Idaho State University
University of Idaho
CAES Center for Advanced Energy Studies
Boise State University
Idaho National Laboratory INL

Quarterly Report

FY - 2008 | *Quarterly Period Starting 1 October 2007 through 31 December 2007* | 1st Quarter

Highlights From the Director's Desk

Construction continues for the new CAES research facility

Completion of the 55,000-square-foot facility is scheduled for Aug. 1, 2008. In December 2007, the contractor began placing the office plenum floor and painting the laboratories' interior ceilings.

The north and south exterior insulation panels were hung and the remaining walls are scheduled for completion by mid-January 2008. The roof over the front entry and second floor conference room are also scheduled for completion in mid-January. Building construction remains on schedule.

CAES Building in Progress

1. Framing is completed.

2. Insulation panels being installed.

3. Main entrance to facility with conference room on second floor.

4. View of the atrium from the second floor.

CAES Web Page

In November CAES rolled out a new public web page based on "portal technology." Features include: Energy News and Funding Opportunities pages that are updated weekly, a searchable database of Idaho's energy education opportunities, descriptions of CAES' research initiatives, links to the CAES partners, and a capabilities catalog.

Nuclear Science and Engineering Forum

On October 18, 2007, CAES hosted an INL Nuclear Science and Engineering Forum for new Nuclear Engineering faculty. Senior managers from the INL Nuclear Program participated as well as approximately 20 faculty members from Boise State University, Idaho State University, and the University of Idaho. During the forum, participants presented their respective areas of research and made specific suggestions on how CAES can enhance their work.

Strategic Research Initiatives

CAES Associate Directors developed execution plans for five research initiatives focused on: Carbon and Water Management, Bioenergy, Nuclear Fuel Cycle, Energy Policy, and the ATR National Science User Facility. The plans include brief descriptions of their vision and mission as well as funding sources and specific activities that will be conducted during this fiscal year.

Selection of EPI Director and Assistant Professor

The CAES Energy Policy Institute (EPI) and the Department of Public Policy and Administration at Boise State have interviewed several candidates and extended an offer for an Assistant Professor who will be focused on energy policy teaching and research. EPI and the Department have also chosen two candidates for the permanent EPI Director position who will be interviewed in January. Both positions are expected to be filled by the start of the 2008/2009 academic year. Research focus for both positions is expected to be in Energy and Environmental Public Policy.

CAES Building Occupancy Plan

A dynamic working relationship was established among the group of facility users in preparation for the building occupancy. An all-inclusive inventory of equipment already purchased with CAES funds was completed, specifying which equipment will stay at the universities' laboratories and which will be transferred to the CAES laboratories.

Also completed was a prioritized list of needed research equipment and infrastructure enhancements. The first draft of the Building Occupancy Plan will be submitted to the CAES leadership team for review by the end of January.

Path Forward

During the second quarter of FY 2008, CAES will:

- Organize and host a one-day energy session during the Idaho Academy of Sciences annual symposium, March, 28 2008, details and invitations to follow.
- Commence executing plans for the five research initiatives referenced above.
- Sponsor and actively participate in the University of Idaho's Engineering Week Expo, April 25, 2008.
- Continue collaborative discussions with the Idaho Office of Energy Research (IOER), the Southwest Regional Carbon Sequestration Partnership, the Massachusetts Institute of Technology, and the U.S. Geological Survey -- to develop joint research proposals.

Quarterly Highlights

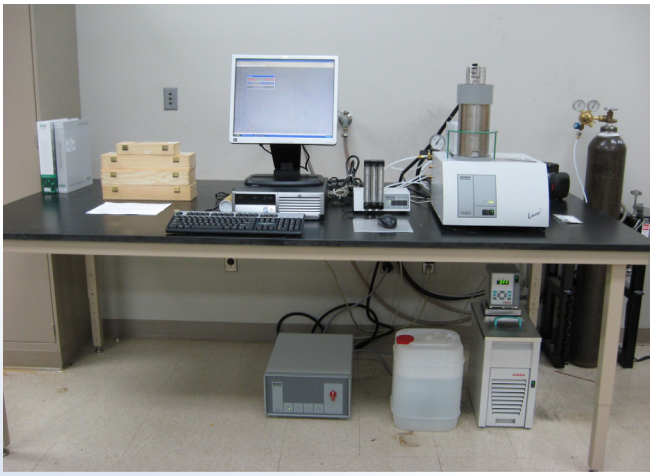
Infrastructure Management:

While CAES research facility construction remains on schedule, CAES partner institutions continue to build research infrastructure with CAES support. Accomplishments this quarter include:

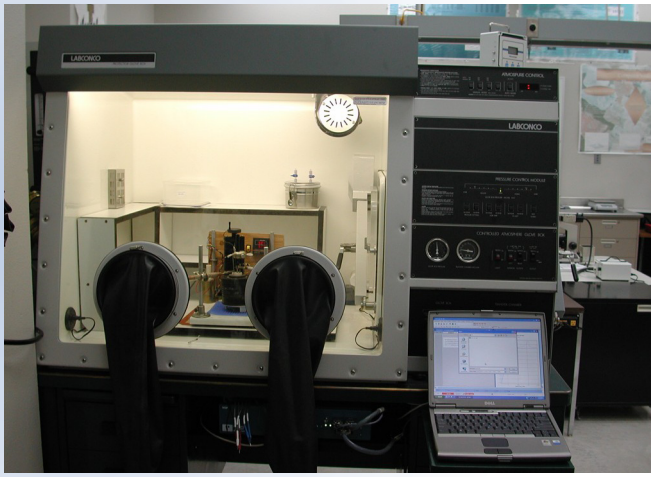
- An MTS 810 hydraulic test system was delivered and installed in the Materials Science Complex at BSU. The first day of training is scheduled for January 14th.
- Boise State University provided matching funds to support the MTS installation by renovating and upgrading a new mechanical testing laboratory.
- The University of Idaho procured a "Simultaneous Thermal Analyzer" (STA) in November 2007 for the GNEP University Readiness Program ($54,730). The instrument can perform various thermal analysis experiments (DSC-TGA, DTA-TGA, and only TGA) on different materials under protec-

tive, oxidizing, and other environments, and will be used to carry out fundamental studies on various fuel cladding materials. A view of the instrument is shown to the right.

- The University of Idaho met its objectives for this quarter to bring the Labconco glove box, purchased with CAES funds, to operational readiness, to maximize the use of the space inside, and to test the efficiency of this glove box.
- The glove box underwent several modifications including:
  - » new ports for the oxygen sensor, rotator control, and the potentiostat control,
  - » shelves were built and installed to maximize the space in the glove box, and
  - » pumps were installed to supply the glove box atmosphere for oxygen analysis by externally mounted oxygen analyzer.
- Initially, the glove box was purged with high purity nitrogen and the purification system was regenerated, revealing that the glove box was very efficient in oxygen removal with the ability to readily maintain a 5ppm O_2 concentration during the experiments.
- Finally, the overall test of the glove box was to see if the general operation of the glove box interfered with the electrochemical experiments: no interference was observed confirming the integrity of the glove box. The glove box is now fully operational and ready for the initiation of two INL projects: (1) simultaneous electrogeneration of lithium and reduction of uranium oxide, and (2) pulse plating of uranium. See Figure to the right.



Simultaneous Thermal Analyzer (STA)



Labconco glove box fully operational at University of Idaho

Collaborative Relations

- BSU research continues supporting AFCI/GNEP and NGNP activities in nuclear fuels synthesis and alloy development. BSU principal investigators (PIs) are collaborating with technical staff at both the INL and the Los Alamos National Laboratory.
- Drs. Butt, Frary, and Ubic, all of BSU, have been collaborating with a number of universities and national laboratories to develop new programs. They co-authored five NERI-C proposals in collaboration with INL, Oak Ridge National Laboratory, U of I, ISU, MIT, UC Davis, Utah State University, North Carolina State University, Penn State University, University of Illinois, UNLV, and UC Berkeley.
- The CAES Energy Policy Institute is currently working with a team that includes BSU and the U of I to write a proposal for the Higher Education Research Council of the Idaho State Board of Education.
- A new collaboration was developed between University of Nevada-Las Vegas (UNLV), MIT, BSU, and INL. Funds are being transferred from UNLV to BSU to investigate the creep crack growth and micro mechanical mechanisms of alloy 230 deformation for the NGNP program.
- The Idaho Nuclear Fuel Cycle Academic Center of Excellence (ACE) is planning its third annual conference for 2008. In addition to focusing on nuclear fuel cycle issues, this conference will feature a technical short course.

Research Programs Status

- BSU's Mike Louis and Carole Nemnich are currently leading a project investigating different methods of public discourse and their effect on the public's perceptions, preferences, and attitudes on nuclear energy. Because the results can be generalized to a larger population group, it should be useful in public policy decision-making.
- ISU's Dr. Paviet continued to work on the draft Materials Control and Accountancy Plan for an aqueous reprocessing plant.
- ISU's Dr. Hartmann continued to work on specification, procurement, and installation of advanced imaging equipment for the INL Hot Fuel Examination Facility at the Materials and Fuels Complex.
- ISU's Dr. Dunzik-Gougar's research continued in nuclear waste management and fuel cycle simula-

tion. One of her students, Mr. Chris Juchau, whose research was supported by the INL, successfully defended his M.S. thesis near the end of the quarter. Two other Dunzik-Gougar nuclear engineering M.S. students, Mr. Philip Tufts and Mr. Curtis Johnson, successfully defended last quarter (both were supported by INL contract).

- Using the STA equipment recently acquired by the University of Idaho (location: ChE-MSE Department, UI, Moscow), an MS student (Sean McCormick) will initiate nuclear materials-related research in January 2008, and will be involved in INL research activities. A graduate research assistant (Mohammad Faheem) and an undergraduate research assistant (Triratna Shrestha) will continue to be supported through the federal appropriations grant.

Status of the CAES LDRD Projects

The CAES sponsored Laboratory Directed Research and Development (LDRD) teams are reporting significant progress. The *Understanding Apomixis: The Basis for a Robust Trait Delivery and Containment Platform for Bioenergy Crops* project team, which includes Tom Ulrich (INL), Jeff Lacey (INL), Robert Zemetra (Uof I), and John Carman (Utah State University), reports that they have successfully infected sorghum with a recombinant barley virus that produces green fluorescent protein and that silences key genes in the sorghum embryo development pathway.

The *Fabrication and Radiation Testing of Semiconductor Materials Useful as Photovoltaic and Nuclear Detection Devices* project team, which includes Robert Fox (INL), Harry Rollins (INL), Kara Keeter (ISU), and Rene Rodriguez (ISU), reports that they are now focusing on the development of methods to synthesize nanoparticles in supercritical fluid CO2, to fabricate photovoltaic devices based on the new nanoparticles, and to test radiation effects on such devices.

Also, the *Consolidated Bioprocessing of Agricultural Wastewater Treatment and Bioenergy Production* project team, which includes Kevin Feris (BSU) and Joni Barnes (INL), reports that they are determining if available carbon can drive photoheterotrophic hydrogen production in potato processing wastewater. They have also collected and are now characterizing 52 nitrogen-fixing photoheterotrophic isolates from Idaho, Montana, and Alaska.

The *Investigation of Public Discourse Methods in Energy Policy Decision-making* project team, which includes John Freemuth (BSU), Patrick Wilson (U of I), Ann Oakes (ISU), and Steve Piet (INL), reports using feedback from external stakeholders to shape the public opinion survey the research team will administer both to establish baselines and to measure effects in their ongoing study.

The *Porosity Evolution during In-Situ Oil-Shale Retorting* project team, which includes Larry Hull (INL), Annette Schafer (INL), and Scott Wood (U of I), reports that they have completed work on oil shale samples that included subjecting samples to simulated retort conditions, measuring changes in pore water chemistry, and analyzing porosity changes.

The *Neutron Slowing-Down Time Spectrometer* project team, which includes DeeEarl Vaden (INL), Jianwei Chen (ISU), Michael Lineberry (ISU), and Ayman Hawari (North Carolina State University), reports that preliminary experimental data match simulations for the neutron slowing-down process in graphite.

The *Risk Assessment Tools to Evaluate Next Generation Technical Systems* project team, which includes Tuan Tran (INL), Steffen Werner (U of I), and Brian Dyre (U of I), reports that they are preparing to identify physiological signatures that correspond to tasks that allow highly accurate performance and to tasks that provoke high-error performance.

The *Development of Microbial Fuel Cell, Fueled by Domestic, Agricultural, and Food Processing Wastewaters* project team, which included Yoshiko Fujita (INL), Chikashi Sato (ISU), Malcolm Shields (ISU), Marco Schoen (ISU), Alba Perez-Gracia (ISU), reports that electrical potential increased 5-fold with a 3-fold increase in the anode surface area, given a fixed cathode area.

Other CAES LDRD projects include: *Microstructural Evolution during Spark Plasma Sintering of High-Temperature Fuels and Coatings; Suitability of Layered Basalt as Targets for Industrial Carbon Dioxide Sequestration; and Oxygen Permeability of Perovskite Ceramics for Energy Applications.*

Educational Programs

CAES continues a high degree of involvement with the Idaho educational programs through multiple venues:

- The three CAES partner universities continued providing energy-related courses statewide, typically one course each semester. The courses are provided in real-time via compressed video and recorded for those students who cannot attend a specific class due to business travel, illness, or personal reasons. Co-instructors from each university typically contribute to the courses within their areas of expertise.
- BSU's Department of Materials Science and Engineering continued to support Patrick Callahan and Lou Bonfrisco in their M.S. research. However, they are being moved off this support in the next quarter due to funding limitations.
- BSU continued to support the undergraduate research of Brandon Christopherson who has been conducting research on the oxidation kinetics and processing of nitride fuels.
- Through INL and BSU support, Gordon Balfour and Daniel Osterberg also conducted undergraduate research in support of this project, although not formally funded through this grant. We will be adding David Thomson, an undergraduate, to the grant to support research activities in nuclear fuels.
- Dr. Ubic is developing and teaching courses on Transmission Electron

Microscopy and is collaborating with several other BSU faculty, including Drs. Butt and Frary, and he is mentoring a number of students.

- Graduate students continue to join the University of Idaho (UI) Nuclear Engineering Program. Approximately six new MS and one PhD students will join the UI Nuclear Engineering Program in spring 2008.
- The first UI graduates in nuclear engineering are expected in May 2008.
- UI telecasted two nuclear engineering undergraduate / graduate classes statewide in the fall 2007 semester. A course in *Engineering Materials* was delivered from Boise to Idaho Falls, and an *Introduction to Nuclear Engineering* class was delivered from Idaho Falls to Pocatello and Moscow.
- UI's new course, *Fundamentals of Nuclear Materials* (3 credits), will be offered as a special topic in spring 2008. This course will be offered from Moscow to Idaho Falls and Boise through compressed video.
- Dr. Paviet taught a fall 2007 course for seniors and first-year graduate students on chemistry and radiochemistry of the nuclear fuel cycle.
- Dr. Hartmann continues to develop a course for spring term 2008 on crystallography.
- CAES paid the tuition and fees for the fall 2007 term for Mr. Jared Horkley, who is working with Dr. Paviet on research related to the CAES LDRD project on separations, for which Dr. Paviet is Principal Investigator. Stipends were provided from this contract to another M.S. nuclear engineering student, Ms. Julie Chapman, who is also working with Dr. Paviet on the same project.

Policy Programs

The members of the Energy Policy Institute continue to be called to support numerous State initiatives, such as:

- Michael Louis, the EPI Assistant Director, continues to participate in the Governor's 25x'25 Renewable Energy Council. He took an action to develop a renewable energy production baseline for the state of Idaho to track increases in renewable energy production, and Eileen DeShazo, EPI graduate assistant, presented the results to the Council in October.
- Louis is also serving on the Energy Plan Directives Subcommittee, tasked with developing paths for promoting policies recommended by the Council.
- EPI completed a final report on the 2007 Energy Policy Survey testing the public's perceptions, preferences, and attitudes regarding the recommendations discussed during the development of the Idaho Energy Plan. Reports were presented to the Council's Interim Committee on Energy, Environment, and Technology.
- Louis met with members of the Boise State University Economics Department to determine ways that their department and EPI can collaborate on research and share resources.
- EPI is currently developing a website to support EPI research and programs. The public-facing portions of the website will be implemented during the second quarter of fiscal year 2008.

Program Development

- BSU faculty members Drs. Frary and Butt (Materials) and Dr. Russell (Chemistry) collaborated with UI, ISU, and INL to develop two LDRD proposals on spark plasma sintering (SPS) of nuclear fuels and electrochemical refining. The proposals were both awarded. As part of the SPS grant, a new spark plasma sintering system was purchased and installed at Idaho National Laboratory. The system is operating successfully. The SPS system will be moved to the new CAES facility once construction is complete. This is a unique capability. The only other such system at a university exists at UC-Davis, with whom CAES hopes to collaborate.
- The arrival of the MTS 810 hydraulic test system led to a new program for Drs. Frary and Butt in collaboration with INL, MIT, and UNLV. NGNP funds are being directed to BSU from UNLV to support mechanical testing of alloy 230.
- Dr. Butt submitted a proposal to the National Science Foundation (NSF), Materials World Network program, entitled "Cermet Encapsulation at Very High Temperatures Using Field Assisted Sintering." This proposal will be executed as a collaborative effort between BSU, CAES (Steve Howe), and the Space Research Centre, Department of Physics and Astronomy, at the University of Leicester. In addition, Dr. R. Grosshans (INL), Dr. Brent Stuckey (Utah State University), and Dr. Butt submitted a letter of intent to NSF to create a Center for Advanced Radioactive Material Processing through the I/UCRC program.
- A highlight of the quarter was the visit of the evaluation team from the Accreditation Board for Engineering and Technology (ABET). ISU is seeking accreditation of its relatively new B.S. Nuclear Engineering degree program. The review went very well.
- EPI's notice of intent for one of Idaho's $75,000 Higher Education Research Council (HERC) grant awards was selected. As a result, EPI submitted a full proposal to the Idaho State Board of Education (SBOE) in October. If EPI wins the grant, it will fund a study that will assess Idaho's renewable energy potential from both natural and agricultural resources benefiting the Governor's 25x'25 initiative. Researchers include members from the University of Idaho and Boise State University. It will also fund a graduate assistant at the University of Idaho for one year.
- EPI Interim Director John Freemuth and Mike Louis met with Paul Kjellander, the head of the newly formed Idaho Office of Energy Resources. The of-

fice is considering a couple of requests for research that could result in renewable energy demonstration projects in Idaho. EPI has also volunteered to investigate a possible Energy Expo/ Conference to identify additional renewable energy projects for 25x'25.

- Louis attended a Nuclear Power Panel in Utah to promote EPI and to develop relationships for collaboration with the Stegner Center at the University of Utah.
- Freemuth and Louis met with several members of Idaho Power to discuss a project EPI is currently doing to investigate different methods of public discourse and their effect on the public's perceptions, preferences, and attitudes on nuclear energy. There is a potential for funding further research using similar methods.
- UI submitted the following proposals for funding:
  - » "Development of Kinetics Model for Electrolytic Reduction of Oxide Fuel," S. Phongikaroon of UI, Dec 2007, $60k (funded).
  - » "Development of Computational Models for Pyrochemical Electrorefiners of Nuclear Waste Transmutation Systems," S. Phongikaroon of UI, International Nuclear Energy Research Initiative (INERI) with DOE and Korea Atomic, $100k for 3 years (funded).
  - » "Laser Induced Breakdown Spectroscopy: Development and Application of In-situ Elemental Analysis for Process Streams in Spent Fuel Reprocessing Facilities," S. Phongikaroon, a continuation LDRD with INL and the University of California, San Diego. INL PIs are Jeffrey J. Giglio, Shelly X. Li, Cal Morgan, and Kevin Carney from the INL; S. Phongikaroon from the UI, and Steven Buckley from UCSD. The graduate student from UCSD is Andrew Effenberger. (pending)

Scientific Eminence

Publications

John Freemuth, Interim EPI Director, wrote a feature op-ed that appeared in the Idaho Statesman on November 23, 2007. It described a current EPI project to investigate different methods of public discourse and their effect on the public's perceptions, preferences, and attitudes on nuclear energy. It also described how the project could be used to further the public dialogue on nuclear energy.

K. B. Gibbard, K. N. Allahar, D. Kolman, and D. P. Butt, wrote "Kinetics of Thermal Synthesis of Cerium Sulfides," and submitted it to the Journal of Nuclear Materials (December 2007).

Professional Contribution

L. Bonfrisco and M. Frary, "The Impact of Crystal Orientation on Oxidation and Corrosion of Polycrystalline Nickel," American Association for the Advancement of Science Annual Meeting (2007).

L. Bonfrisco and M. Frary, "The Effect of Surface Orientation on the Oxidation Behavior of Nickel," The Minerals and Metals Society Annual Meeting (2008).

D. P. Butt and B. J. Jaques, "Synthesis of Actinide Nitrides," Presented at the ANS Annual Meeting, Washington D.C., Nov. 2007.

J. Crepeau, A. Siahpush and B. Spotten, "Evaluation of Computational and Quasi-Static Solutions of Phase Change with Internal Heat Generation," 2007 American Physical Society, November 2007, Salt Lake City, UT.

John Freemuth, EPI Interim Director, moderated a nuclear energy panel at the Idaho Environmental Summit in December.

B. J. Jaques, "Thermodynamics and Kinetics of Nitride Fuel Sintering and the Effects of Americium and Dysprosium Nitride Additives." Presented at the GNEP Annual Review Meeting, Litchfield, AZ, October 2-4, 2007. (Poster presentation).

S. Phongikaroon, "Elucidation of Bubble Size Distribution in a Mock-Up Experiment for an Oxide Reduction Electrochemical Cell," AIChE, November 4-9, 2007, Salt Lake City.

A. Ridluan and A. Tokuhiro, "SRANS and URANS CFD Simulations of Turbulent VHTR Lower Plenum Flow," ASME International Mechanical Engineering Congress and Exposition, November 10-16, Seattle, WA. IMECE 2007-42474

Recognitions & Awards

The Idaho Academy of Sciences (IAS) requested that CAES sponsor and host a one-day session during the IAS upcoming 50th Anniversary celebration and annual Symposium, "Energy in Idaho," in March 2008.