**Nuclear Energy Advisory Committee, Facility Subcommittee visit to Idaho National Laboratory May 19-20, 2010**

The Nuclear Energy Advisory Committee, Facility Subcommittee visited the Idaho National Laboratory on 19-20 May 2010 to tour the nuclear infrastructure and to discuss the INL plans for facility modernization as a dimension of the DOE Office of Nuclear Energy's (NE) mission.

Team Members:

Dr. John Ahearne, Sigma Xi, Research Triangle Park, NC

Dr. Dana Christensen, Oak Ridge National Laboratory

Dr. Thomas Cochran, Natural Resource Defense Council, Washington DC

Dr. Andrew Klein, Oregon State University (second day only)

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Dr. John I. Sackett, Idaho National Laboratory, Retired,

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Prior to the visit the team members reviewed two key DOE documents which underpin the mission basis for NE: 1) Facilities for the Future of Nuclear Energy Research: a Twenty-year Outlook, February 2009, and 2) Nuclear Energy Research and Development Roadmap: Report to Congress, April 2010. The second document is a mission strategy document for NE and the first document discusses the facilities needed to achieve the mission strategy.

**DOE Roadmap**

During the visit, INL first reviewed the DOE Roadmap document and explained its evolution.[1] The four key objectives of mission focus were discussed together, to include notional timelines.

1. Develop technologies and other solutions that can improve reliability, sustainability, and safety, and extend the life of the existing fleet.

2. Develop improvements in affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals,

3. Develop sustainable nuclear fuel cycles.

4. Understand and minimize the risks of nuclear proliferation and terrorism.

[1] Presentation by Phillip Finck, INL Associate Laboratory Director for Science and Technology

The timelines extended well beyond 2020 and were included in the Roadmap document. In addition to the time lines, the presentation noted many of the facilities, both at INL and ORNL that would be expected to contribute to the success of the mission. Also, for the 2020+ time frame, there were numerous facilities that were noted for re-activation and as new acquisition (new construction). This was the first time that we have seen these facilities associated with each of the four key objectives. These facility relationships were not part of the actual DOE Roadmap document, but appear to be an enhancement to the mission document.

**DOE Facilities for the Future of Nuclear Energy Research**

We then received a briefing on the Nuclear Energy RD&D Infrastructure needs.[2] Included in the briefing was a summary of the DOE Facilities for the Future of Nuclear Energy Research document, noted above, but the presentation went beyond this document. It included an effort to align the mission document with the infrastructure document, which was a necessary tie to make. There is reasonably good alignment between the NE Mission and the facilities which are available to meet that mission. The objective of INL management is to build and operate a world-class nuclear user facility, primarily for fuel cycle R&D without engaging in advocacy for or against particular advanced reactor and fuel cycle options. The INL facilities would be integrated with other important user facilities at other DOE laboratories, e.g., HFIR at ORNL, and facilities at non-DOE sites, e.g., MURR at MIT, supplemented by foreign facilities.

The vision for National Nuclear capability in Idaho was then presented. It included:

· ATR performing neutron irradiation materials research

· Fuel fabrication research and development capabilities (metals/ceramics)

· World-leading post irradiation examination (PIE) capability in place, including data link to research and education campus

· TREAT (currently on standby) meeting transient testing needs for the U.S. and international research.

· Advanced Separations/waste form research conducted at lab scale and additional capabilities in standby if needed in the future.

· Actualization of the hub-and-node approach

The details of this plan included the construction of a large number of new facilities to include a post-irradiation examination facility, irradiated materials characterization laboratory, radio-analytical chemistry laboratory, and a number of office and support structures. All of these were to appear over the next 4 years. It is not clear that NE has agreed with and approved this level of construction.

[2] Presentation by David Hill, INL Deputy Laboratory Director for Science and Technology

On the main grounds in the city of Idaho Falls INL has significant plans for linking the University Place campus with the Center for Advanced Energy Studies and then further linking these existing facilities with a suite of new capabilities involving a National Scientific User Facility, Research and Education laboratory, Energy Systems Laboratory, a Research and Development support center and a number of additional office and support facilities. Finally, they have plans to reactivate the TREAT facility in order to perform transient testing. Again, it was not clear who was to pay for these investments.

The vision is noteworthy and would certainly represent a recapitalization for the site. It will be important to develop the more detailed strategy and tactics for the reinvestment effort. Given that most of these new facilities are either nuclear or radiological facilities, it is unlikely that all can occur in the time frame advertised.

The Hub-and-node approach notionally has INL as the National Nuclear Capability in the center with outreach to universities, science laboratories, other national laboratories, international institutions, and EPRI (industry connection). It is assumed that this will be the mechanism to capitalize on the capabilities existing elsewhere (universities, National Laboratories, and international organizations.) There was little detail presented about the various mechanisms to be employed in developing the various relationships and more specifically, how INL will engage capabilities on these nodes in order to optimize the institutional investments, internally. As indicated in the presentation, it could easily be interpreted that, over time, all nuclear energy research will be housed at INL. This makes the hub-and-spoke discussion moot.

Still, the reference for the core nuclear energy research and development capabilities and facilities is as identified in the DOE Facilities document and critical facilities and relationships are clearly noted.

**Long Term Experimental and Facility Needs**

This discussion emphasized a number of goals for the future.[3] First, it was emphasized that the program within NE needs to move into a science-based mode and take advantage of our modern analytical, characterization, and computational capabilities. Both surrogate and hot environments will be needed and we will need to explore new fuels, new cladding concepts, and new structural materials for reactors. There was an emphasis on lab-scale and component scale testing. For this, a new International User Facility was proposed where researchers from around the world could come for executing research. A number of cross-cutting facility needs were discussed, including facilities that exist elsewhere. It was acknowledged that there will be a significant need for modern facilities critical for achieving success of the DOE Roadmap. New science capability will need to be established and new component and engineering scale capabilities are needed. The DOE Facilities report notes these same challenges.

The ATR National Scientific User Facility was offered as a prototype for a facility where world-class research is conducted in partnership with the university community to further DOE-NE programmatic missions.

[3] Presentations by Phillip Finck, INL Associate Laboratory Director for Science and Technology, and Mitchell Myer, INL Scientific Program Manager, ATR NSUF.

In response to questions, Dave Hill said that INL has not had trouble recruiting qualified personnel, although the number available is limited.

**Relating to Industry Practice**

1)It is recognized that in the nuclear industry R&D programs can often take decades to conduct. The R&D roadmap as presented had many long term milestones (20 to 40 years) but lacked short term goals and objectives. Complimentary short term objectives should be developed and clearly communicated.

2) By the National Laboratories own admission there is a lack of input by industry to the roadmap requirements, milestones and requirements. As such some of the R&D work seemed redundant with what was already being conducted by industry.

3)It would be interesting to map the current National Laboratory R&D programs for nuclear energy onto the industrial companies that stand to gain by the results of the research.

4) There is a danger that R&D programs are falling behind foreign countries. For example when asked where the US ranks compared to Japan and France in advanced fuel technology, the presenter admitted we were currently lagging behind both countries.

(5) It would be interesting to confirm that the INL has not replicated existing equipment already available to the program at other National Laboratories, universities or industry support facilities

We recommend that future investment in facilities, infrastructure or upgrades be supported by a simple business case. This is common practice in industry and helps to clearly identify why the investment is required, investment dollars and schedule for the R&D program. The business case should clearly identify where similar facilities can be found at the other National Laboratories, universities, industry facilities or internationally. The cost of using the industry, university facility or international facility should be identified and compared to building a new facility.

**Tours**

Center for Advanced Energy Studies (CAES): The CAES is a public/private partnership between the Laboratory and the State of Idaho and affiliated with 3 universities (Boise State, Idaho State, and the University of Idaho). It is a 55,000 square foot, light duty laboratory that was in the process of being equipped when we toured. We were briefed on the eventual outcome for the facility. This facility appears to be an excellent project for the Laboratory and will represent a face to the university public for research across multiple energy topics.

Advanced Test Reactor (ATR): The ATR is a test reactor that is used for a) materials testing and development of new naval reactor fuels, b) development of alternative LEU fuels for conversion of U.S. and foreign HEU-fueled reactors under the Global Threat Reduction Initiative (GTRI), c) material testing and development of new fuels for civilian power reactors, and d) limited isotope

production. The material testing is primarily focused on nuclear energy systems to include structural material testing and nuclear fuel development. It is obvious that significant effort has been made to assure that the reactor is operating properly and that the facility surrounding the reactor is in proper condition. It is the opinion of the subcommittee that the reactor is an important asset for the Department and that the staff at INL is properly managing and maintaining the facility.

Test Train Assembly Facility: The TTAF is a new facility located immediately adjacent to the ATR and is used for the assembly of experiments that go into the ATR. It houses a variety of precision alignment equipment, welding equipment, metal turning equipment and other industrial quality gauges and assembly hardware. This is an important facility to support the ATR and its materials experiments.

Materials and Fuels Complex: The MFC is a large hot-cell suite within which is performed a large variety of work involving reactor fuel development, power source system assembly, pyrochemical separation chemistry research, hot fuel examination, and a variety of miscellaneous projects. The hot-cells appeared to be in good working order and the complex was well maintained. This complex is a national asset. It appears to be managed as such and the work being performed appears to be appropriate for the laboratory and the NE program. We are not able to assess whether the volume of work fills the capacity for the complex.

Hot Fuel Examination Laboratory: The HFEF is a very large hot cell facility and is used to perform research on irradiated fuels. We were told that it is also used to support work in fuel cycle activities and in the space nuclear power programs. It includes the Neutron Radiography Reactor, which is used to image small test components to explore internal features and flaws. This facility is also to be considered a real national asset and should be maintained to perform work for the long term. It appeared to be in excellent shape and there was a substantial amount of work being performed while we visited. It appeared that every station was fully utilized.

Fuels and Applied Science Building: This is a facility where engineering work is performed both on “cold” materials and on mildly “hot” materials which could be handled in glove boxes. The equipment in the facility appeared to be crowded in place and we were told that the installation was to be relocated in the near future. A facility of this type is necessary in order to support the work in the hot cell facilities. Rebuilding this capability in a more space-appropriate location is likely a good idea.

Electron Microscopy Laboratory: This laboratory occupies the corner of one building. There were several large new microscopes, some installed and at least one not yet utilized for research. This will be a great characterization capability once the entire suite is operational. In talking with the researchers about staff capability, all indicated that they are essentially one-deep in all areas, meaning that there will be significant excess machine capacity. This did cause us to ponder whether acquisition of modern analytical equipment is outpacing both the mission need and the ability to actually apply the capability to ongoing milestones. No doubt the capability will be needed eventually.

**Summary**

1.We endorse the overarching objective of building and operating a suite of world-class nuclear user facilities, primarily for fuel cycle R&D without engaging in advocacy for or against particular advanced reactor and fuel cycle options.

2. The facilities that were visited appear to be well maintained and upgrades appear to be consistent with authorization basis requirements. Some of the facilities, e.g., ATR, appear to be fully subscribed, or nearly so, while other facilities, e.g., hot cell facilities, are clearly underutilized.

3. We were told that some (many?) facilities do not yet have DOE approved Authorization Bases. Establishing the license to operate these facilities should be a primary focus for the Laboratory.

4. It is encouraging that the Laboratory and the NE programs are beginning to find ways to make some limited funds available for new buildings and to obtain some state-of-the-art equipment and capabilities. However, NE still needs to find ways to fund new buildings and capabilities. So far it appears that the INL leadership has managed to utilize funds that they have identified within existing programs and activities The Lab has had to scrape and struggle to find their own funding, rather than obtain direct appropriations from NE. Scraping and scouring is a very useful skill set for a Laboratory, but cannot be relied upon by NE to build the kinds of first-class facilities that will be needed to advance NE's mission, vision, goals and interests.

5 The CAES represents a significant expansion of engagement for the Laboratory and the Laboratory should capitalize on this facility as soon as possible.

6. Regarding CAES, there was a significant amount of equipment installation ongoing and therefore, we were unable to actually visualize how the capability would eventually be applied to problems of importance, but the description of the various laboratories sounded impressive. Every effort should be expended to finish the equipment installation so as to realize this success.

7. The ATR appeared to be in excellent working order and the life extension program appears to be addressing aging challenges within the facility. This facility is a national asset for materials research and will be essential to the development of next-generation reactor fuels and materials. Every effort should be taken to assure that the ATR is maintained in fully working order, for the long term.

8. Hot-cell facilities all appeared to be in a well maintained condition and they all appeared to be well, perhaps fully, utilized. We did not discuss staffing issues for the hot-cells but there is a concern that the skill necessary to properly operate the remote handling equipment is learned by doing the work, hands-on, and cannot actually be taught. It would be good to assess the level of staffing necessary to assure that there is adequate capability and training. Again, these hot-cells are national assets and every effort should be taken to maintain them in good working order. There are too few such hot-cells around the world of this size and capability.

9. The large investment in characterization and analytical capability is impressive. Utilizing such equipment will accelerate the introduction of new concepts into next generation fuels and materials. At some INL facilities and at CAES (which has been in operation for only about one year) there was a visible lack of staff engaged in significant research. Our one day tour did not provide an

opportunity to fully understand the status and staffing of ongoing research programs, but with the exception of the ATR there was an appearance that equipment was being installed in search of users rather than the other way around. The amount of new equipment was impressive but it was clear that there were inadequate trained staff to actually operate some of the various new instruments. Every effort should be taken to hire and train the staff necessary to fully utilize the capability.

10. There was little discussion as to how INL is integrating with other capabilities either in the US or at international locations. We were not apprised of how investments at INL were being integrated with either existing capabilities or new investments elsewhere. It is recommended that NE look closely at the ongoing investments in order to assure that there is not duplication of capability. This analysis should also investigate if there are gaps in capability that remain across the complex. The DOE Facilities for the Future of Nuclear Energy Research: A Twenty-year Outlook plan is two years old. It identifies critical capabilities, necessary for the Nuclear Energy program, and it should be reassessed in light of the changes occurring at INL.

11. The development of new LEU fuels for the GTRI program—funded by NNSA rather than by NE—represent perhaps the best use of several of the INL facilities pending further development of NE-sponsored nuclear fuels research at INL.

12. The development of HTGR fuel for the NGNP also represents an excellent example of effective use of these facilities, as does the growing use by the university community as part of the ATR-NSUF.