NEAC Facilities Subcommittee DRAFT Report 6/8/2015

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Teams from the NEAC Facilities Subcommittee visited Argonne National Laboratory, Idaho National Laboratory and Oak Ridge National Laboratory to assess the state and availability of nuclear facilities appropriate to further development of nuclear technology. In addition, a survey was conducted of nuclear facility capability within the University Community.

There are several types of infrastructure facilities in existence to support advances in nuclear technology. They include DOE supported facilities (principally DOE-NE), significant facilities supported by their organizations and made available to DOE-NE through the National Scientific User Facilities (NSUF), significant facilities not part of the NSUF and many small and isolated facilities. The committee addressed the first three categories.

Listed below are the major recommendations and related observations:

Recommendations

1. The design, construction and operation of a test/demonstration reactor should guide the planning and prioritization of future investments in irradiation, post irradiation examination (PIE) and other facilities across the complex, as well as enhanced efforts to sustain the human resource pool. While a vibrant combination of irradiation test facilities exist (ATR/HFIR/MITR/etc.), a new test/demonstration reactor will serve to expand the capability and can fill critical capability gaps.
2. A test/demonstration reactor project, supported by simulation and extensive validation and verification, should incorporate as a major goal the reduction of investor risk for new reactor types by early resolution of key licensing issues and reducing the time to acquire a license. This is important for any technology chosen, whether a test or demonstration reactor and will require additional test facilities for components and systems. Early identification of needed test facilities is important.
3. Ion beam irradiation capabilities should be supported to confirm their relevance to high energy neutron damage to materials in a reactor environment.
4. The role of the National Scientific User Facilities (NSUF) should be expanded to enhance access and utilization of test facilities across the DOE complex. To enable such expansion, the processes used to designate NSUF and partner facilities should be reviewed, as well as the basis for allocating funding for research support at these facilities.

Facility Capability:

5. There is considerable capability available for irradiation testing and PIE of nuclear fuels and materials. Current funding levels are insufficient to make this capability fully available and a long-term plan for capability replacements and upgrades is lacking.
6. The existing facilities available for property measurement, irradiation testing, PIE, technology testing, and validation of analysis models provide a credible starting point for a national test/demonstration reactor project of known technology (light water, helium gas or sodium). However, test facility capability will need to be added for component and system testing once a test/demonstration reactor project is defined.
7. There has been a lack of transient testing capability. Restart of the Transient Test Reactor (TREAT) will close this gap and excellent progress is being made.
8. There is a lack of fast neutron testing capability, important for accelerated testing of nuclear fuels and materials for some reactor types.
9. Ion beam irradiation facilitates in-situ examination of irradiation effects on materials, and supports validation of computational models of radiation damage. Because damage dose rates can be much higher than with neutron irradiation, Ion beam irradiation also has the potential to complement in-reactor irradiation testing by providing a faster and less expensive means of screening candidate fuel, cladding and structural materials. Significant effort is required, however, to verify that the technique is representative of neutron damage sustained in a reactor environment. If its relevance can be shown, there are a number of facilities that can provide irradiation services and proposed facilities which would extend its capability significantly.

NSUF

10. The Nuclear Scientific Users Facilities (NSUF) has proven its value in providing access to facilities across the complex. Its role should be expanded to more fully realize the goal of a virtual user facility that encompasses the family of test facilities across the complex.
11. The quality and number of specialized instruments for PIE of nuclear fuels and materials is impressive and, especially for the Center for Advanced Energy Studies (CAES) facility, well used. Advances in diagnostic instrumentation have created important opportunities for examining legacy materials.
12. The quality and enthusiasm of young researchers is impressive. They represent considerable capability for advancing the state of nuclear technology, especially in design of a test/prototype reactor. To sustain this human resource, new reactor builds are necessary.

Modelling and Simulation

13. Validation and verification of modeling and simulation for nuclear systems is critical to design and licensing of new reactor builds. While significant test capability exists, there are many opportunities to better coordinate efforts between experimenters and modelers in ensuring the accuracy of simulation, especially to support licensing.

14. With selection of a test/prototype reactor, there are opportunities to identify test facilities important to validation and verification of the modeling and simulation to be used in design and licensing.
15. DOE-SC supercomputing facilities have enabled important advances in modeling and simulation of nuclear fuel and reactor systems in support of the DOE-NE modeling and simulation programs, DOE's Nuclear Energy Advanced Modeling and Simulation (NEAMS), the Consortium for Advanced Simulations of Light Water Reactors (CASL) and the DOE-SC Center for Exascale Simulation of Advanced Reactors (CESAR). Funding coordination between DOE-NE and DOE Office of Science is increasingly important and necessary if facility capability and utilization effectiveness is to be sustained and enhanced. Especially as capabilities in modeling and simulation expand, there is much common ground between the two offices. This is also true of use of light sources and neutron scattering facilities "owned" by DOE-SC.

Risk and Priorities:

16. The major risk for many new reactor concepts is not technology risk which, except for truly new technology, is well supported by past experience and existing facility test capability, but financial risk associated with licensing, including the early resolution of key licensing issues that impact costs, and reducing cost by reducing the time it take for new reactor concepts to acquire a license.