, a backlog of needed repairs and rehabilitation has accumulated. It is estimated that $9.3 million at ANL-W and $10.8 million at INEEL are needed just to ensure the continued safe operation of important experimental facilities. An additional several million dollars will be needed to address deficiencies in the balance of plant (utilities, etc.) on the two campuses.

Additional General Purpose Program (GPP) funding of about $10 million is needed annually for the normal maintenance, repair, and upgrades that keep facilities functional and in compliance with escalating requirements in areas such as safety and environmental protection. Throughout the last decade, GPP funding was well below requested levels. As a consequence, many needs were deferred, and a backlog was created. Adequate GPP funding will prevent premature deterioration or failure of facilities and systems resulting from deferred repair and will also ensure compliance with ES&H regulations and permits.

3. Equipment Upgrades

In order to provide the most useful set of experimental tools for the assigned missions much of the equipment used at the two laboratories is in need of replacement and/or upgrading. While the details are facility specific it is reasonable to expect funding needs in the area of $50 million. Without such an expenditure it is unlikely that new missions will be successfully accomplished or that these laboratories will be able to maintain positions as national leaders in nuclear energy research.

4. Mission Readiness

This is a category of readiness that requires full staffing and equipment for the expanded tasks required of the facilities. While it varies from one facility to another it is clear that few facilities at either lab are fully "mission ready." The laboratories must themselves provide resource requirements to reach this level of preparedness. Suffice it to say that new resources in the tens of millions of dollars annually will be necessary if all the major facilities at the two sites were to be at this level.

5. Advanced Test Reactor (ATR)

The ATR is well positioned to support a number of NE programs now under consideration. These programs include development of the Supercritical Water Reactor System, Gas Fast Reactor System, Lead-Cooled Fast Reactor System, the Very High Temperature Reactor System, the Advanced Fuel Cycle Initiative, Series I and II and the Nuclear Space Initiative.

Each of these programs has unique test requirements, which can be addressed using ATR with some special modifications or improvements in the reactor core geometry to simulate the desired radiation levels. For example the design and deployment of a supercritical-water loop for super critical water reactor materials testing in the ATR reactor would require more then $10 million dollars and 3 to 4 years to construct. This modification, while expensive, would allow the program to move forward without having to build a new facility for this purpose. Similar modifications can be envisioned to do capsule type irradiations of Gas Fast Reactor System components by building a fast flux booster around one of the flux trap locations. The cost for this modification is estimated to be in the $10 million range and can be done in about 3 years.

Similar modifications have been proposed for this facility and are summarized in the facilities description to be included in the updated Roadmap.

The important point is that this facility is well staffed and in very good operating condition. Presently it is used and funded primarily by the U.S. Navy and other smaller customers. It is our understanding that the Navy is interested in some cost sharing with DOE and they are willing to share this facility so long as it is available to the Navy on a regular basis. It is important to recognize that this facility may not be able to simulate all the conditions called for in the NE programs mentioned above. It would then have to be determined to what extent the facility can be modified to simulate high temperature and high neutron flux conditions needed to study new fuel materials, etc. These questions could be deferred until a better definition is made as to the extent and scope of program are better defined, based on the available resources. The ATR could be a very useful tool for many of the applications discussed under the NE-Gen-IV missions, but scheduling of various activities mentioned above, along with the Navy requirements appear to be a significant challenge.

6. Fuel Processing Facility (FPF)

One of the facilities mentioned as a candidate to support the Advanced Fuel Cycle work is the FPF, a second-generation nuclear fuel processing facility that was built for this purpose but never completed. As described in the facility description to be included in the updated Roadmap, FPF was never completed and presently is not useful unless one is willing to invest several hundred million dollars to install basic services such as electrical, heating and ventilation, control rooms, in addition the basic fuel processing equipment. This is a good example of the type of facility that needs to be left out of the initial NE nuclear energy initiative, unless this initiative specifically calls for spent fuel processing and recovery of enriched uranium as an oxide product. The present AFCP separations and by-product handling needs are significantly more diverse. A feasibility study to assess the FPF modifications needed to accommodate the new requirements will cost hundreds of millions if you include other safety analysis costs and NEPA requirements to reopen such a facility. The ITF recommends that any study or plans to complete and open the FPF be abandoned.

7. Proposed INEEL Consolidated Laboratory Support Facility

Along with the need to establish scientific teams to undertake the new advanced reactor NE programs INEEL is proposing consolidation of the many facilities now available to undertake this new mission. Some of these facilities are scattered all over the Idaho desert and are in various stages of readiness. Some facilities are mission ready while others will require significant upgrades and/or improvements in order to meet the new mission needs. INEEL feels that in addition to setting up the new technical teams it is also important to provide a high quality work environment in a cost effective manner, one that will be attractive to new personnel who will be required to undertake this new mission. The facilities description to be included in the updated Roadmap identifies the INEEL facilities to be considered for consolidation, including specific building locations, the year a facility was built, physical condition, and the present and/or potential use.

Another reason for wanting to consolidate these facilities is to consolidate high risk functions involving the handling of irradiated nuclear materials now located out in the desert and move lower risk activities to town (Idaho Falls) to reduce operating costs.

In general the majority of the facilities located in the desert, where most of the radiological work is now performed, are in poor condition and will require a substantial sum of money to bring these facilities into full operation. The cost will be dependent on the number and type of facilities to be used in the new NE programs, but in general the laboratory feels that a significant amount of money could be saved in the long run by not having to keep some of these structures open.

The committee feels that this consolidation could indeed yield these benefits in the long run, but if funds are limited, then consolidation should be second in priority and program funds should be used for program development, except where a new facility is clearly identified as necessary or when the upgrading costs of a given facility not now in operation (such as the TREAT reactor), will be close to what it would cost to bring a new facility into operation.

INEEL is urged to develop a facilities consolidation plan, once the NE technical mission is better defined.

B. Staff

1. Human Infrastructure

It is the committee's view that to be successful, an organization needs to invest a significant amount of effort on three critical elements of their "business":

- People (human infrastructure)
- Ideas (intellectual infrastructure)
- Tools (physical infrastructure)

The physical infrastructure (tools) is useless without the intellectual innovations (ideas) that can effectively utilize these tools. And these ideas cannot be conceived of without the ability to recruit and retain top-notch people.

INEEL and ANL-W each have their own management structure as well as individual strategic plans for future laboratory direction. However, these laboratories share a common experimental site and through official memorandum of agreement as well as informal affiliations and arrangements work together extensively and collaboratively in various phases of nuclear technology research and development. Therefore, issues related to personnel staff readiness, recruitment and retention need to be considered for these laboratories at the Idaho Site.

Historically, like other major U.S. national laboratories, INEEL and ANL-W have enjoyed the benefits of reputations that attract top-notch individuals. Their role has been leadership of U.S. R&D in civilian nuclear power, and establishing specialties in nuclear

power-related areas that were many and deep. If a student's interest and/or graduate work was in nuclear reactor safety, for example, the student knew very well the cadre of reactor safety people at Argonne and Idaho, and of the work they did, whether it be in light-water reactors or liquid-metal reactors. This reputation continues today, but it is not as strong as it once was. INEEL and ANL-W still have scores of world-class people in reactor physics, computer-code development, reactor safety, nuclear engineering, fuels and materials development, fuel cycle, and nuclear facility design and operations. But with the exception of certain areas (e.g., fuel cycle or reactor operations), the number of key scientists and engineers are not as large as they have been historically, and they are aging. Both INEEL and ANL-W have lost capabilities in certain key areas; e.g., reactor design, reactor safety and large component development.

2. ANL-W Approach to Staff Recruitment

The Argonne National Laboratory (ANL) nuclear R&D program is roughly $80 million per year, and provides the lab some flexibility to move expertise from one program area to another as emphasis changes. Our NERAC Task Force raised a question in this regard over resuming operations at TREAT, noting that there was apparently a "skeleton crew" at the facility. The ANL response was that the lab still has the expertise needed to restart TREAT, but that this expertise is currently assigned elsewhere at the ANL-W site. ANL contends that if a sufficient market for TREAT can be developed, key personnel can be reassembled. The task force remains unconvinced.

However, the ANL staff was also quick to point out that this flexibility would not last indefinitely (or even past the next few years). For example, in reactor operations, this is difficult because there is little related work that can substitute effectively for it.

Argonne has always emphasized close relations with the nuclear science and engineering programs in the Nation's universities and it will become increasingly important for both ANL-W and INEEL to continue this emphasis. Several years ago for example, given ANL's increasing interest in the complete nuclear fuel cycle, it broadened this academic community focus to include chemistry and chemical engineering. This shift toward other disciplines may continue in the future as nuclear security programs grow in importance. As a whole, Argonne has formal interactions with about 700 students annually, and typically supports about 40 students each summer at ANL-W on the Idaho site. Almost invariably, students are enticed by the breadth of the work at Argonne, and these interactions often lead to success in recruitment.

In the mid-1980's ANL conceived of an educational program that is continued as a basic model for student interactions at ANL today. It was called the "IFR Intern Program", with the following features:

- Seek bright, motivated seniors and first-year grad students,
- Assign them to work directly with our best researchers,
- Pay them well (create demand), encouraging them for grad study,
- Encourage continued summer work at Argonne,
- Encourage Argonne related graduate research,
- Hire them whenever possible.

ANL staff points out that this model has been a rich success: three of Argonne's programmatic Associate Division Directors in their nuclear energy programs (of a total of ten), and one of their senior program managers in fuel cycle, resulted from application of this model.

ANL staff has also pointed out that faculty collaboration have not been as robust. There is recent emphasis to improve this. ANL staff serves on a number of engineering department advisory councils. Numerous faculty members, in turn, serve on the independent Division and program peer-review Committees of the University of Chicago. This area of continuous contact and collaboration with a broad spectrum of faculty is something that deserves constant attention.

The ITF recommends and believes ANL staff would agree there is a need to emphasize stronger ties with faculty and students in the universities with major nuclear (and allied) programs. There should be an important local component to this as well with Idaho State University, the University of Idaho, and the other Inland Northwest Research Association institutions. The major drawing card in all of this is that INEEL and ANL-W will be where the research will be centered, and it is where the major facilities needed for next-generation reactor and fuel cycle R&D exist.

3. INEEL Approach to Staff Recruitment

INEEL management also recognizes that top-notch scientists and engineers are pivotal to perform high quality research and to produce superior products and services. To this end, INEEL employs a variety of recruiting methods aimed at attracting the best and brightest in the technology fields of the future. The INEEL compensation policies are designed to attract, retain, and motivate the highest performing employees. Although the role of compensation certainly cannot be underestimated in recruitment, INEEL also emphasizes the exciting opportunities and challenges that lie ahead with the advent of renewed commitment to nuclear technology R&D.

INEEL has been quite successful in retaining technical staff with the needed expertise to carry out growing nuclear energy R&D programs. Some of INEEL's large, core missions such as ATR operations, USNRC technical work, fuel cycle reprocessing for the Navy, and environmental-management and fuel-cycle separations work have all provided a solid base for retaining much of the expertise that will be necessary to carry out the expected growing NE mission. Over the next several years the INEEL expects to hire a number of new staff members with expertise in the fields of nuclear engineering, materials, reactor design, nuclear fuels, thermal-hydraulics, nuclear physics, and related areas.

Although a source of programmatic funding must often be identified prior to extending an employment offer to an applicant, INEEL management has indicated that for some exceptional candidates, INEEL extends the employment offer even before the specific source of programmatic funding is identified. This has been done on a number of past occasions with excellent results. In fact, recruiting such top-notch technical expertise has often been an important factor in developing the programs that those technical staff members later lead. In general, INEEL employs a combination of national advertising, university affiliations, industrial networking and internal recruiting.

One element of future recruiting efforts that INEEL identified focuses on closer relationships with selected universities that offer nationally recognized nuclear programs. Such relationships may take any of several different forms: e.g., periodic visits to selected campuses to meet with graduate students who have been identified by key faculty, collaborative research projects, internships, summer employment programs, and post-doctoral research assignments. While such arrangements require effort and financial support, they have proven to be highly valuable in forging strong ties with selected universities and in attracting promising candidates for employment at INEEL. Industry networking also provides an effective way to fill specific positions, often with specific individuals.

The NERAC task force commends the INEEL for these recruiting and development efforts. To become even more effective, the ITF recommends that INEEL benchmark their practices against other laboratories', including Argonne, the DOE Office of Science laboratories and the NNSA laboratories.

4. INEEL and ANL-W Staff Development Efforts

Although recruitment of high quality technical staff is key to the success of these labs (INEEL and ANL-W) for its nuclear R&D mission, the continuing professional development of current and future staff members is equally important. Professional development programs are critical to any labs success in attracting and retaining highly qualified technical staff, and provides an important opportunity for staff members to remain at the forefront of their chosen fields. Both INEEL and ANL-W have staff development effort focused on continuing education program for employees, support of participation in professional societies as well as encouragement in serving on regional as well as national professional and governmental committees.

The NERAC Task Force commends INEEL and ANL-W on their efforts here, but would recommend again a peer benchmark with staff development practices at other laboratories, such as the DOE Office of Science and NNSA laboratories.

C. LDRD Funding and Use

The general objectives of any Laboratory Directed Research and Development (LDRD) program are to continually enhance its diverse R&D portfolio. This:

- Enhances the labs ability to address future DOE missions, as befitting a multi-program national laboratory,
- Fosters creativity and innovation at the forefront of science and technology,
- Reinvigorates the technical vitality of the laboratory,
- Serves as a proving ground for new research that is high risk and high value.

ANL annually publishes an Institutional Plan. One part of that plan is devoted to a discussion of the major areas of strategic initiative for the lab. These interests are based upon a meld of lab expertise and current needs/interests of the nation. These are relatively long-term development plans drafted for each of the strategic areas. Research supported by the LDRD program is a part of the early stages of these development plans.

The FY03 the strategic initiative areas were:

- Nanosciences and Nanotechnology (Center for Nanoscale Materials)
- Rare Isotope Accelerator
- Functional Genomics
- Advanced Computing
- Advanced Reactor Development (under energy concepts)

Approximately $3.6M was applied to the Advanced Reactor Development initiative. Development of this research program started with a review of the plan for nuclear energy deployment presented by the six Directors of the DOE National Laboratories. The goals of this plan were to reduce actinide waste and plutonium stockpiles by closing the fuel cycle, and also to provide sustainable energy sources that mitigate global climate change. These goals translated into ANL strategic areas are Benefit Analysis, Reactor Technology, Advanced Reactor Concepts, Hydrogen Production, and Advanced Recycle Technologies. Within these broad topics specific studies were formulated and funded to answer questions concerning system costs and potential cost saving concepts, passive safety, fuel designs, low-temperature hydrogen production, reactor design specifics, strategies for reactor/fuel cycle deployment. From these studies it is envisioned that a clear picture of design and deployment strategy will emerge for the future use of nuclear energy.

The INEEL's LDRD program directly supports and reflects the Laboratory's priorities as defined in its Institutional Plan. Thus, as the missions and priorities of the Laboratory evolve, the composition of the LDRD portfolio shifts as a reflection of those priorities. The composition of the portfolio is also directly determined, in part, by the relative amounts of funding received from the various Offices of DOE. The INEEL policies that govern INEEL's overall LDRD program require that the LDRD funding dedicated to projects in various technical areas must be roughly proportional to the amount of direct programmatic funding received from the DOE Office that would be expected to benefit from the LDRD research. These policies do not appear to be adopted at other DOE laboratories. Since most INEEL funding now comes from EM, this INEEL constraint requires INEEL to spend most of the LDRD on EM related projects. Of a total FY03 portfolio of approximately $21M, about 15% is directly relevant to the NE mission. With the recent announcement that the INEEL would become DOE-NE's "command center" for nuclear research and development, the ITF believes that INEEL should anticipate the expected changes in funding and begin funding NE projects now.

D. INEEL and ANL-W Relationship

The NERAC Task Force requested additional information regarding the formal and informal interface between INEEL and ANL-W to better understand these labs past relationship and how it would be altered given the recent announcement by DOE Secretary Abraham. Several interfaces exist between INEEL and ANL-W in order to accomplish both individual and corporate missions.

The three major interfaces are summarized below.

Memorandum of Understanding between DOE-ID and DOE-CH

Signed in 1997, this MOU details the roles and responsibilities of each field office in carrying-out environment, safety, health, and safeguard and security interfaces between the sites. Specifically, this MOU details site services provided to ANL-W by the INEEL such as dosimetry services, radio and paging services, telecommunication and paging, fire and emergency response support, and other transportation and utility-type services. The interface agreement is currently undergoing revision but will not substantially change in content. The interfaces resulting from this MOU work well and are expected to continue into the future.

DOE Nuclear Reactor Technology Lead Lab Charter: Argonne National Laboratory and the Idaho National Engineering & Environmental Laboratory

This charter was signed in July 1999, and identified that ANL and INEEL will serve as NE's Lead Laboratories for Nuclear Reactor Technology. The Lead Laboratories for Nuclear Reactor Technology were named to assist DOE Office of Nuclear Energy, Science and Technology in maximizing the value of the various reactor technology research activities conducted for the DOE. The charter does not detail the level of interface required but rather forms the basis for all such interfaces. The interfaces resulting from the Lead Laboratory charter work well. Teaming and communication is generally good between the laboratories as the nuclear missions for the Idaho site continue to evolve.

Programmatic Memorandum of Agreement between ANL-W and the INEEL

This MOA was signed in October 2001 between laboratory management and provides the guidelines for which ANL-W and INEEL cooperate to share each other's resources, whether facilities or intellectual resources, in order to solve the Department's most challenging problems at the Idaho site and throughout the complex. The MOA is an informal agreement intended to foster cooperation between the laboratories. It is exercised when programmatic budgetary concerns exist for one laboratory that could be alleviated by excess capacity from the other laboratory. Sharing of personnel and facility capabilities per this MOA has occurred since its signing and continues to occur on an as-needed basis.

In a sense, INEEL and ANL-W might be thought of as "sister laboratories." They are located near one another; they share this major DOE mission; the staff, at both laboratories, work collaboratively on certain projects, and cooperate by working to leverage the unique capabilities, complimentary facilities and infrastructure for the benefit of the DOE Office of Nuclear Energy mission. In the years ahead, it is very likely that the INEEL and ANL-W will work even more closely together. The labs will need to coordinate with DOE to ensure that the resources of both laboratories are optimally used to carry out this R&D mission.

Given the assignment of INEEL as the lead nuclear energy laboratory the NERAC Task Force recommends that the ANL-W/INEEL Memos of Understanding and Agreement be reviewed and clarified as appropriate.

E. Laboratory and University Interfaces

The DOE Office of Nuclear Energy has aggressively expanded its research and development missions to encompass a wide range of topics, such as:

- Advanced Fuel Cycle Initiative (Series 1 and Series 2),
- Generation IV Roadmap and associated Advanced Reactor Design,
- Nuclear Energy Research Initiative (NERI and INERI) for basic studies,

These initiatives along with service to NASA and the Navy in nuclear energy activities encompass, what might be called "Nuclear Energy Beyond 2010". Such a wide range of endeavors beyond the Nuclear Power 2010 initiative requires active and careful coordination with other DOE laboratories and universities that provide leadership as well as crucial research support. DOE Secretary Abraham has designated INEEL as the lead NE lab for nuclear technology, thus it is incumbent upon INEEL to organize these nuclear energy research activities, which it is to lead, not only with ANL-W but also with the other DOE laboratories (whether of Office of Science or NNSA) and leading research universities.

Given the assignment of INEEL as the lead nuclear energy laboratory the NERAC Task Force recommends that the INEEL establish an external review process for laboratory activities to assist in this strategic planning and missions coordination.

F. Program Matrix

During the exit meeting of the ITF visit to INEEL and ANL-W, the ITF requested that a matrix be developed showing priority responsibilities for INEEL/ANL-W work on the various R&D topics associated with the DOE Office of Nuclear Energy, Science and Technology nuclear energy programs. In our meeting on January 7-8, 2003, we asked that two additional program columns be added to the matrix: radioisotope power systems and licensing preparation. This matrix is shown in Table III.1.

The ITF has reviewed the revised matrix and believes that lead roles have been appropriately identified. As noted elsewhere in our report we believe further study is needed to determine whether the ATR can be suitably modified to accomplish the fast neutron flux R&D. And we have concerns about the viability of restarting TREAT in support of safety analyses and testing.

Table III-1. INEEL/ANL-W Responsibilities Matrix

Program	Irradiation Testing	Fuel Development	Reactor Materials	Aqueous Fuel Separations	Pyro Fuel Separations	Waste Form Development & Testing	Core Design & Analysis	Safety Analysis and Testing	Reactor Component Design & Testing	Non-proliferation Technologies	Gen IV, Space Reactor, & Hydrogen Demonstration	Licensing Preparation	Radioisotope Power Systems
Generation IV	1	1	3	1	1	1	1	1	2	3	1	1	-
Advanced Fuel Cycle	1	1	3	1	1	1	1	1	2	3	-	1	-
Space Nuclear Systems	1	3	3	-	-	-	1	1	2	-	1	2	2
NP 2010	1	2	4	-	-	-	-	-	3	-	1	2	-
Key Facilities[1]	ATR, HFEF	FMF	IRC, EML, HFEF	FDP, RAL	FCF, HFEF, 205	HFEF, RAL, AL, TRA Hot Cell	ZPPR	TREAT, ATR, TAN 607	TAN 607, EDL	-	TAN 607, TAN 650, EBR-II Containment		

1 = Lead role and heavy technical involvement
2 = Non-lead role but with heavy technical involvement
3 = Selected technical contributions
4 = Technical involvement limited to requirements definition, evaluation of results, or etc.
5 = No technical involvement

[1] For definition of acronyms, see Appendix A.

G. Other Topics

The short time frame assigned did not permit the ITF to examine a number of topics that we believe DOE should include in a thorough infrastructure review. If not being managed properly or receiving inadequate attention, these topics could adversely affect the ability of INEEL and ANL-W to effectively provide leadership for DOE's nuclear energy R&D activities. The topics have been listed in order of their importance.

Table III-2. Additional Topics for Infrastructure Review

1. Effectiveness of INEEL communications and working relationships with other DOE laboratories, private industries and universities.
2. Strategic planning to establish focus and priorities for nuclear energy programs.
3. Effectiveness of industrial health and radiation safety programs and integrated safety and security management.
4. Effectiveness of quality management, quality assurance, performance indices, and self-assessment programs.
5. Impact of INEEL and ANL-W DOE contract negotiations on work force morale and productivity, particularly on projects with demanding time schedules.
6. Effectiveness of management-craft labor relations.
7. Effectiveness of community and public relation activities, including advocacy role for nuclear energy R&D.

IV. CONCLUSIONS

- ITF believes it is significant and important for DOE to have designated a lead laboratory for nuclear energy research and development.

- INEEL and ANL-W were cooperative in obtaining the information needed for this report.

- The funding at the Idaho site, given the lead-lab status is clearly insufficient.

- ITF notes that when appropriate resources are available, world-class facilities exist (e.g. ATR, FCF) and are supported by top-notch staff and innovative programs.

- ITF conversely notes that there are certain facilities (e.g. FPF) that have lost their missions and/or for which significant maintenance challenges exist. These facilities should be abandoned.

- ITF observes that if Idaho site facilities are to be used for the proposed missions (e.g. AFCI, Gen IV and other nuclear energy work beyond 2010) resources must be provided at appropriate levels.

- INEEL is urged to develop a facilities consolidation plan, once the NE technical mission is better defined.

V. RECOMMENDATIONS

1. DOE Administration

- Given events since the *National Energy Strategy* was issued, the ITF believes that the federal commitment to nuclear energy needs to be restated and reinforced by the White House and other senior administration officials.

- For the Administration to go forward with "nuclear energy beyond 2010" the lead lab site at Idaho requires an immediate and significant increase in funding to, e.g., clear up maintenance backlog and make key facilities mission ready.

2. Idaho Site

- Make a public and positive statement of support for "nuclear energy beyond 2010" from ANL and INEEL. For example this could be a public version of the six laboratories directors' letter.

- ITF recommends that university participation (faculty and students) be a basic element of "nuclear energy beyond 2010" R&D.

- For key facilities at the site with a clear mission, funds should be committed for major equipment upgrades and associated staffing. Examples include the ATR, FCF and the analytical laboratories.

- Some facilities should be shut down or not considered for further development. In the ITF view this includes the uncompleted Fuel Processing Facility (FPF) that ITF recommends be abandoned. There may be others such as the Flourinel Dissolution Process Cell (FDP).

- New facilities will probably be needed for the purposes of "nuclear energy beyond 2010". We believe this might include a source of fast neutrons, among others. In this regard ITF recommends a specific study on the need for steady and transient fast neutron facilities in the U.S. This study should consider accessibility of existing support facilities.

- In order to optimize the use of resources ITF strongly recommends use of facilities beyond the Idaho site but in the U.S. (e.g. ANL-E, Oak Ridge, and Savannah River) and international sites in the Gen IV partner countries.

- ITF recommends, and believes that ANL staff would agree, that there is a need to emphasize stronger ANL ties with faculty and students in the universities with major nuclear (and allied) programs.

- If TREAT is to be restarted ANL-W should look outside of the Idaho site for personnel experienced in the operation of pulsed reactor facilities.
- To become even more effective the ITF recommends that INEEL benchmark their recruiting and development efforts against practices at other laboratories, including Argonne, the DOE Office of Science laboratories and the NNSA laboratories.
- To become even more effective the ITF recommends that INEEL and ANL-W benchmark their staff development efforts against the practices at other laboratories, such as the DOE Office of Science and NNSA laboratories.
- Given the assignment of INEEL as the lead nuclear energy laboratory ITF recommends that the INEEL/ANL-W Memorandums of Understanding and Agreement be reviewed, updated and clarified as appropriate.

- Given the designation of INEEL as the lead nuclear energy laboratory ITF recommends that INEEL establish an external review process for laboratory activities.

- In completing their review of the INEEL readiness for assuming leadership of DOE's nuclear energy programs, DOE should assess the topics identified in Table III-2.

- ITF recommends that a broader revision of the *Roadmap* be undertaken to bring it up to date. The new data generated by the ITF warrants a revision of the *Roadmap* that should be made and submitted to the NERAC soon after publication of this Report.

Acronyms Reference Table

Acronym	Laboratory	Facility
AGHCF	ANL-E	Alpha Gamma Hot Cell Facility
AL	ANL-W	Analytical Laboratory
ATR	INEEL	Advanced Test Reactor
EBR-II	ANL-W	Experimental Breeder Reactor-II
EDL	ANL-W	Engineering Development Laboratory
EML	ANL-W	Electron Microscopy Laboratory
FCF	ANL-W	Fuel Cycle Facility
FDP	INEEL	Fluorinel Dissolution Process Cell
FMF	ANL-W	Fuel Manufacturing Facility
FPF	INEEL	Fuel Processing Facility
HFEF	ANL-W	Hot Fuel Examination Facility
IRC	INEEL	INEEL Research Center
RAL	INEEL	Remote Analytical Laboratory
TAN 607 (Hot Cells)	INEEL	Test Area North-Manufacturing and Assembly Area
TAN 650	INEEL	Test Area North 650
TAN CTF	INEEL	TAN Contained Test Facility
TRA Hot Cells	INEEL	Test Reactor Area
TREAT	ANL-W	Transient Reactor Test Facility
ZPPR	ANL-W	Zero Power Physics Reactor

Appendix A