INL/EXT-09-16749

Component Test Capability Potential as a National Scientific User Facility

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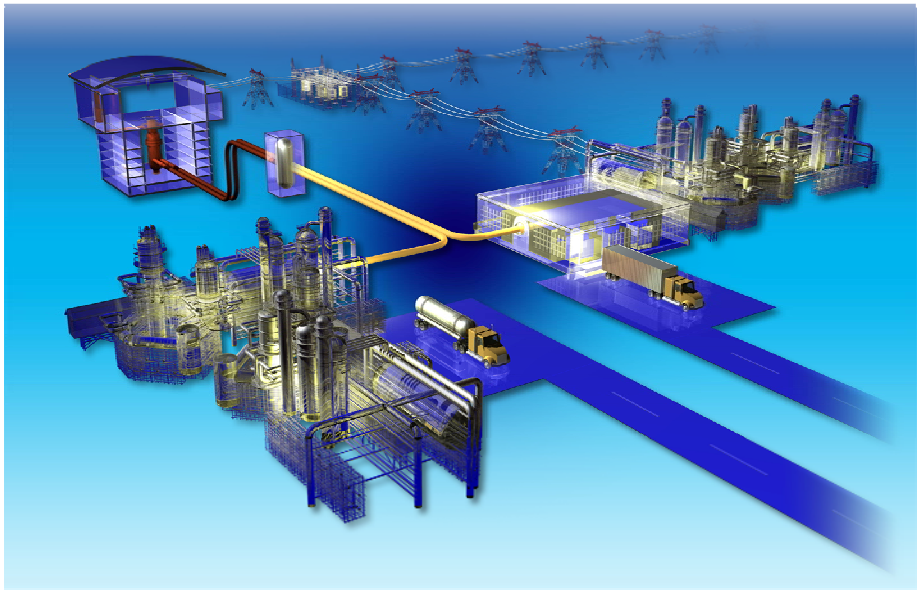
September 2009



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Idaho National Laboratory

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Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

Next Generation Nuclear Plant Project

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INL/EXT-09-16749

September 2009

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9/2/2009
Date

ABSTRACT

The U.S. Department of Energy (DOE) may designate a facility, such as the proposed Component Test Capability (CTC), as a National Scientific User Facility (NSUF). This designation allows that facility to become a cornerstone of nuclear energy research and development (R&D) within the United States, making it easier for universities, the commercial power industry, other national laboratories, and international scientific organizations to conduct nuclear energy R&D at that facility. With an established NSUF program, the CTC could be a key component in reestablishing the U.S. scientific and nuclear industry base, which is needed for building and advancing a new generation of nuclear power plants within the United States. A national CTC user facility has the potential to reassert U.S. leadership in nuclear science and technology and strengthen nuclear education within the United States.

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OVERVIEW

The U.S. Department of Energy (DOE) may designate a facility, such as the proposed Component Test Capability (CTC), as a National Scientific User Facility (NSUF). This designation allows that facility to become a cornerstone of nuclear energy research and development (R&D) within the United States, making it easier for universities, the commercial power industry, other national laboratories, and international scientific organizations to conduct nuclear energy R&D at that facility.

With an established NSUF program, the CTC could be a key component in reestablishing the U.S. scientific and nuclear industry base, which is needed for building and advancing a new generation of nuclear power plants within the United States, in compliance with the *Energy Policy Act of 2005*.[1] A national CTC user facility has the potential to reassert U.S. leadership in nuclear science and technology and strengthen nuclear education within the United States.

BACKGROUND

The summary mission of the CTC, as discussed by the initial DOE and Idaho National Laboratory (INL) Integrated CTC Project Team during the Alternatives Analysis Meeting on August 4th and 5th, 2009, is: The national capability that supports domestic and international research development and deployment (RD&D) of advanced nuclear systems beginning with Next Generation Nuclear Plant (NGNP) of high temperature reactors with adaptability/flexibility to support other energy programs.

NATIONAL SCIENTIFIC USER FACILITIES

The DOE Office of Science oversees the construction and operation of some of the nation's most advanced R&D user facilities, located at national laboratories and universities. These state-of-the-art facilities are shared with the science community worldwide and offer some technologies and instrumentation that are available nowhere else. These Office of Science facilities support particle and nuclear physics accelerators, synchrotron light sources, neutron scattering, genome sequencing, supercomputers, and high-speed computer networks. In FY 2007, these facilities were used by more than 21,000 researchers from universities, national laboratories, private industry, and other federal science agencies.

Advanced Test Reactor NSUF

The DOE designated the Advanced Test Reactor (ATR) as an NSUF in April 2007. This designation allows ATR to become a cornerstone of nuclear energy R&D within the United States by making it easier for universities, the commercial power industry, other national laboratories, and international organizations to conduct nuclear energy R&D.

The mission of the ATR NSUF is to provide nuclear energy researchers access to world-class facilities, thereby facilitating the advancement of nuclear science and technology within the United States. This mission is being accomplished by providing state-of-the-art experimental irradiation testing and postirradiation examination facilities for the user community and technical assistance in designing and analyzing reactor experiments.

The NSUF exists to meet user community needs for nuclear R&D. The user community effectively executes nuclear energy research programs through the user facility. For the ATR NSUF to be successful, it must become an essential and integrated component of the nuclear R&D portfolio of industry, academia, and regulatory agencies. The attributes of a successful NSUF[2] are:

- A system that is easy to use and responsive to user requests
- Routine, on-time completion of projects at or below projected cost
- A strong and interlinked user community that facilitates partnering between industry, academia, and national laboratories.
- Reasonably priced services for proprietary users
- Facilities that offer the R&D capabilities required by users to advance DOE's objectives
- A strong educational program.

All sectors will respond positively to a service that is easy to use, reasonably priced, and schedule compliant. Specific actions are required to streamline existing ATR experimental processes. Among these are revamping the experiment design, engineering, and insertion process; standardizing processes and experimental hardware to control costs, and staffing appropriately to meet user needs. Also critical to its success is the ATR's ability to achieve irradiated fuels and materials for future evaluation or irradiation. Several capability enhancements are planned or under consideration for the ATR NSUF in order to meet R&D user needs.

A key issue facing the nuclear industry is the impending shortage of trained professionals who are capable of supporting the nuclear industry expansion. The ATR NSUF includes an educational program design to stimulate interest in the nuclear industry and to introduce and attract nuclear researchers to the INL. This program combines internships with a summer school that began in FY 2008, which was expanded in FY 2009 to include technical development courses and, potentially, postdoctoral fellowships for the development of testing instrumentation.

An effective marketing plan will be implemented to inform the research community of capabilities and services available at the ATR NSUF. This marketing approach will include an annual user workshop, a public website, advertising in academic and trade journals, earned media, and capability briefings to universities, federal agencies, and industry.

FY 2008 was a formative year for the ATR NSUF that included transitioning to the new organizational structure, developing the foundational processes, and establishing the new organization and staff. A substantial evolution, in terms of services and operational capabilities offered to users of the ATR NSUF, will take place during the FY 2009 to FY 2013 time period.

Inadequate and inconsistent funding is a primary risk in effectively implementing the ATR NSUF. Dedicated and consistent funding by DOE and Battelle Energy Alliance, and the reinvestment of user facility irradiation fees will be required to support initial growth. Within 5 years, this investment will allow the ATR to offer irradiation test capabilities to users on par with the top test reactors in the world. Another risk is the shortage of staffing resources, which will be mitigated through the implementation of the staffing plan.

Per DOE Order 522.1, "Pricing of Departmental Materials and Services,"[3] research user facilities (e.g., accelerators and light sources) managed by the Office of Science are built by the government with the express purpose of being available for research by a broad community of qualified users on the basis of programmatic interest, scientific merit of research proposals, technical feasibility, capability of the experimental group, and availability of the resources required.

1. Use of user facilities will be authorized at no charge for research which is of DOE programmatic interest and which is approved by laboratory management, usually with the advice of program advisory committees. Use free of charge will apply to experiments approved for conduct during periods in which the facility operates in normal mode for its primary purpose. The facility manager will determine which requests meet those criteria and report periodically to the appropriate DOE program manager.
2. When facilities are made available for proprietary research, the user will be charged a fee that realized full cost recovery.
3. When facilities are operated for special circumstances, such as running the facility outside the normal operating mode or schedule, the user will be charged a fee that recovers the incremental costs.

The success of the ATR NSUF will be defined in broad terms by the quality of work conducted for users, number of user projects, number and quality of technical publications, facility capabilities, and user satisfaction. An index that quantifies the success in meeting these principles was developed in FY 2008 for FY 2009 implementation.

THE CASE FOR A CTC NSUF

The behavior of materials and components in a high-temperature nuclear reactor environment is extremely complex. This complexity currently limits the full exploitation of the potential of nuclear fission as an energy source. It also provides a rich field for scientific investigation. The complex nature of high-temperature phenomena in materials and components can only be understood through a scientific program that includes high temperature testing in a controlled environment.

There is a direct link between the scientific research that would be conducted in the CTC at the INL and U.S. energy security. Research conducted in the CTC could contribute to improvements in the next generation nuclear reactor's reliability and safety, reduction in operation costs, and extension of plant life. The development of next generation nuclear energy systems that support increased U.S. energy security require expansion of the current materials and components technology base to include materials and components that can perform at much higher temperatures, in aggressive coolants, and to higher irradiation doses. Developing new technologies that can be deployed in future decades is an important part of U.S. strategy to expand the use of nuclear power to help meet the future demand for electricity and process heat.

Joint development of nuclear energy science and technology by three major sectors—academia, the commercial nuclear power industry, and the federal government—is key to increasing scientific understanding and overcoming nuclear energy challenges. All sectors share a common need for experimental capabilities, whether for basic scientific investigations, applied research for existing materials and components, validation of data for regulatory agencies, or research underpinning the development of advanced nuclear energy systems. A major shortfall, which currently hinders our ability to advance the state of nuclear energy science and technology, is a state-of-the-art high temperature testing capability for materials and components.[4,5]

This need could be met with the CTC at INL. Complementary facilities and support organizations at INL would also be available to support experiment engineering and fabrication.

In the *Energy Policy Act of 2005*,[1] DOE was tasked with demonstrating high temperature gas-cooled reactor (HTGR) technology to economically and reliably produce electricity and hydrogen by the year 2021. As the lead nuclear technology development laboratory of DOE, INL has initiated the work necessary to complete this task. The CTC will be an integral part of this demonstration and future deployment of the HTGR technology.

Advantages and Disadvantages

The advantages of the CTC being designated as a NSUF are:

- The potential to reassert U.S. leadership in nuclear science and technology and strengthen education in the United States.
- The ability to share state-of-the-art facilities with the science community worldwide and offer technologies and instrumentation that are not available anywhere else.
- Attract new users—universities, laboratories, and industry—to conduct research at the INL CTC.
- Contribute to the development of improved products and processes, encourage innovative scientific research, and increase the scientific competitiveness of the United States.
- An educational program designed to stimulate interest in the nuclear industry and introduce and attract nuclear researchers to INL.
- An additional mission beyond the NGNP.
- Recognition of INL as the preeminent nuclear energy laboratory with synergistic, world-class, multiprogram capabilities and partnerships.

The disadvantages of the CTC being designated as a NSUF are:

- The NSUF designation may impact the availability of the CTC to support NGNP development.
- Additional staff and funding will be required to obtain the NSUF designation.
- Additional staff and funding will be required to implement and maintain the CTC NSUF.
- The additional staff and funding required to obtain, implement, and maintain the CTC NSUF may detract from the original mission of the CTC, which is to support domestic and international RD&D of advanced nuclear systems, beginning with the NGNP, and of high temperature reactors with the adaptability and flexibility to support other energy programs.

PATH FORWARD

The need for domestic high temperature CTC will need to be validated through meetings and workshops with industry, academia, national laboratories, and other federal agencies. Based on these meetings and workshops, reports on facility need will be generated and letters of support will be prepared.[6] It is estimated that establishing relationships with interested industry, academia, national laboratories, and other federal agencies and conducting the meetings and workshops will require approximately one year and cost approximately $800K (2 FTEs + travel + meeting/workshop arrangements + report preparation). This work could be performed in conjunction with the CTC alternatives evaluation process.

Resulting reports and letters of support will be used to prepare an implementation plan, which will accompany the official DOE NSUF designation. The implementation plan will summarizes the national need and business case for designating the facility as a NSUF. It will also outline the budgetary requirements by fiscal year. An example of the NSUF designation and implementation plan can be found in Appendix A of Reference 2.

The costs to operate an NSUF vary widely, depending upon the type of facility and level of user involvement. As an example, the FY 2009 operating budget for the ATR is approximately $61M and the FY 2009 ATR NSUF budget is approximately $15M or 25% of the operating budget.

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