Nuclear Energy Advisory Committee Facility Subcommittee visit to Oak Ridge National Laboratory 26 August 2010

The NEAC Facilities Subcommittee made a site visit to Oak Ridge National Laboratory (ORNL) on August 26, 2010. Subcommittee members included John Ahearne (Vice Chairman of NEAC and Facilities Subcommittee Chairman), Dana Christensen (ORNL), Thomas B. Cochran (Natural Resources Defense Council), Michael Corradini, (University of Wisconsin-Madison), and Andrew Klein (Oregon State University). Tansel Selekler (Department of Energy Office of Nuclear Energy) accompanied the Subcommittee. The visit was well-coordinated by Sherrell Greene, who insured that briefings were on time and that Cochran, Corridini, and Ahearne could get to the airport on time to catch departing flights.

Thomas E. Mason, ORNL Director, welcomed the subcommittee and gave a summary of the lab's funding of about $1.5 B/yr. The Office of Science funds about one-half for R&D. The other half comes from other energy technology funders and NNSA . ORNL is the technology provider for USEC. He stressed that facilities are needed to get real data to validate the many codes now in use. ORNL is down from thirteen nuclear facilities to four facilities and HFIR. Hot cells have been reduced to 4 from 10 in 2001.

Tim Powers, Director, Nonreactor Nuclear Facilities Division noted that reducing the number of hot cells has reduced costs. However, the current funding for the remaining hot cells is inadequate and is not sustainable. They have used the Navy's nuclear program as a feeder for new people but they are having trouble getting and retaining those individuals.
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Sherrell Greene, Director, Nuclear Technology Programs noted that the NRC provides $15M and that about 8 % of the budget comes from industry. ORNL's capabilities and infrastructure support major DOE/NE programs. Regarding new hires, Green said generally they get the people they go after, but it is getting harder.

The Subcommittee toured the following Facilities: a Fluoride Salt Reactor Loop and Salt Melt Demonstration in Building 5800, Room D-111, the Irradiation Fuel Examination Laboratory (IFEL) in Building 3525, the Low Activation Materials Design and Analysis Laboratory (LAMDA) in Building 4508, the TRISO Fuel Fabrication Laboratory in Building 4508 (Room 240), Irradiated Materials Examination and Testing Laboratory (IMET) in Building 3025E, the High Flux Isotope Reactor (HFIR), the Radiochemical Engineering Development Center (REDC), Building 7920 and 7930.

David Holcomb described the work on molten salt as being important and funded by LDRD. They use a fluoride salt as coolant and have looked at the pebble bed reactor and the HTGR as a salt reactor. They have 700 ^{o}C output and aim at 1000 ^{o}C.

At the Irradiated Fuel Examination Laboratory, Chuck Baldwin described the capability as being able to examine full length fuel rods. They do PIE for NR and on AGR material. They have looked at the MOX rods from Catawba. The capacity is under-utilized currently. He described a problem in disposing of the residuals from examining commercial fuel. A dispute between DOE and the state of Idaho has led to Idaho refusing to allow the residuals to be shipped to INL for disposal.

Jeremy Busby described the work at the Low Activation Materials Design and Analysis Laboratory (LAMDA).The criterion for material in this lab is <60 mr/hr at one foot. This lab is fully utilized and customers include Naval Reactors (NR), DOE Office of Nuclear Energy, DOE Office of Fusion Energy (OFE), DOE Office of Science (OSC), the ITER project, and Japan. The staff includes about 20 researchers and has workers from the UK, Russia, and Japan.

John Hunn gave a tour of the TRISO fuel lab. Fuel manufactured here set a record of 19 % FIMA after 3 years of irradiation. No failures were found out of 300,000 fuel particles. However, they are struggling to keep funding.

At lunch Steve Zinkle spoke about material work at ORNL applying modern material science to old alloys. This has given significant improvements, such as a 50 % increase in strength for small changes in concentrations. Another development is radiation damage resistant materials.

Jeremy Busby gave a tour of the Irradiated Materials Examination and Testing Laboratory (IMET). It handles Category III materials with beta and gamma radiation, but excludes materials with alpha radiation. They receive samples from around the world. The lab is an old building and has 20-year old mechanical systems but 2-year old electronics and controls.

Ron Crone gave a presentation at the site on HFIR. It provides a flux of $3\text{-}4 \times 10^{15}$ n/cm^2 and has four tubes for loading experiments. One of the last US research reactors using HEU, a plan would convert HFIR to LEU in 2019. The reactor is well-funded for the next seven years.

Bob Jubin presented a tour of the Radiochemical Engineering Development Center (REDC), which was built many years ago in response to a letter from Glenn Seaborg. Among other products, REDC could produce 1.5 – 2 kg/yr of Pu238 for space missions. This is a plan for which DOE does not have funding, but NASA does. IMET also produces Ca232.

<u>Subcommittee observations and comments.</u>

Over the past decade ORNL has done a good job in consolidating, integrating and coordinating its hot cell facilities, reducing the number of hot cell facilities from 10 in 2001 to four today, namely, the REDC hot cells in Buildings 7920 and 7930, IFEL in 3525 and IMET in Building 3025E. Three of the four facilities appear well utilized. These facilities together with hot cell facilities at INL are adequate to fulfill those basic research and development missions of DOE-NE which require hot cells. The working areas around the hot cells at ORNL appear to be cleaner, tidier and better maintained than those at INL. ORNL exhibits a better safety culture relative to that at some INL facilities.

HFIR appears to be fully utilized and well run. There is no plan to accelerate the conversion of HFIR from HEU fuel to LEU fuel sooner than the plan conversion by about 2018. ORNL, INL and perhaps DOE-HQ place a higher priority on maintaining the neutron flux and existing experimental capabilities at HFIR and the ATR at INL, than on reducing national security risks by eliminating civil use of HEU globally. This is not a good example to set given the high priority of converting foreign research reactors from HEU to LEU fuel.

Lack of facilities does not appear to be a roadblock to DOE-NE basic research and development plans. More critical are institutional inefficiencies, for example, those caused by limits placed on waste inventories at INL imposed by the State of Idaho. The DOE could improve the efficient use of its national nuclear facility assets by facilitating better consultation and coordination among the national labs, DOE programs and facility users to address institutional issues and roadblocks.

NE's financial stake into ORNL is small (<$ 50m) compared to the $1.5B NE budget and is thus highly leveraged. Materials research within the Physical Sciences at ORNL is cross- cutting and benefits NE to a large degree and is closer to basic R&D than the nuclear systems work. Over 40% of funds in support of the Nuclear Labs at ORNL are from indirect costs (which may be reducing LDRD pool).
The ORNL laboratories in nuclear fuel, structural materials have decreased in number to match capacity to need.
The HFIR reactor is a national resource and highly utilized along with the REDC labs affiliated with it
The crucial choke point for the nuclear lab capacity is inventory at sites and potentially manpower.

Managed collaboration/competition should be encouraged between the labs (especially INL and ORNL for NE). Otherwise, many unique facilities (like the TRISO fuel development lab) could be orphaned.

<u>National Scientific User Facility</u>

The concept of a DOE-Lab wide National User Facility (NUF) complex (beyond just INL) should be investigated.

Characteristics:
1] National user facilities network could involve national labs, universities, and industry.

2] NUF network would have certain criteria to accept such lab facilities

3] Each lab facility would be responsible for its own infrastructure costs
(e.g., ORNL needs to decide what it gets from OSC + overhead is OK)
(e.g., University needs they get from their administration + NEUP is OK)

4] NUF network would get the funds (and compete peer-reviewed) to support experiments on these qualified facilities so that collaboration is maximize and facilities are used w/o needless bickering (e.g., HFIR vs. ATR or ORNL vs. INL)

5] NUF network would have a director and management board that represent constituents

6] DOE-NE would separate its funding out from its projects but keep aligned to mission as appropriate.

7] NUF would establish formal ties to other national user facilities (e.g., Office of Science networks - APS, SNS) to optimize the scientific possibilities.

8] NUF would connect with international facilities by trading "equal value" data or info without shifting of taxpayer funds.

9] NUF network facilities that provide capability to the network are reimbursed for usage based on some known structure.