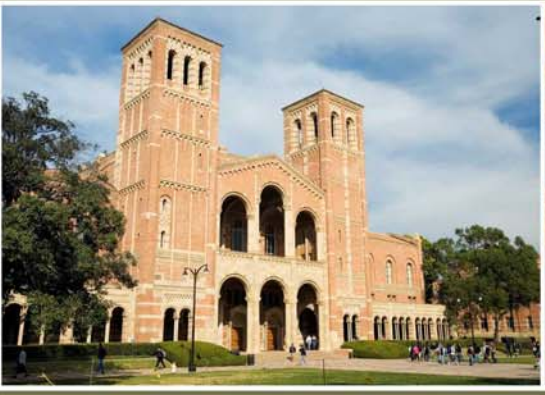
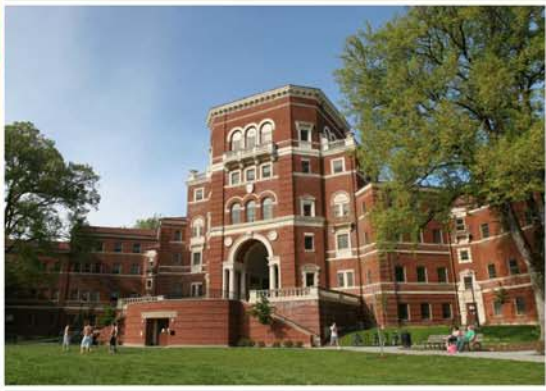
NEUP Nuclear Energy University Programs

U.S. Department of Energy

FY 2011 Nuclear Energy University Programs Workshop





Final Report & Breakout Session Transcript

TABLE OF CONTENTS

ACRONYMS AND INITIALISMS

ANS	American Nuclear Society
APS	Advanced Photon Source
ARC	Advanced Reactor Concepts
ATR	Advanced Test Reactor
BWR	Boiling Water Reactor
CFD	Computational Fluid Dynamics
DOD	Department of Defense
DOE	Department of Energy
EPRI	Electric Power Research Institute
FCR&D	Fuel Cycle Research and Development
FIB	Focused Ion Beam
FOA	Funding Opportunity Announcement
FY	Fiscal Year
GEN IV	Generation IV Nuclear Energy Systems Initiative
IAEA	International Atomic Energy Commission
I&C	Instrumentation and Control
INL	Idaho National Laboratory
IPSC	Integrated Safety and Performance Code
LANSCE	Los Alamos Neutron Science Center
LWR	Light Water Reactor
M	Million
MeV	Million-Electron Volt
MIT	Massachusetts Institute of Technology
MOOSE	Multiscale Object Oriented Simulation Environment
MOU	Memorandum of Understanding
NE	Office of Nuclear Energy
NEAMS	Nuclear Energy Advanced Modeling and Simulation
NEUP	Nuclear Energy University Programs
NGNP	Next Generation Nuclear Plant
NNSA	National Nuclear Security Administration
NSF	National Science Foundation
ORNL	Oak Ridge National Laboratory
OSTI	Office of Scientific and Technical Information
PBMR	Pebble Bed Modular Reactor
PWR	Pressurized Water Reactor
QA	Quality Assurance
R&D	Research and Development
SMR	Small Modular Reactor
TPC	Time Projection Chamber
UP	Unsolicited Proposal
VHTR	Very High-Temperature Reactor
VUQ	Verification and Uncertainty Quantification
WNR	Weapons Neutron Research (facility)

PROGRAM BACKGROUND

The U.S. Department of Energy's Office of Nuclear Energy (DOE–NE) created the Nuclear Energy University Programs (NEUP) in 2008 to consolidate its support of universities under a single program. NEUP supports nuclear energy research and equipment upgrades at U.S. colleges and universities and provides scholarships and fellowships to students through three separate funding opportunities.

NEUP plays a key role in helping NE accomplish its mission of leading the Nation's investment in the development and exploration of advanced nuclear science and technology.
NE promotes nuclear energy as a resource capable of meeting the Nation's energy, environmental and national security needs by resolving technical and regulatory barriers through research, development and demonstration.

Through NEUP, NE will better integrate university research with technical programs, producing outcomes relevant to the Nation's interests. The NEUP goal is to support outstanding, cutting-edge, and innovative research at U.S. universities by:

- Attracting the brightest students to the nuclear professions and supporting the Nation's intellectual capital in nuclear engineering and relevant nuclear sciences, such as health physics, radiochemistry, and applied nuclear physics.
- Integrating research and development (R&D) at universities, national laboratories, and industry to revitalize nuclear education.
- Improving university and college infrastructures for conducting nuclear-related R&D and educating students in relevant fields.
- Facilitating transfer of knowledge from an aging nuclear workforce to the next generation of workers.

FY 2011 NUCLEAR ENERGY UNIVERSITY PROGRAMS WORKSHOP

NEUP held its annual workshop for universities on July 27–28, 2010, at the Hilton Washington, DC/Rockville Executive Meeting Center in Rockville, Maryland. The workshop provided U.S. university researchers and educators the opportunity to understand and weigh in on the proposed scope of the NEUP funding opportunity announcement (FOA) for fiscal year (FY) 2011, to review and discuss lessons learned from the FY 2010 solicitation process, and to become familiar with anticipated R&D priorities of the various NE programs. All parts of NEUP were discussed, including R&D solicitations, infrastructure grants (equipment and reactors) and scholarships/fellowships.

Round-table discussions provided ample opportunity for questions and constructive dialogue on research requirements for the Generation IV Nuclear Energy Systems Initiative (Gen IV), the New Reactor Concepts program and the Fuel Cycle Research and Development (FCR&D) program.

Workshop PowerPoint presentations referred to in this document can be found on the workshop registration website: http://events.energetics.com/UnivWorkshop2011/agenda.html as well as the NEUP website: http://ne-up.org/.

AGENDA

TUESDAY, JULY 27, 2010

7:30 am ***Registration/Continental Breakfast***

8:30 am **Welcome Remarks**
- **Ms. Mary McCune** – *NEUP Program Manager*

8:45 am **Review of the NEUP Program in 2010**
- **Dr. Marsha Lambregts** – *Relationship Manager, NEUP-Integration Office*

9:15 am **Survey Results and Lessons Learned**
- **Mr. Greg Bala** – *Deputy Relationship Manager, NEUP-Integration Office*

10:15 am **Proposed Changes to the NEUP Program in 2011**
- **Dr. Warren F. Miller, Jr.** – *Assistant Secretary for Nuclear Energy*

10:45 am ***Break***

11:00 am **Implementation of the Proposed 2011 Process**
- **Dr. John Gilligan** – *Director, NEUP-Integration Office*

12:00 pm **Discussion of Ground Rules for Open Microphone Session**
- **Dr. John Gilligan** – *Director, NEUP-Integration Office*

12:15 pm ***Lunch***
- Responsive and Effective Proposal Writing – ATR NSUF
  Dr. Todd Allen – *University of Wisconsin, Madison*

1:30 pm **Open-Microphone Session**
- **Dr. John Gilligan** – *Director, NEUP-Integration Office*

3:00 pm **Preparation for Tomorrow's Sessions**
- **Dr. Marsha Lambregts** – *Relationship Manager, NEUP-Integration Office*

3:15 pm ***Break***

3:30 pm **DOE-NE 2011 Program Needs**

- FCR&D Overview – **Buzz Savage**, *DOE-NE*
- Reactor Concepts – **Sal Golub**, *DOE-NE*
- Nuclear Energy Enabling Technologies – **Rebecca Smith-Kevern**, *DOE-NE*

5:00 pm ***Adjourn***

5:30 pm **No-Host Reception and Opportunity for Informal One-on-One Discussions Between University and DOE-NE R&D Program Staff**

WEDNESDAY, JULY 28, 2010

7:30 am ***Continental Breakfast***

8:00 am **Break-Out Sessions #1/2/3/4**

- Modeling and Simulation **(Dan Ingersoll/Hans Gougar/David Pointer)**
- Separations, Waste Forms and Used Fuel Disposition **(Kevin Felker/Peter Swift/Xin Sun)**
- Safety and Licensing **(Don Williams/Jim Peltz)**
- Safeguards and Nonproliferation **(Dan Vega)**

10:00 am ***Break***

10:15 am **Break-Out Sessions #5/6/7/8**

- Materials **(Will Windes/Richard Wright/Jeremy Busby/Stu Maloy/Xin Sun)**
- Power Conversion **(Jim Sienicki)**
- Neutronics **(Hans Gougar)**
- Nuclear Instrumentation and Control **(Dan Ingersoll/Don Williams/Dan Vega/Suibel Schuppner)**

12:15 pm ***Lunch***

- Integrated University Program Status

  John Gutteridge – *NRC* **David LaGraffe** – *NNSA* **Mike Worley/Mary McCune** – *NE*

1:30 pm **Break-Out Sessions #9/10/11/12**

- Reactor Designs **(Dan Ingersoll/Chris Grandy)**
- Systems Analysis **(Hans Gougar/Don Williams/Brad Williams/ARC)**
- Nuclear Fuels **(Dave Petti/Stu Maloy)**
- Nuclear Physics **(Dan Vega)**

3:30 pm **FY 2012 Workshop Planning**

4:00 pm ***Adjourn***

Q&A

REVIEW OF THE NEUP PROGRAM IN 2010

and

SURVEY RESULTS AND LESSONS LEARNED

MARSHA LAMBREGTS' PRESENTATION

Question: How do you become a new university for scholarships and fellowships?

Answer: There's an FOA. It is open the entire year so you can sign up now. It's out on grants.gov and FedConnect. If you want to contact us, we'll get you the information and the name of the FOA. It's on our website as well.

GREG BALA'S PRESENTATION

Question: Do you do any benchmarking against any other processes that are similar to this one, such as NSF?

Answer: We do understand how they are running their programs; we understand the peer review process that we use. We have some unique circumstances that we respond to, but we have looked at those programs, and yes, we do benchmark.

PROPOSED CHANGES TO THE NEUP PROGRAM IN 2011

DR. WARREN F. MILLER, JR., ASSISTANT SECRETARY FOR NUCLEAR ENERGY

Hello, everyone. I see a lot familiar faces out there. Welcome to the workshop. I certainly want to thank the impressive staff who run this NEUP program. It has come a long way from where it began, from everything that I have seen since I have been here. I have been with the Department for a year now—as a matter of fact, I was confirmed on August 7, so almost exactly a year.

NEUP is one of the areas that my Principal Deputy Pete Lyons and I have focused on most because NEUP happens to be a personal love of mine. I led a study of the Department's nuclear energy support efforts of university activities for the American Nuclear Society not too many years before I got sucked into this. John Gutteridge is here, and he and I have a long history with this effort. I'm really proud of what's happened over a couple of years. But it requires us to continue to be open, to continue to want to improve, to continue to listen. And it requires you to participate and help us improve, and it requires you to help us do the peer reviews. Receiving 609 pre-proposals means someone has to help us look through 609 pre-proposals and then the full proposals. I wouldn't be surprised if next year it's not more than that because of what is hopefully going to be a larger budget than in 2009.

So first of all, why is this program so important—and I think I can take off from what Greg said and the last question that was asked. In one sense, I think it's fair to compare NEUP and the NSF and the Office of Science. But in another sense it isn't. And in the sense that it isn't, this is 20 percent of the R&D program of NE, and we have a mission to accomplish. You're part of helping us accomplish the mission, so it's not just an infrastructure and science program, and it's not just a program to develop our young people and the seed corn for the future. All of that's important, but it's also part of us responding to our program requirements and fulfilling our mission. So you're part of our mission. We have to find the right way to balance these two things: being similar to NSF but also contributing to program goals.

As I've looked at the program since I've been here, there are certain parts that I believe could be improved at very high levels. I'm going to present some ideas, but I'm not going to get into the implementation of those ideas because my esteemed colleague John Gilligan is going to answer all of the questions that you have about what I'm about to say. It comes from talking to

many people. It comes from talking to a lot of you, getting input from my former colleagues at the universities, and talking to people within the Department of Energy and finding out what they see, where the program can improve. I'm presenting to you what I'm calling a "Proposed Nuclear Energy University Programs New Direction." I say "proposed" because I want to hear what you have to say at this workshop, and I say "proposed" because after this is done, I want to talk to our NE program managers more about these proposals. Then the buck will stop with me, and I'm going to have to decide what we do for fiscal year 2011 with all of that input. Thank you, everyone in the NEUP family. I think you guys do a wonderful job, so thank you.

Since you're also helping me fulfill my mission, this is our mission: first, advance nuclear power. I could have said "promote" nuclear power—and that's certainly part of it, promoting nuclear energy—but to me, because we are an R&D organization, the main thing we need to do is advance. We advance the technology because we're contributing to energy supply, the environment, and energy security. We're resolving issues—the cost issues, safety issues, security issues—and we do that through research, development and demonstration.

When Pete and I arrived a year ago, we wanted to put together a roadmap that identified objectives and identified how we were going to meet the objectives. We got what I will call "encouragement" because the 2009 appropriations language required NE to submit a plan. So Congress told us to do it, but we had already wanted to develop a roadmap, and so we did. We had mainly national laboratories participating, but we also included universities, and there was interaction with industry and, of course, the federal staff. We have four objectives, and those objectives are indicated here. I don't want to spend a lot of time on them; the roadmap is published.

The first one has to do with existing reactors, doing our part—what is the appropriate federal role in making them even better as far as performance is concerned? The main thrust is, can we safely extend the life even beyond the 60 years that many of them will have as their license lifetime? I don't have to tell you what tremendous performance we're getting out of the existing fleet. The country is well-served if we can continue safely getting electricity from that fleet. So there is a program called Light Water Reactor Sustainability, and it deals with aging of components, structural materials, that kind of thing.

The second objective is basically new bills and that ranges, from our point of view, beyond research and development. It includes loan guarantees for Gen III reactors. It includes research on SMRs, small modular reactors. It includes gas reactors, NGNP particularly, which is a flagship reactor for process heat. And this objective includes advance reactor designs.

The third, as you know, has been controversial owing to the decision not to proceed with Yucca Mountain. Now we have a redirected program in Fuel Cycle R&D, and there are basically three subcomponents. One is trying to get the best we can get out of once-through: higher burnup fuels, uranium resources, how long we can establish a once-through fuel cycle, what the price of uranium is going to be, etc. The second one is the complete closing of the fuel cycle, not unlike what was done in GNEP, but looking at more of the technical obstacles that face completely closing the fuel cycle. The third one we call modified open cycle: what can we do to modify once-through in order to improve uranium utilization and the efficient use of

repository capacity? So this may be one small reconditioning step, as simple as maybe re-cladding, driving off volatile fuel, fission products…but doing the minimum amount of work we can in order to get much larger uranium utilization. We call that modified open cycle.

Finally, we are looking at new ways of thinking about proliferation risk. How do you analyze proliferation risk? How do you compare fuel cycles, for example, as far as how risky they may be from a proliferation point of view? We're starting a significant effort in proliferation risk assessment, and I'll talk about that as we proceed.

So those are the four objectives in our roadmap. It's on the web, or you can order it from our offices.

We submitted the 2011 budget and, well, we were certainly nicely treated by the President's submitted budget. We have now a mark from the Senate. We know approximately what's coming from the House. But we do not know yet what our 2011 budget is going to be, and it is very likely going to be a continuing resolution. So all we can do is try to plan for our program, not knowing what the 2011 budget is going to be. The budget elements, or program areas, are indicated here [indicating PowerPoint presentation]. These are the components of the budget as they were submitted. So under Fuel Cycle R&D, these are the program areas.
[from presentation:]

- Separations and Waste Forms
- Advanced Fuels
- Systems Analysis and Integration
- Materials Protection, Accountancy, and Controls (MPACT)
- Used Fuel Disposition and Storage

Under Reactor Concepts, these are the areas.
[from presentation:]

- Small Modular Reactors (SMR)
- Next Generation Nuclear Plant (NGNP)
- Light Water Reactor Sustainability (LWRS)
- Advanced Reactor Concepts (ARC)

We restructured the program. My proposal is to organize NEUP this way—that is, our call for proposals will be structured this way in this new 2011 budget format. For example, you'll be asked to submit proposals in support of the small modular reactors program. There's no Gen IV anymore. Our budget submission has Fuel Cycle R&D and Reactor Concepts and another part which is brand new—something called NEET, Nuclear Energy Enabling Technologies. It has in it reactor materials, proliferation risk assessment, advanced methods for manufacturing, sensors, and modeling and simulation. Again, we would expect you to respond in these areas as you submit your proposals.

There is a risk of duplication here, and let me explain the logic that we used in restructuring our budget this way. Our Reactor Concepts R&D is like the models of Honda. The Accord, the Civic are like the Fast Reactor and the LWR. On the fuel cycle side, Honda worries about fuel efficiency, about whether they can use flex fuels, about the emissions to the environment…so Honda worries about their fuel cycle. But they also worry about cross-cuts—drive trains, electrical systems—they worry about those things that cross models. So we have not had a significant budget, in our opinion, that focused on underlying cross-cutting issues that face nuclear energy—the ones that go across models.

So we proposed this and finally, after much argument, got it through the Office of Management and Budget and, after much convincing, got the Congressional staff to agree. So it looks like we're going to have this component as part of our approved appropriation.

So, there are three components: Reactor Concepts, Fuel Cycle R&D and NEET. We're planning to organize NEUP in these areas, and we hope the university community will help us resolve issues in these areas and contribute to our program, as well as continuing to help with students, infrastructure, seed corn, all of the great things we've been discussing. We need both from you.

Let me talk about the NEET program in the broadest sense. I see more than 20 percent of our R&D budget is being used to support university-based activities. The NEUP part is up to 20 percent, but in addition to that, MIT, North Carolina State and Michigan are participating in a new modeling and simulation hub, a nuclear energy hub. We're funding that, and that's not part of NEUP. In addition, we support reactor fuels, fuel management and research reactors—that's in addition to NEUP. In addition, when we fund work at INL or ORNL, they oftentimes support universities from their NE programs, and that's not part of NEUP.

With NEUP, we're only talking about our peer-reviewed program. All of our university work that's peer reviewed is going to be done under the NEUP umbrella. Many of you don't realize that there is a DOE requirement for university cost share. With NEUP, that has been waived, at least for the last few years. I hope it's going to stay that way.

So what would I like to see us do? I'd like NEUP to have three components. I call them Program Directed, Program Supporting, and Mission Supporting. I am going to go through what each of these mean.

Let me first be general. First bullet: competition and peer review are required for all NEUP activities. I'm proposing that we evaluate them in two areas: technical quality and program relevance—and I'm not married to the term "program relevance," but those are the two areas. I've heard people say, "Well, this component is investigator-initiated." All of NEUP is investigator-initiated, and that's what I've told Congress. The ideas come from you. So I've tried to get away from this discussion that the Blue Sky part is investigator-initiated. It's all investigator-initiated.

Next, as we go from Program Directed to Program Supporting to Mission Supporting, the components require projects to have less emphasis on relevance to specific program direction.

When I talk to you about Program Directed, I'm going to show you that relevance is going to be more important. When I get to Mission Supporting, program relevance is going to be less important and technical quality is going to be more important. So the weighting is going to be different as we go through these three components.

There seems to be some confusion as to the role of the federal staff, with their laboratory advisors and technical advisors, in the peer reviews. I want to make that perfectly clear: relevance is evaluated by my program managers, as well as the laboratory people who help them manage the program; technical quality is evaluated by peers. We have two scores and two clean lines. Peers can be both university faculty and lab people, but the latter are lab people who are peers, not lab people who are helping manage the program. We're going to need a lot of you to be peer reviewers because I'm also going to ask that the pre-proposals be peer reviewed, and we got 600 of those. That means you are going to have to help us.

Pre-proposals are required, as I mentioned before. The program is administered by CAES and managed by NE. Here's the structure of the program:

Under Program-Directed, I'm going to ask for integrated research partnerships. These are center-like activities—hub-like. They're not quite that large but they're larger than you're used to; we can't fund more than a couple of them a year. I'm going to explain what my ideas are about these integrated research partnerships. This area would be around 20 percent of the NEUP budget.

Half the budget would be under Program Supporting. This part would include the NEUP program you're used to—the one that Greg talked about, the one that Marsha talked about, the one that Mary talked about, the one that you've seen over the last couple of years—the research and development part. That's part of Program Supporting. The infrastructure program that they discussed is also under Program Supporting.

Mission Supporting is the part that is much more Blue Sky. When reviewing research and development proposals under Mission Supporting, relevance has much less weight, and the technical quality has much higher weight. All the student and faculty programs are under Mission Supporting. I have faculty investments. We haven't decided exactly what to do about seed grants for faculty, young investigator awards. But whatever we do, it will be under that category.

As I mentioned, the Program Directed component will have integrated research partnerships comprising about 20 percent of NEUP. There is $2.5M a year for three years—something like $8M total—so if you do the arithmetic, you will see that we can only do a couple of these. My proposal is that you can re-compete once—that is, you can actually renew once. These partnerships could last up to six years. What would they be like? The idea is that they would be much like the hub. In our modeling and simulation hub, we decided what we programmatically needed: teams of universities, labs and industry that could get the multiphysics of a complete reactor design. Even a virtual reactor. So we put out the call with an understanding of what we wanted. This is what I want to do here. I don't mean that you should propose any center that comes to mind. I mean that these are the programmatic areas in which we want to make a

significant investment. This is the guidance. It's a much larger and more top-down-directed program than you're used to--a mini-hub.

So give us your ideas and we'll have peer review competition. The weighting in this case would be 50 percent relevance and 50 percent technical quality. I consider that a pretty hefty weighting on relevance. This is something that we programmatically need.

Next is the Program Supporting component. It's important to the program, but notice that it is 35 percent relevance and 65 percent technical quality. This one doesn't have to respond to a specific need for a center, but my colleagues are going to describe the areas in which they are interested. It's going to be much more of a menu of areas. For example, under small modular reactors, there will be a call saying, "These are the things we're interested in," and then relevance will be evaluated to the degree to which you are responsive to what's needed. Of course, I'm not proposing any changes to general scientific equipment or reactor upgrades. That remains the way it's been.

The last component is Mission Supporting. Here relevance is 20 percent and technical quality is 80 percent, so it's less top-down-driven. On the other hand, we don't want to fund windmills or photovoltaic cells. It's got to be somehow relevant to what we're doing in nuclear energy. I never want relevance to be zero. I'm trying to have a program that lets us drive where we need to go using the university community as well as the lab community to help us get there.

This [slide shows information about] our 2010 appropriations. We have $872M, and the R&D part of that is Gen IV and Reactor Concepts R&D. When we talk about 20 percent of the R&D, it's not the overall budget. The budget also includes INL infrastructure and program direction (meaning the Feds, like me). So we're not talking about 20 percent of the overall budget; we're talking about 20% of the R&D part. Now, if we get the budget for 2011, which went up significantly, the size of the program could potentially be quite large, going from $60M to $80M. I'm not going to promise that for a lot of reasons. One reason is that I don't know what the budget is going to be. The second is that I have to be convinced the quality of the work justifies increasing from $60M to $80M. That's a lot of money. I'm not going to commit to that yet. We have to see what we get from the point of view of technical quality. When you have a boss like Steven Chu, believe me, you pay attention to technical quality.

If we were to get $80M, all of that arithmetic would boil down to this: approximately $16M in integrated research partnerships, $10M to $15M in infrastructure, about $30M under Program Supporting research, about $15M under Mission Supporting research, and about $5M to $10M in scholarships, fellowships and faculty support.

My purpose for being here is first to thank you for coming and thank you for your participation. Obviously, we couldn't do it without you, from the point of view of you and your universities helping us meet our mission requirements, from the point of view of the peer review, from the point of view of mentoring students, our young people…and helping us in every way that you do. My purpose is to thank you and also to talk to you about what Pete and I are proposing as a modification of the program going into 2011. One of the purposes of this workshop is to get your feedback. There will be an open-mic for that, but we can take a few questions now.

Question: What is your view of the role of industry in these programs?

Answer: There are lots of ways in which industry participates in our program. First, let me start by saying that one end of our program is loan guarantees. We work with industry assisting or discussing with them how they work with the loan guarantee office at DOE, both for enrichment loan guarantees as well as loan guarantees for new Gen III+ reactor bills. Industry is involved in our hub. The modeling and simulation hub includes Westinghouse, EPRI and Tennessee Valley Authority. They are part of the modeling and simulation hub. We involve industry to help us shape our Fuel Cycle R&D program so it meets industry requirements. In our NGNP program, we deal with industry, which hopefully will deploy a gas reactor. So industry is involved in many aspects of the program—but not NEUP, unless you happen to have industry as one of your partners in your proposal. You can certainly include industry in any proposal, but I don't think industry can be a PI; it's a university program.

Question: Is there an international component to NEUP? For clarification, how does this all fit with the proposed NEET? What you proposed here was just NEUP, not NEET, correct?

Answer: I don't think we have a way in which federal NEUP money can go to a non-U.S. university. It's possible that we could give some extra points if you have cost share with an international university—the two of you are working together, and they're paying for theirs, and we're paying for ours. I think we should encourage that, absolutely.

NEET is part of the DOE-NE R&D program, so 20 percent of NEET goes into NEUP.

Comment: The U.K. is sponsoring a program. I'll be going to Manchester University in three weeks to see what research they're doing that dovetails with NEUP. The U.K. is funding me to go over there, and they're funding about 20 other university professors to go to England to see if we can develop joint programs that tie into the research that they're doing.

Response/Question: I think that's great. You'll let us know or give us a report?

Answer: Right.

Comment: I had the same general thrust about international collaborations—bringing professors here or us going there. Is that encompassed? Another question regarding NEET: Will that follow the same rubric of how you outline Program Directed, Program Supported and Mission Supported?

Answer: The three parts of our program—NEET, Fuel Cycle R&D and Reactor Concepts—that's our direct-funded program. Most of the work is probably going to be at national laboratories, so we're probably going to that work the way we already do work at national laboratories. In a couple areas, especially advanced manufacturing, we're going to make sure that we have an industry participation. In fact, we may do an industry solicitation for methods for advanced manufacturing. All of this will be discussed at the NEET workshop on Thursday. Twenty percent of NEET is going to NEUP. NEET is a program. It happens to look different

because it's cross-cut, but it's a direct-funded program. In NEET, some people are arguing that some of the subcomponents should be excused from the 20 percent contribution to NEUP, and instead, universities should compete for the program itself. So far, I have taken the position that NEET is going to be treated just like the rest of the program: 20 percent of it goes into NEUP, the universities compete for the 20 percent, and we're going to run the program like we run everything else, which means mainly national labs and industry. So this is one of the debates that's going to happen Thursday during the workshop. I particularly asked Rebecca to make sure that this issue was discussed.

Question: Can universities be partners in NEET projects that are lab-driven?

Answer: Universities can be partners in any of our programs that are lab-driven, be it Reactor Concepts, Fuel Cycle R&D, NEET. That university support is not in the NEUP program. That's why it's more than 20 percent—lots of universities are funded by our budget—we fund the lab and the lab funds the university. That is the difference between NEUP and working with a lab that is supporting you. The labs make the decisions, and they don't have to peer review if they don't want to. They follow whatever procedure a lab follows when it has university partners. But this is NEUP, which we do as a peer review. That's why I keep saying significantly more than 20 percent of NE's budget goes to universities.

Question: Will proposals with a Program Directed, Program Supporting and Mission Supporting flavor be accepted in all three areas: reactors, fuel cycle…?

Answer: I plan to give the program managers a budget. It's going to be a matrix. The matrix down one line will say Fuel Cycle R&D, Reactor Concepts and NEET. The other will say Program Directed, Program Supporting, and Mission Supporting. I will put a different amount of money in each. For example, I might call for an integrated research initiative in Reactor Concepts but not in NEET. It will not all be equal, but it will add up to 20 percent.

Question: The research programs support application of nuclear technologies to industry and benefit the advancement of nuclear power. Application of isotopes or nuclear technologies to industrial processes will eventually also benefit the advancement of nuclear power. I don't see such segments in any of the program solicitations so far.

Answer: Let me take isotopes specifically. Research on isotopes is in the Office of Science; it is not in NE. I don't have any money in that area, so I cannot do a call for proposals for an area in which I don't have appropriated money. The call has to be within the framework of NE's mission—with one caveat. Part of our program proposed in the President's budget was called "Transformative." It was a request for money that would be used for a general call to anyone on anything to do with nuclear. It is unclear whether we are going to get that money because there are some people on the Congressional staff who did not like that idea. There were some people who did. So we do not know what's going to happen.

Question: How about the technology of applying these isotopes to advance industrial processes if the technology advances nuclear power processes too? Let me give a simple example: NTD technologies.

Answer: If you are applying isotopes to something like aging phenomena, then yeah, sure! If you're supporting one of my programs like LWR Sustainability, if you're understanding structural materials, if you're trying to understand cladding and using isotopes as a method to do that, then that's fine.

Response: But there is not a specific promotion of this kind of application or developments of this kind of application.

Answer: Not generically because it's not part of our mission.

Comment: There is a nuclear data in the physics component I'll be talking about tomorrow **(inaudible)**. It's specifically for high-priority isotopes **(inaudible)**.

RESPONSIVE AND EFFECTIVE PROPOSAL WRITING/ATR NSUF

TODD ALLEN – UNIVERSITY OF WISCONSIN

First I want to do a quick update on the user facility. A lot of you already understand the concept of the user facility, so I'll do a quick overview and tell you some of the things that might be new.

The idea behind the user facility is that you provide access to a national facility through a peer review proposal process. We allow somebody with a very good idea to technically execute something that they wouldn't be able to otherwise. The ATR User Facility started out with the Advanced Test Reactor as its focus, but we have broadened that a little bit. So if you want to do an experiment that requires reactor irradiation, either you could do that in the ATR or we can do it in the MIT reactor. If you need a controlled distribution of neutrons but you don't need a lot of them, we've opened up the ATR Critical Facility. Think of this as a very low-power but exact replica of the ATR. This might help you do your detector work if you want neutrons. We've opened up the Radiography Reactor if you do radiography. Coming out of the experiments, it's critical what kind of post-radiation examinations you do. We have some facilities at Idaho, but we've also paired up with six different universities who are offering some of their capabilities. We've started to pair with the other national user facilities, so if it makes sense for your science for us to take a sample from the Advanced Test Reactor and send it to the Advanced Photon Source, then that's what we are trying to do. That's the big picture with the user facilities. For instance, we may do an experiment where we do irradiation at MIT, and then we do the analysis at University of Nevada, Las Vegas. It's become very distributed.

In the three years we've been doing this, we've had 75 project proposals, and we've got 23 ongoing projects. As an example, one came out of the University of Florida, by Juan Nino. Essentially he's a materials scientist, not a nuclear engineer, and he had a better idea on how to build a better inert matrix fuel. He had a NERI project, and he could do development until he got the composition and the structure and the density he wanted; but to prove the principal, he really needed a test reactor. So he wrote a proposal to the user facility, and the peer review people said, "Yeah, that's a good idea." His experiment has now come out of the reactor, and we're starting to do some transmission electron microscopy and some thermal conductivity measurement. Somebody with a good idea needed access to a national user facility, and we made that possible through this user facility construct.

It is separate from any UP. You have to write a separate proposal to get time with the user facility. We did that very purposefully. We want to make sure that you are technologically ready for time in the reactor. We don't want to promise it before you are there. We have two parallel timelines: for the big reactor experiments or the big post-irradiation-only experiments (meaning material that has been previously irradiated). We keep that material in what we call "the library," and if we've already irradiated the material you need, then you can write a proposal to look at that material without having to do a new irradiation. So for the new reactor experiments and for the larger post-irradiation-examination programs, you can submit a proposal any time. Twice a year we'll gather them and do the reviews, and then we'll announce the winning project. The next proposal call will close in October for the big reactor experiments.

If you're a university facility and you've got some capability that you think supplements or augments what we do and you want to propose yourself as a partner, you can do that at any time. It's very simple. You just tell us what equipment you want to add to our broader user facility, and we've got a review committee that looks at that.

We got feedback from people who said, "If I only want to take one sample to a microscope or to the synchrotron light source, why am I competing against big irradiation experiments?" That logic made sense to us, so this year we created a new way to get into the user facility. It's called "rapid turn-around." If it's a fairly small project—if you just want to take a sample from the library and send it to the APS—we've created a different review process. We will review those proposals as soon as they come in and decide whether to fund them.

We are constantly trying to improve the type of equipment that is available to you. Anything you can do at the university—cutting-edge science—we want to be able to do on radioactive materials. By the end of fiscal year 2010, we will have added in Idaho a new nanoantenna atomic force microscope. I won't read the whole list of examples to you, but it includes a new 300 kilovolt field emission gun stem and a new atom probe. All these things are designed for you to be able to look at radioactive materials. In addition, we'll install our second dual-beam FIB, so we'll have the ability to process and make very small samples starting with radioactive materials.

For those of you who say, "Sounds alright, but I don't have any idea how to do a reactor experiment," we created something called the "new user experiment." Essentially, we're going to start from the beginning of the design process and go all the way through an irradiation. To be part of this, you just have to tell us that you're interested. We view it as a training exercise. By the end of it, you're comfortable with the idea of writing your own proposal. We've had a number of schools—17 different participants. In this case, the user facility staff decides what to irradiate. We're not allowing these folks to just bypass the proposal process by signing up for the New User Facility with a new user experiment. We think it's a nice way to bring new people into the discussion in learning how to do these experiments.

If you want us to come talk to you, we have spent a lot of time going around the country visiting various universities, and we've got a few requests in the queue. But certainly if you want us to come visit, talk to you in person, have a more detailed discussion, give a presentation to your students about the user facility, we'd be glad to do that. Feel free to contact us at any time. If

you're interested in doing a major experiment, the staff can help you. We remove ourselves from the peer-review process, so we are not involved in the selection. We want to make sure you have all the right answers about the reactor or any capabilities so that you can write a good proposal to get into the reactor.

Now I'm going to transition to the other part of my talk: proposal writing.

So what's the big picture here? Everyone wants to get successfully through peer review. You want to get funded so you can do some good research.

The next question is, "Why did they ask me to give this talk?" So I thought about it. Two years ago I started doing the user facility job, and during that time period, I honestly have not found the time to be the lead writer on any proposal. But at the same time, as soon as I stepped aside, then Wisconsin started doing very well, so it's clear to me that me stepping aside has helped them. I think because Wisconsin has done fairly well for the last few years, I've been asked to give this talk, so I'll give it my best shot.

So what was my approach in this case? I said, "Okay, all you guys that wrote winning proposals, tell me what you think worked." And then I talked to some of the people who do the reviews and said, "Of the ones you've read, what mattered?" So nothing I'm going to show you is an original thought on my part. I'm giving you my colleagues' impressions.

The first thing they said is, "Attend meetings like this." These things tend to be driven by DOE Office of Nuclear Energy programmatic needs, and understanding what those programs are doing is critical for getting a proposal done.

The second thing should be obvious. You have to understand what issues DOE is working on and you need to do your research on the topic. With something that is very programmatically driven, to be successful you have to understand what the research topics are.

The next comment I got was that it's very important to work with the people at the national laboratories. These programs are being driven to a large extent by the national laboratories, and in many cases, they can help you focus the scope on their needs.

Make sure that the proposal has technical relevance and answer the key engineering questions. Pick a technical problem that you can actually solve. Don't over-propose because the technical reviewers can tell if you are proposing something that's impossible for you to solve. You should be somewhat realistic in your expectation.

Another comment: If you are used to proposing to NSF or basic energy scientists, these nuclear energy programs tend to be more to the practical and realistic side than the dreamy and revolutionary side. So if you have something that is a solid, sensible, technological approach to answering a question, that has traditionally been valued by these programs.

Networking. Very important. The comment here was, "There are people at the laboratories and in industry that may have technical references that you are not aware of." They write these

reports that don't get put into the general literature. They do get put into the DOE OSTI system, for instance, but they might not be easy for you to find. So if you talk to the contacts that they provide you in the NEUP office, in a lot of cases they can get you the most current reports so that you are up to date when you try to write your proposals.

Develop a coherent plan to work with the labs to disseminate the information you get from the proposal. You're allowed to have lab members on the proposal. You don't have to, but in a lot of cases those are the guys doing the work, and adding them on helps keep you current and relevant. Form a good partnership.

If you're doing other work, certainly leverage other areas to make yourself more cost-effective. Build a team that includes other national experts in the field. You don't necessarily have to do it all from your institution. These projects have gotten to the size where you can probably team with people. Build on your strength and somebody else's strength at the same time so that you end up with a good teaming relationship.

Propose to the capabilities and expertise at your institution. You know what you're good at; make sure you leverage what you're good at.

Know what work is already being performed. If you just write a very good proposal but there's somebody else already doing that, then generally speaking that will not get funded. I'm not saying it's never happened, but make sure you know what's already being done in the field.

Be balanced in the way that you write your proposal. Don't spend so much of your time or your allotted pages writing, say, the background that you don't do a very good justification with the rest of your proposal. Make sure that it is fairly balanced so that each component is well described within the time that you have.

Make sure that your proposal is well written, that the English and the content and the organization are easy for people to follow.

Be reasonable in your budget requests. The program comes out at 20 percent of the budget. So if the fuel cycle program is huge and the LWR Sustainability program is very small, there's not going to be a lot of LWR Sustainability projects. So you need to understand what the odds are, and you can figure that out if you know what the total budgets available are for the different projects.

Start your proposal writing early so you have a chance to evaluate yourself, what you did. Be critical about it. Have your colleagues read it to see if it's understandable. Similarly, read carefully to make sure your proposal says what you want it to say. Do things to make sure that the peer reviewer, the person who's going to read it, very clearly understands what you're trying to say and why what you're proposing is important and new and innovative.

At Wisconsin, we have followed the advice that I just gave you. Throughout the NEUP program, we have worked very hard to form partnerships. We've got projects where we're working with all the different national laboratories, and we've tried to find university partners to

work with us where it makes sense, where we can leverage their skills with our skills. I really think that that works—at least in our case, we think that worked very well.

OPEN MICROPHONE SESSION

Question: With regard to the fellowships, what age/year level are you targeting?

Answer: Primarily the fellowships are meant to encourage students to come in to the nuclear energy program. We do target them primarily at the first, second and—at most—third year of their studies. We intend to be very clear about that in this year's call. That does not preclude someone who is returning to school who has a master's degree and wants to start the first year of PhD work. That would certainly be encouraged. But we want to see those folks who are later in their career—who have completed their first three years, for example, under NEUP's fellowship—to be involved in one of NEUP's research projects for the remaining years of their degree. We hope that having the first three years under a fellowship has given them enough time to get through their initial schooling so they can then roll on to a research project.

Question: There are some students who are on their way to becoming U.S. citizens, maybe holding a green card. Would they qualify for consideration for either the scholarships or the fellowships?

Answer: Several times someone has asked whether a student who is a permanent resident can apply for these, and in the last two years we have not allowed that. They had to be U.S. citizens to receive scholarships or fellowships. That is tied to the money we have coming in from United States taxpayers who want it to go back, focused on students who would then work in the United States, work at, say, laboratories where you need a clearance, things of that nature. We are considering a permanent resident option, but we don't have an answer for you at this time. Someone who holds a green card but who is not a United States citizen or a permanent resident would not be eligible for these.

Question: This morning John mentioned a visiting faculty program. Could we have some elaboration on what that might be?

Answer: Faculty can spend time at labs—they frequently do, either in the summer or for a semester—but also the reverse, lab folks spending time as a faculty member. We're talking about the program in both ways. I believe the Energy Policy Act 2005 talks about the availability of some things like that. Right now, labs typically pay out-of-program funds for faculty if the labs want them to visit or for a sabbatical. This would be an additional source of money that labs and/or universities could use to have people visit. It's a good thing, and it happens already. The question is, do we want to commit funds from this program to enhance that?

Question: Let's say I wanted to be a visiting faculty at the University of South Carolina. Would it pay the travel expenses for me to go to South Carolina to present courses there?

Answer: Not right now. You're talking about university to university?

Comment: That was not the original intent. It was a pass-on of knowledge, the idea being that we have all of these very knowledgeable experienced people working at national laboratories, and it would have been a way for them to communicate that experience and pass that on to the next generation of people—the students who are coming into the program now. To give specific courses on something that might be their particular technical expertise that might not be available in a university community. There are certain very specialized areas like separations chemistry, radiochemistry, certain graphite technologies…you know not many universities have those. A university might want to bring somebody in for a semester or two who works in one of those areas to develop a course.

Question: Following up on the fellowship program: Is that for nuclear engineering students only?

Answer: It's for all students who can show that their course of study is applicable to something in nuclear energy. We did fund a few of those. The last slide that I had in my presentation talked about a health physics student we funded. We have radiochemistry and chemical engineering students; we have a variety of engineers. The majority are nuclear engineering students. But of course your university has to be approved. You have to submit an application and show you have the basic structure to educate that student in nuclear energy**.**

Question: Is this year's pre-application process going to be looking at technical quality of the applications versus just whether the applicant is responsive to the call? The follow-up to that is: How do we structure this program if we're going to look at technical quality? I have a serious question about how you assess the technical quality of a proposal on two pages and the PI's resume only.

Answer: You're right, in the past that review was done as a conglomerate of both the relevance and the technical. It was done by two people, but it was combined. What we're proposing now is a two-step review: a relevance review by a lab and/or program person and then a technical review by a faculty-member-type panel or individual. So there would be much more emphasis on both sides. It's definitely an increase in the effort that goes into the pre-application stage. How long do those proposals have to be? Right now we're at three pages, which includes a budget. Certainly I could do a review of a three-page proposal if I know the area and the people and their publication record. You could make a pretty quick judgment, but that's on the margin in terms of a technical review. Whether we go to four pages or more, we're open to your view of that. Some faculty members say "five would be better, but it's much more work to put together a five-page proposal than a three-page proposal. It would be better for the reviewer, who would certainly get more details of the technical approach. What's your feel, five pages?

Question: Five isn't bad, but the big one for me is that we include all of the personnel. The reviewers are not even looking at who the co-PIs are, so you're doomed if you are a junior professor acting as the PI. In some cases, a junior professor in a mentoring situation is going to be the PI.

Answer: We really do want to get your opinions here. With a show of hands: Are three pages enough? I'm looking at about 10 to 15 percent of the audience, maybe 20 percent. Is five pages enough? I got less than 10 percent. More than five? Okay, less than three.

Question: Back to the fellowships. You made it clear about citizenship and the interest in working in a nuclear field, but there's no agreement to work in the nuclear field afterwards. Is that correct?

Answer: That's correct. We did not want to be turned into a policing agency where we look to say, "Thou shalt work for DOE or at a national laboratory." Our mandate is to train people for the next generation in industry, DOE, NRC…. We are trying to get people with advanced degrees who are going to work in nuclear energy, wherever that might lead them to work.

Question: For the nuclear enterprise to be sustainable into the future, it's got to live beyond any particular administration. Around the world, most competing programs are really not either industry or government but combined government and industry—almost like national companies. So what are your perspectives on the role of the nuclear industry in research? Also, where do they belong in the economic scheme of things? As a potential other source of research funds, their research time horizons are extremely low—maybe 18 months to the next refueling cycle. Is there any interest in industry increasing its time horizon and maybe working with NEUP?

Answer: In the past year I've had a chance to interact with various companies, who talk to us about what they want, what their interests are, what their perspective is. I have found that a number of smaller companies are innovative, are at the R&D end. Examples are TerraPower, G.A., NuScale…. Often they talk about collaborations with universities. The bigger ones are the ones that are interested in Gen III deployment or near-term deployment of any kind of reactors. They don't have a lot of interest in R&D. As you point out, it's the nature of business in the United States. We have thought a lot about energy parks, particularly the idea of a small reactor potentially providing electric power at a big DOE facility—an example would be the Oak Ridge site that has Y-12, Oak Ridge National Lab—and having a collaboration that could involve universities.

Comment: Universities are an ideal place to work with industry because we have a lot more flexibility than DOE. We've had programs where we've had trainee-ships with local utilities, but over the years they've shrunk their horizons, and they don't have a lot of cash either. I would like to see more interaction with industry myself.

Question: About the visiting faculty/visiting national lab researcher program: It seems a little harder to get the national lab researchers to come to the universities since their mission and so many different activities they are working on are dropped cold. Have you thought about

offering something where they could do some distance classes? It could be live time interactions with a class at a university where they didn't have to personally be there. They might be funded at, say, a third of their salary, so they get a 33% release time to develop and offer a course on a semester basis. One of the advantages is clustering a couple of universities together to take advantage of that. It would be wonderful to find some mechanism to tap into their expertise without requiring people to leave their homes for six months.

Answer: Definitely the video age allows that to happen, doesn't it? Thank you.

Comment: I think the universities have mechanisms for it—they offer adjunct faculty positions to researchers from national labs. I think it is really good to make the cooperation with the labs work both ways.

Question: Concerning collaboration with industry: I'm a member of the CASL consortia, and Westinghouse is a full-blown partner. With the integrated projects, do they envision industry partners to be equal partners or just minor partners? Could they get funding from DOE at the same level as universities or national labs?

Answer: I wouldn't envision the latter. I'm thinking of the NSF model right now. They do stimulate work with industry, but I don't think they don't pay industry; they expect industry to pay them to be part of it. Maybe the small reactor community would be willing to kick in 20K or 30K to be part of a consortia that really delivers something that would be of importance. But then you've got the intellectual property issues, the competitive issues, some proprietary issues… If we could figure out a way to get industry as part of the integrated research partnership proposal, I think it would be a good thing to do.

Question: My question is regarding the infrastructure component of the program. As I looked at the numbers this morning, it seems like the reactor upgrade component both major and minor is about $5,000,000.

Answer: It's targeted at about $7,000,000.

Response: Nationally, many of our research reactors were built back in the '60s, early '70s, and have reached that critical time of relicensing. Many states are suffering from financial problems that put additional burdens on these reactors. I'm wondering if the $7,000,000 that's proposed is going to be sufficient to maintain this really critical element to research and education in universities. Is that assessment done at the DOE level? Have there been any discussions with the reactor community to see if enough funding has been allocated for this critical need?

Answer: That's a good point. This is the first year I've really seen a big investment in reactors in a long time. If I'm incorrect let me know, but it's going to take a number of years of sustained investment to bring even 10 or 12 reactors up to modern standards. If you have to build a new reactor, how much would that cost, 30 or 40 million dollars? Investing in current reactors at a million or two per year makes a lot of sense if they're useful and serve a research or educational purpose. A trend that I see now is that a lot of nuclear engineering programs don't

have reactors anymore. Why? How can they get by without one? Even new programs now don't have access to reactors. Is a reactor absolutely necessary?

Question: I'm curious as to how much you think is reasonable.

Answer: In the days of the reactor sharing program, I think DOE was putting $20M or so per year into the reactor programs. That's what I think it's going to take to sustain this national asset in all the states. By the way, in answer to the question, "Why do these universities not have research reactors?": When colleges/universities come under financial pressure, it's easy to decide to let go of the research reactor because they're very costly to maintain. Nuclear engineering programs are small in size compared to everything else at the university, so it's to let these reactors go. Without DOE support, we are going to lose more reactors in the future.

Comment: Seven million dollars is good compared to not having any, but it would be nice to have a little more money because most of those operating reactors are approaching 40–50 years old. There is some infrastructure need. Most of those infrastructure needs are beyond the budgetary means of the universities because none of the universities are going to spend one or two million dollars to upgrade those facilities. Therefore any help from the DOE would be appreciated and would affect the long-term viability of those reactors.

Question: A follow-up question in regard to reactor sharing: Is there a way to share the resources of a reactor with a larger number of partners/other universities?

Answer: Yes. Reactor sharing is useful in this regard. That could be a part of either the infrastructure or a reactor program because some of the universities don't have access to a reactor. Therefore they can have small projects, and reactor sharing is supported for visitation, and it will foster interest in nuclear engineering as well. It would be useful to start a program like that.

Comment: The reactor sharing/upgrade program never exceeded $1.5M a year, so it was very small. The program helped reactors, but it wasn't intended exclusively for them, so it was never near $20M dollars.

Comment: If we use these reactors as an outreach, it's part of the early pipe-line tool. It's potentially powerful. Kids get excited: "The blue light is what turned me on to nuclear." Everyone had that kind of nuclear moment. So we have these assets. If you're just so concerned about keeping it up, you don't have the ability to do all the outreach that you could be doing. That little support is leveraged so strongly to have outreach programs associated with the reactor. For R&D, we have the ATR and the bigger reactors, but this other aspect would really grow well with a little bit of seed money and would fit into the pipe-line part.

Question: You have adopted an NSF program group concept in your next round. NSF also has expert awards for novel research, which is not a very large amount—$100,000 or something—but that might help people who want to get involved. The preliminary proposals may be significantly improved if something like these expert awards is also increased. The PIs

would do some work, and when they write a bigger proposal, they have their points all worked out.

Answer: That's a good thought. In our current proposal, we have the blue-sky projects that are around 200K per year, which is bigger than what you are talking about. We are also talking about a seed grant program for younger faculty that would be 100K per year total for a relatively small number of awards, five to ten per year. There are probably 20 to 25 new faculty positions open right now among all universities in nuclear engineering alone, not to mention mechanical and everything else. So there's a significant amount of hiring going on for new faculty. It will take some time for them to get funding, and they might not be competitive for some of the bigger awards (although they haven't done too badly so far with their programs in general). I could see the value of that if we could find the funding for it.

Comment: Somebody asked about benchmarking your program with other programs. I wanted to make a point that your program could be used as a benchmark by some other programs, including NSF, where you have broken the barrier and allowed people from other disciplines to go for this kind of work. There are some restrictions that are not easy to break through.

Question: Is that true that NEUP won't fund adjunct faculty positions or joint faculty positions?

Answer: Joint faculty positions are typically funded part by the university and part by the lab. They can get it from any source—programmatic funds or lab-directed research or any of those things—but we don't have a program specifically from NEUP to fund those sorts of things. The reason is those are open-ended. Those are huge commitments. What happens if the NEUP money goes away and then the university is stuck with that individual as a faculty member? You have to pick them up full-time—or vice-versa—if the university money goes away then the lab has to pick them up full-time. There are very specific negotiations that have to occur that are tailor-made for a particular area and a particular group and a particular person at a university. They do help you get a lot of insight into what's going on at the lab from personal interaction, but you can do the same thing by spending the summer at the lab.

Question: We've talked about the vendors, but we haven't talked about EPRI and utilities. Where do you see EPRI as a funding source and utilities as partners in research playing a role in this program?

Answer: The one place that any industrial partner can play a part is up to 20 percent of any R&D project. So if you choose to partner with an industrial partner, and you need to pay them up to 20 percent of that contract, you certainly can—as you can subcontract with any type of national lab or industrial partner.

Question: Do you see a benefit by associating with a utility? Will that give you extra points on a review?

Answer: It's not "extra points." It's really in the team qualifications. If that person is an important part of your team—if you can't get that work done without them—that's where that comes in. It's the value of the entire team to producing that particular piece of research…

(audience remark)… Dr. Miller is asking if you think it should be that way, if you should be given a bonus if you've got an industrial partner.

Comment: You keep saying "industrial partner" and I keep saying "utility." Utility is the actual user, the front-line people with regard to the reactors. They're the people who know what the problems are. They're the people who really run the reactors, buy the reactors, etc. I think they have to play a key role in the whole program.

Comment: So you're advocating for us putting in some type of bonus for that?

Comment: No, just encouraging utilities to be involved somehow.

Comment: So if I say "industry" you don't hear "utility," so I need to say "industry and utilities" in our calls? We meant "industry" to mean the greater non-national lab, non-university community.

Question: Since the number of university reactors and research reactors in general has been shrinking, the number of state-of-the-art university labs has not been growing. The virtual world has been becoming more and more popular. Virtual reactors, virtual experiments are used to perform advanced computations and develop modern capabilities. One needs advanced computers and one needs access to those computers in terms of a proper timeshare. In the case of the current family of projects in the NEUP program, is each PI supposed to make arrangements on his own? Or in the case of any computational-intensive projects, will access to computers be facilitated by the program?

Answer: We expect the PI to make those arrangements either though a national lab or through NSF or whatever access cluster or big computer they want to have access to. I don't think it would be up to the centralized NEUP to have a contract with a particular IBM manufacturer or computer at any given location because it's not going to suit the needs of everybody anyway. At the hub, the Jaguar machine, the Oak Ridge machine or others are going to be dedicated to that particular project, but I'm sure there are going to be other needs, other computer clusters that are going to be used as part of that as well. The amount of modeling and simulation work that we have currently is pretty small, so we just don't have the critical mass to really go out and negotiate for something big. Eventually we might.

Comment: For the joint appointments, in my experience, the problem is never the money; it's the intellectual property negotiation. So NEUP is not going to help with that.

Question: You showed on one of your slides the split among the community between raising the number of pre-applications that get invited and the number that don't. So my question is, what are you going to do about that? Is it going up or down? I suggest that you throw the ball back into the PI's court. Give them some suggestion on where they are in the big scheme of things—top third, middle third or bottom third—then then let them make the decision to either invest or fall out.

Answer: Actually, you're in good agreement with Dr. Miller. He's given us some thoughts with respect to that type of a situation, and that kind of option is under consideration for this year's call. Last year we did give people the indication of where they fell in the quartile rankings, but that doesn't allow for them to submit anyway. We're trying to figure out what kind of mechanism we could use for that.

Comment: NSF does have centers that require you to go out and get participation from the industry. I would think that if you're going to have centers, you'd want to encourage faculty to go find people who are interested in their research, get ideas from industry about what they should be doing and what direction they should take in their research. And also seek funding. So when you look at the centers, it might be a good idea to give people credit for going out and taking the extra steps to get industry involved.

Response: I tend to agree with that.

Question: The review process seems to be a merit review which comes up with some kind of score, which is seen more or less in isolation. Now clearly one reviewer could be more severe than another reviewer, so to compare absolute scores without seeing everything together…. I'm not sure how to address that, but I'm not sure that the numbers are so absolute.

Answer: We have three reviewers on each proposal. At least two are university professors. We give them a guideline of what a score means and hope that they follow that guideline. When the scores came back, we found that the scores were very close to each other in over 90 percent of the cases. On those times where the scores were not very close to each other, we flagged it and took a look at it to see if the dichotomy was something we needed to address. So if the professors give the proposal an 80, an 81 and an 82, we think they all agree. If it's a 60 and an 80 and an 81, then we take a look at it and say, "Why did that one professor give it a 60?" So we do try to address that; that's part of our panel process.

Comment: So effectively what you're saying is that everyone comes up with the same scores independently? More or less.

Comment: They do, more or less. The system is working. We get a lot of comments back that say, "I just don't think they understand my proposal." Three people didn't understand your proposal? We try to do the best we can to get the appropriate reviewers—and that's where you guys can really, really help us if you'll help us populate our database a little better. The database is pre-populated. If you've been a reviewer for us, we've got that part of your data. What we're looking for is more information on you and what you do so that we can pick the best possible reviewers for the proposals.

Comment: We do more or less look at the trends of the reviewers. Some always grade low, some always grade high. We try to flag those and make sure that's taken into account in those panels, but inevitably university faculty are tougher on each other than people outside. A lab person or an industry person is much easier on us than university faculty, so you don't want all three to be university reviewers.

Question: Will the peer reviews for pre-applications be semi-blind?

Answer: We are talking about the new pre-application center, and pre-applications never have been semi-blind. The reviewers see the entire three-page proposal, including all the information that's given to us. There is no intent to make that semi-blind for this year either.

Question: Can industry be paid from the Program Supported and Mission Supported proposals?

Answer: Our R&D piece, that 20 percent is allowed to go to an industrial partner, so that's a pretty straightforward question.

Question: Are we keeping track of feedback on the review or the reviewers and the helpfulness of the reviews for resubmission?

Answer: We do a little bit of internal checking, but we don't do a concerted collection of information, so I'll take that comment back and hold that for consideration for next year. We are looking at trying to keep some metrics on how reviewers play—for example, that reviewer that always reviews low—we'd like to have some idea of how that's working. This is our second year, so once we improve our database we hope to keep track of that a little better.

Comment: We are going to keep track of the performance of the reviewer. If you only give very brief comments and they're not very helpful, we're going to track you too. If you give rich comments and they're important, we'll ask you to do more work because that's the kind of reviewer we want. And you want that feedback, too, when you're a proposer.

Comment: Things that are substantive and helpful and are conducive to producing that better proposal next year—that's what we encourage.

Question: Is there a re-direction time at the pre-proposal or after the technical review?

Answer: I don't really quite understand this. The way I read that is, "If I wasn't successful at pre-application, would you give me a chance to fit and then put in a full proposal?" And realistically, we just don't have time to do that. So we give you back what we can, and we hope that the next year you might be more successful. You use that commentary to help produce a better proposal next time, or you talk to the technical points of contact and try to get information on how better to apply the next year. Maybe ask what different types of projects you should be looking at.

Comment: You could send a very informal white paper to one of our technical program contacts beforehand to get informal feedback on your pre-application before you send it in.

Question: What are the rules or guidance for working with foreign-owned companies with business interests in the U.S. given that most of the reactor vendors are foreign-owned?

Answer: Each proposal goes through an export control mechanism. If there are any requirements or requests made for that, that would be put into the contract for the research and development. We find that most basic research is pretty easy to get past that, but if you start getting into very specific things, we have to defer to our export control people to help us answer that question.

Question: I am concerned about the infrastructure of people. Do we have enough quality undergraduates who are coming into nuclear energy to be those graduate students and professionals? How do we attract support and retain these undergraduates?

Answer: Undergraduate research is not something that we have specifically targeted. We do allow a variety of schools to have research elements here, and certainly we don't discourage them from including undergraduates on their research projects. We also have an element that we look at for curriculum development. It hasn't made it high enough up on the list yet that we're funding it, but it might in the future. We also give out the scholarship program, so we're trying to make sure that those people who are interested are recognized with a scholarship.

Comment: Mary, you were on the review observing that the recipients of the scholarships were much better than they were the previous year based on the GPA and so forth. I think that's encouraging.

Comment: We had a larger pool in both the scholarships and fellowships this year to draw from, so it was very competitive in both cases.

Comment: I was an observer in the peer review of the fellowships and scholarships and found that they were very high-quality submittals. It was very difficult to make decisions on who got them.

Question: Clearly state which programs are or will be funded next year.

Answer: Greg tried to address that in his presentation. He stated it as clearly as we can. DOE reserves the right to balance for the program's best interests. If you say, "I'm going to give $5M dollars to separations," and 50 different projects come in, that's great. I've got a highly competitive process, and I can give out that five million dollars easily. What happens if I get two? I can give a $1.2M out to each of them. What to do with the rest of that money? Would you rather I just gave it back to the program? The way that we have it set up is to pick the best and most competitive projects with an ability to balance across the program and decide what is best for DOE–NE's mission as a whole. We do guarantee that if you get the highest-rated proposal in an area and we're going to fund that area, it will be your proposal that gets funded. There are program factors that we have to have within the process. We also have to put in that relevancy to the mission. So it will always be a balancing act.

Comment: Let me just give an example of something that occurred last year. We knew that SMRs were becoming more visible, and yet there was no LWRS money in the budget last year. We probably got a few proposals along those lines because faculty knew that this concept was going to be revisited. Yet we couldn't fund them because we didn't have the

money in that area. In the future, if it falls in something like a Blue Sky area, then we'll have more ability to fund something like that at a small level. Maybe we can look a little farther out with projects we don't have exact programmatic money for.

Comment: Let me just clarify one point. They speak of the program as a whole, but they recommend projects. They aren't making the decisions on which ones to fund, they recommend projects. DOE management makes the final selection and approval. Don't blame them. They recommend, but the final say comes from the Department.

Comment: We [CAES] run the program to be as independent as possible to assist the program, but they're our bosses. They're the ones with the money. They make the rules. They make the final determinations. We try to run as fair and open a process as we possibly can, to tell you exactly how we're going to judge your projects, to make sure that anybody who wants to submit a project can submit a project that will be fairly considered. We try to make sure that just because you're a brand new professor, you're not precluded from participating in this process. That's part of our "semi-blind" process. We believe it's successful. About 20 of the professors were new young faculty. Does it solve every problem? No, of course not. Are we going to make sure that every review is the best possible review we can conduct? I have to rely on you and your integrity and the integrity of every person who provides us feedback and information throughout the process. It's driven by people. There are always going to be a few mistakes. We apologize. We do the best we can to address them as they come up, and we do want to hear from you, and we do hope to make improvements as we go along.

Question: You had an incentive to help partner with faculty from minority-serving institutions. How many proposals did you receive that would qualify under that? How successful were you?

Answer: [34 pre-applications submitted had minority-serving institutions as collaborating partners, and 15 had minority-serving institutions as leads.] At full proposal phase, about ten to fifteen came in with minority partners, and five of those were eventually funded. [Five funded projects partnered with minority-serving institutions; one funded project was led by a minority-serving institution.]

Question: If the full proposals are semi-blind in the evaluation, why are the pre-applications not that way to be consistent?

Answer: At pre-application phase, it was primarily to be a judgment on relevancy. So our first and foremost goal is that any project that we're going to fund be relevant to the NE mission. Is it relevant? Is it not relevant? If we get 600 applications and have to cull it down, it becomes more of a judgment of, "How relevant is it?" There's no need when all you're judging is relevancy to make it a semi-blind. When you're focusing on that highly technical aspect of it, you want to be sure that your peer review committee is not just saying, "Oh, I know that guy, he's a good guy, and he gets a good grade." That's where we're trying to really get at the meat of the proposal.

Comment: In 2011, we are proposing that the technical review be done at the pre-application stage too. It's a short time period, and there's no need to be semi-blind at that point because you want to look at the whole thing since it's only three pages.

Question: If that is the case, would it be possible to do something more like a recommendation for the reviewers? In the nuclear energy community, you have a scarcity of expertise. Therefore when you do something that could be biased, trying to avoid putting names on it, you can still detect it through references. Even junior faculty have publications listed. When you send something to a journal for publication, you can recommend the reviewer. I'd rather listen to a specialist in the field critique my work or my proposal instead of having someone else who doesn't know my work criticize me about something that they don't understand. If people who don't know anything write something bogus in their report and you don't even understand the points that they're making, it's misleading and very discouraging.

Answer: This year in the full application process we did ask, "Who do you believe would be a good reviewer for your paper?" We also asked, "Who would you prefer NOT to review your paper?" We did not tell people that we would take their advice, but we did look not to send it to those people they told us not to send it to. We tried very hard not to go to those folks. We didn't always go to the people you asked us to, however. We did look for those reviewers in some cases, and we used some of them when we could. It may be that the person you have requested as a reviewer is conflicted in your area. We did get a broad group of people, a mixture of people, to do the reviews. We also may have used your preferred reviewer for someone else's paper in that area, so thank you very much for that information.

Comment: I've been reviewing a lot of papers for the journal, and it's not so difficult to know who the writer of the proposal is from the references. But it would be kind of funny to write a proposal without references.

Response: We asked people to try and maintain the integrity of the process as we defined it. We don't tell you that you can't put your references in because that would harm the process.

Comment: I'm not judging anything. I like the idea of addressing the bias issue. I'm just concerned that some reviewers do not have a lot of expertise in the area. For example, say there are five people doing work in that area. Let's say four applied for NEUP, and the fifth is a collaborator. You limit all the expertise. Those experts know what work has already been done, especially outside the country. If you don't have that knowledge, you end up funding work that has already been conducted. I see no point in reinventing the wheel—instead of a collaboration, which you can do through I-NERI. That's my concern. I like the idea of avoiding conflict of interest, of trying to avoid the bias issue.

Response: Well, we will try to increase our reviewer database. I hope there will not be conflict as you've described, but this is just part of the business. We're well aware of the situation, and the team spends a lot of time tracking all of the details and trying to make sure that we get the best reviewers for a particular proposal.

Comment: Finding reviewers is very difficult. That's why this more comprehensive database we are having built will help us. Number one, it's going to ask for a lot more information to describe the type of expertise that you do have. Number two, we will be having some other people look at the database and verifying that we do have a good database of reviewers and that we do have the expertise that is needed to do these reviews. I know that, especially in some of the fuels areas, a lot of the experts happen to work at the labs. One of the things that you wanted last year was to have more peer reviewers from the universities, which is what we did. We had only two proposals that didn't have at least two university reviewers. We are trying really hard to accommodate you. I know every single one of you is busy, but we really need your help to do at least a couple of reviews for us.

Question: There is little communication between CAES and the PIs on the contracts.

Answer: We assign a technical point of contact to each funded proposal. That technical point of contact is someone within the program that's upholding that mission. That person is the one who is supposed to provide you an "in" and an "out." So they help you get information, and they help bring your information into the program. It's a very important part of the process of NEUP. It is not necessarily CAES's job to provide that communication to the outer world, but your technical points of contact should bring you into the greater program at DOE–NE.

Comment: If you're having problems with that, let us know. We can stimulate that and make that happen. We need to close that loop a little better. The program leaders need to require that the technical points of contact write summaries of your work so that leadership knows that they're paying attention to your contributions and your deliverables as part of the program. That's going to be included here pretty quickly because we're just through the second quarterly reports that have been submitted for 2009 awards. We're just starting to get that feedback.

Question: Is there any communication about the program to the rest of the world? It seems a lot of good research is being conducted and very little of it is known outside of Fuel Cycle R&D.

Answer: I'm surprised to see this one. It's a "publish or perish" world that you live in, and all of this work is publishable work, so that's your outlet to the world. We also encourage people to present at professional society meetings. In fact, for the student population, we have open poster sessions at the meetings for them to present their work. At the next ANS meeting, the student competition will have a particular part to judge students who are part of the NEUP process and call them out. We hope that you're going out and talking, not just coming to the program meetings. We hope that you're getting out there in the rest of the world, that part of your proposal for NEUP is travelling, going to meetings and presenting the work.

Question: Would it help the process of building this database if, instead of having to provide a two-page resume, you were required to provide your expertise on the database as part of the pre-proposal process? Would that be something that the community would be willing to do?

Answer: The fields we're evaluating in the database will reflect the same technical areas that we have issued in the call. Then we're also using a technical ontology. That's a series of terms to which we provide a context in terms of the areas that we offer. You'll have the opportunity to

self-identify in those areas, and then that will be an opportunity for us to ascertain a level playing field between the reviewers. Then we're also asking for a CV. We'd certainly like the opportunity to machine-read that, but we don't have that. So that will become a personal interaction. So with respect to the pre-proposals, are you suggesting that the short CV that is submitted with the pre-proposal be entered into the database as a cross-reference or as a tool of selection?

Response: Well, it seems that one way to help with the review process is to increase the pool of qualified reviewers. One of the struggles is getting people to make themselves accessible for the review process. So combine the two. Make it so that in order to submit a pre-proposal, you are in the database. You're providing the information in your resume, right? You're just formalizing it and putting it in a format that could also be used for this. As I said, I don't know if there's less willingness to get into the database. That's why I finished the question with: Is this something someone's willing to do, or is this something that a lot of people are going to be opposed to?

Answer: Let me point out that we have not paid this gentleman to make that point. But we do note that there are many more who choose to participate in an open call for proposals who know who we'll choose to identify themselves as a reviewer. Let me also say that we have cross-referenced the database, and those individuals who have provided applications for funding in the past will be emailed an invitation to participate. So part of the juncture that we were driving to in developing the database was to allow a self-user-populated tool where we were no longer entering the data, but you could enter the data. That becomes important as an example for annual update. It becomes important as changes occur in priorities and other areas of the programs. We're going to be reaching out to individuals by email. You're, in essence, getting a first look at that. And we have that first module built. So you make an excellent point, thank you so much for that.

Comment: I would add to his point that if you were funded by NEUP, we do feel like you ought to help us out on reviews.

Question: On indirect charges, is there going to be some restriction on overhead charges? Some of our schools charge us an egregious amount.

Answer: We have not done so, but it might be something worthy of consideration.

Question: Question on the infrastructure grants: Going back to last year, are we going to get any of the feedback from the infrastructure proposals? Also, are the abstracts from the infrastructure proposals ever going to get posted so we can see what our colleagues are doing?

Answer: There will be feedback. The feedback is a little slower because we're limited in man-power, and our priority is getting the grants out, so the feedback will be coming. As far as abstracts of those awards, we could do that on our website. We haven't done that in the past. The infrastructure for the equipment hasn't been that big of an interest to others, but we could do it if the desire was there.

Comment: I figured that the reason that we wrote the abstracts was so that we could post them at some point.

Response: I'm sure we could do that.

Question: Another question on the R&D proposals. There's a section in there, Quality Assurance. I remember struggling with that, saying, "If I'm going to try to do this as expansively as possible, it's going to be almost impossible as a university." And then I heard a comment: "Well, at the universities you do it a little differently." It was also in the write up, but it wasn't clear to me what was required. I thought if there was a set of steps, that would be the minimum required, and then additional information could be input. It would be nice to have that as a format. One could then acknowledge, "I will be doing this," as opposed to recreating the wheel. Even at universities, we can all agree to some standard protocols that would be entirely appropriate for quality assurance, and everyone would then just have to sign on to that. If they had additional things that they were doing for training students above and beyond the minimum, that could be sort of additional information.

Answer: That's a very good comment; I'll take that back, thank you.

Comment: As we ask for current and pending, maybe we should also ask for past work and what publications and citations came out of that work and the nature of that work over the past ten years, anything that was DOE/NRC-funded.

Response: Thank you.

Question: I have a question about graduate student fellowships this year. Now the student is up to $50,000, so you just send a check and he will pay his tuition by himself? In previous programs, they used to pay extra; there was a spread for tuition, for stipend and maybe a small amount for travel and books. But now, it's a block of $50,000 and they pay for everything by themselves?

Answer: No, that is not correct. The way that it's designated out. There is a $50,000-per-year fellowship. Out of that $50,000, $30,000 is a stipend to a student as if they were working on a research project—a regular stipend to the student that is paid out in a monthly fashion. Then there is $19,000 that is set aside for tuition, books, fees, any other expenses that are normally accrued by the university or college; and beyond that there is a $1,000 travel award. From that $19,000, should they not use it all for tuition, books, fees and any other of the costs of going to school there, they can additionally accrue housing against that . Housing must be the last thing. So they get their $30,000—that's their stipend—which they can spend however they pay for their living expenses while they are students. It was requested, and we did allow, that housing be included if they'd already paid for their tuition/books/fees.

Comment: The money goes to the university, and then the university takes out the tuition and everything and gives them the stipend, and the stipend pays out monthly.

Comment: Follow-up on quality assurance: I don't know about all the programs, but Fuel Cycle R&D has a QA plan that has a specific section on universities and what we would require in our program regarding QA for the universities. Maybe that plan could be shared with all of the universities or included in the solicitation somehow to give some better guidance.

Response: Additionally, on the NEUP website, you would find some standard types of quality assurance guidelines and/or procedural types that you could implement should you not have that already available at your university.

Question: Back to the fellowship question: Where is the requirement to disperse the money that way? Is it when we signed up to be administrator universities? At the risk of getting into trouble, I'm absolutely certain that that's not how we're doing it, and I'd say that a lot of other universities are handling it a lot like ours, which is: "Here's money—we can't touch it—Student, it's yours."

Answer: I don't know if we have those exact rules in the grant. I think they may be through the fellowship to the application, but I'll have to check into that. The rules are in the request for application; it says that's how they're supposed to do it. [These details are provided in an addendum to the grant.]

Comment: The university doesn't see the requirements you put into the application that the student fills out.

Question: With regard to this research, the Commerce Department has set up a new 20-page document we have to fill out with regard to any nuclear research we're doing. I gather this has come out of the Iranian situation, and these are IAEA requirements—that all nuclear research must be reported?

Answer: Is this the "additional protocol"? Should this impact our program?

Response: Some of the PIs are really concerned because they're not really filling it out. It's almost a volume. They're wondering if they're getting into trouble. About a year ago a gentleman from U.C.–Berkeley had been assigned to look into this.

Comment: Just to clarify… We looked at that. Unfortunately, when the Commerce Department published their requirements in the federal register, somebody there thought that "fuel cycle" meant everything from mining to reprocessing, including reactor design and reactor work. Additional protocol only has to do with fuel cycle and enrichment and reprocessing. It's very open ended. If you wanted to comply literally, you'd have to write everything you're doing in nuclear research. That was not the intent. NNSA should clarify this. You are technically in violation because it's a compliance issue. There are ways to write it. If you write it as related to the fuel cycle, that's a lot easier.

Question: If I had an infrastructure award this year, does it impact my chance for winning an R&D award next year?

Answer: Absolutely not. In fact, it doesn't impact you getting an infrastructure award in the next year. It doesn't impact your scholarships or fellowships either. You can get an R&D award, and the next year you can get another R&D award. We do not limit that. It is an open competition.

Question: Is the $30K for the fellowship over twelve months or nine months?

Answer: Twelve months.

Question: So this is penalizing for some of our graduate students who would go to a national lab and earn $4,000 per month in the summer.

Response: Seems like they could get both amounts of money, could they not?

Response: That's what I'm asking.

Response: They get their stipend no matter what. They can go and get a job at a national lab and get paid there, too.

Question: So they can get double pay?

Answer: Yes, sir. We have nothing to do with the internship program, and we don't preclude it. We don't have anything to do with any other type of mechanism at the college. If they need to do a teaching assistantship, we have that in the RFA. It tells them that if they're required to do a teaching assistantship, they still have to do it.

Comment: If they work in the evening at Taco Bell, that's fine too.

Comment: They have to fulfill all of your requirements. We don't impinge on those.

Comment: They do have to be making steady progress on their degree, etc., so if they're moonlighting on the side and that's affecting their performance, that's not good.

Question: In Dr. Gilligan's presentation, 30 percent of the funding was going to materials and waste management. For next year, is there going to be a big chunk on materials and waste management?

Answer: Tomorrow are the breakout sessions. In those breakout sessions, you'll get to hear about all the different calls, all the different work scopes, that people are looking at or considering for inclusion in next year's call.

Comment: If you're just talking about the big breakdown, there's $200M in fuel cycle, $200M in reactor concepts and $43M in NEET. But it depends on the funding from Congress, of course.

Question: If I want to take a student starting at the end of August, but NEUP starts in October, how am I going to fund that student during this period?

Answer: This year, your contract will start on the day that it's issued, so you can charge to it as soon as you have it in hand. As soon as it's there, your university's got your money—you're good to go. If you've got a contract in place now, you can charge to it now. There's no requirement to start October 1.

Comment: Under the grant process, if you were notified of a grant, you could charge 90 days before your grant became official and get it retroactively.

Comment: The subcontracts have to be in place. You can't charge before the subcontract is in place, but you can charge the day it's in place.

Question: Last year, you encouraged teaming. That's a good thing, especially compared with other programs. However, let's say you're teaming experimental with modeling and simulation, and your experimental is for the validation of the model. Which category/group do you submit the proposal to? When you submit to the modeling people, they say, "The experimental part of it is too big," because it's 50/50 with two investigators. How do you resolve these two investigators?

Answer: I don't think I have a really great answer for you. Sometimes it's a challenge to figure out the category when someone presents a concept that really crosses two or three of the workscopes. Next year, the way Dr. Miller's got it set up, at least it would be considered because it would be for small modular reactors, for example. But I could also foresee a PI saying, "I'm working on this concept for this really new type of fuel, and I think it would be applicable to the small modular reactors and ARC. How do I do that?" So there's still going to be those situations, and we're just going to have to work on them on a case-by-case basis.

Question: They couldn't submit the same proposal to three different areas?

Response: Not last year. We didn't allow for them to submit the same exact proposal to three different areas. We did ask for them to identify their primary and secondary work scope areas; so if we took it to the primary work scope area, and they said, "No, it doesn't apply to us," then we took it to the secondary and asked, "Does it apply here?" In as many cases as we possibly could, if we did move it, we tried to talk to the PI ahead of time and ask if it was okay. Can't say we were successful 100 percent of the time, but we did try to do that. We have to have a conversation with the program folks as to where it really belongs.

Comment: Remember 70 percent of the proposals that were funded were experimental. That gives you some indication as to where the challenge problems really are.

Question: For Blue Sky research, in our new 2011 funding, it's still about $200,000 per year. Looking from a university angle, that's typically two investigators—in contrast to the other Blue Sky type of research, where they are single investigators. I don't know which way is the way to

go, but I noticed that NEUP funding is mostly for teams. Another observation is that NEUP funding is much more in dollar numbers in comparison to other programs.

Answer: Actually, we allow for it to be up to that highest amount. You don't have to ask for all the money. You can have small projects that are single-investigator projects, and we do see a split. We have some that are single-investigator, some that are small-dollar projects, some that are large, almost consortia-style projects. And there's no plus or minus to either way. We do want that mixture of projects. If you're looking at Blue Sky, you don't have to ask for $200K per year. You can ask for $50K per year if that's all it takes to do the project you have. We don't want you to force it to fit into a large group or to be a teaming partnership. It can be just a single person who has a good idea and wants to see it funded.

Question: Based on the list of selections last year, you reach that conclusion: "I'd better ask for $200,000, and I'd better have a team of two or three people." On the other side, if you'd really give me, say, $250,000 as a single investigator, my concern is how I'm going to find all these graduate students to start this year on this project.

Answer: I think it's a challenge for all of us to find good graduate students to do this work. It requires a lot of recruiting effort. Growth is an issue for us in different ways, and this is one way that it's reflected.

Question: Are there any planning grant opportunities—like if you wanted to start putting a team together for one of the integrated research partnerships or one of these larger, more ambitious projects? Are there any opportunities so you can start getting all your ducks in a row a year in advance, for example?

Answer: No, not right now. We don't have any plans right now to do so. We've spent pretty much every dollar we've been given this year.

Comment: That's a good question for your department head or dean.

Question: On the slide with the breakdown of the NEUP program, some of the boxes were labeled "RFP," which I think was the R&D proposals, and the rest were FOAs.

Answer: Because those are grants, and the RFP is a contract. That's the difference. We're not even sure on the integrated research project center-type things whether they'll be FOAs or RFPs. It's undecided as yet.

Question: So there has been no change in the process for submitting a proposal for the infrastructure?

Answer: No, they'll still be grants.

Question: I'd like to go back to the pre-proposals. Last year there were 130 pre-proposals encouraged. That was consistent with the number of expected awards. It makes sense to cut it down so there is not an enormous number of full proposals. However, you also told us it was

not feasible to evaluate them technically, so they are evaluated primarily for relevance**.** That essentially means that 80 percent of the projects were rejected without ever being evaluated for technical content. Maybe for next year, the idea is to give more to technical content. How do you marry these two things?

Answer: That's the plan. That's the proposal. There will be technical review of the pre-proposals as well. How much depends which category it falls in. If it's the integrated research-type projects, it's 50/50. If it's Mission Supported, it is 20 percent relevance and 80 percent technical. If it's in the middle [program supporting], it's linear between the two: 35/65.

Question: Regarding the equipment bought under the NEUP R&D projects: after the project ends, will it go back to the INL?

Answer: No, it will not leave your university. We formalized that intent to make sure that everyone understands that the equipment stays at the university. We have no intention of forcing it back to INL.

Response: On the FY10 contracts, the universities will retain the title to the equipment. On the FY09 contracts, it's still going to be government equipment because of the subcontract language. More than likely, it will stay at your university when your project is done. You'll be required to submit some paperwork to us; maybe it will go to a different project within your university. The title to the FY09 equipment stays with INL or with the government.

Comment: There's no intent at this time for the INL to say, "You're done, gimme." That's not the intent.

Comment: I received a lot of questions on the infrastructure awards. You'll start seeing them trickle out in the first part of August, the bulk of them probably by the end of August. Not too many will slip into September. If you have a piece of equipment that you need to conduct an experiment that's critical and time-sensitive, if you have a quote expiring, if you have a special need…let me know, and I can see if we can get it put on a fast track for you. If you all come in and say you all need them, then they'll all come out about the same time.

Question: You mentioned the business of having people from the national labs teach at the universities. Could we get some kind of release time from the labs so the person can be compensated and come teach at the universities? And what is the time frame to realistically envision somebody teaching in the fall of 2011. We'd have to put a proposal in now? Is that how it works?

Answer: We don't have any formal program planned for that right now. It's something that we are discussing, but there's nothing imminent that we have money for right now. It's still in the pipeline. But we're thinking along those lines.

Question: What I've been hearing today has mainly been dealing with reactors. If one has, let's say, a very innovative nanotech nuclear battery, can that be funded under this program? Is there a home for something that is nuclear but not a nuclear reactor?

Answer: If you look at it as part of the fuel cycle, then maybe yes. Pu-238?

Answer: Ni-63.

Answer: So a specific isotope. I don't know.

Comment: Where does a space power battery fit into the scheme of things? It is a question that we get occasionally.

Comment: The thing that we keep remembering is there is no congressional appropriation called "NEUP." This is money that is in the existing appropriation lines that we are spending for university programs. Consequently they are constrained by all of the appropriation language and congressional justification that went into those appropriation lines. For example, SMR says you do certain things in our SMR program. Used fuel disposition says certain things. Our public budget in the appropriation language…. I can't think of any that have the breadth that would allow us to do the kinds of things that you're describing. Having said that, I will find out whether our very creative budget people can tell me if any of our budget lines are that flexible. That's the constraint: this isn't a separate program with separate money.

Question: Isn't that a great thing for ARPA-E?

Answer: That would certainly fit under their charter, but ARPA-E tends to put out calls in areas as opposed to a general call for general areas. It would have to be responding to one of their calls. This is the third time this question has come up, so I'll look into it.

DOE-NE 2011 PROGRAM NEEDS

JOHN HERCZEG – FCR&D OVERVIEW

Question: How much money will there be for each of these challenges?

Answer: Our budget is in the neighborhood, for all three offices, of $190-$200M; 20 percent of that goes into the pot. So 20 percent of $200M is $40M. If it were proportionally given out—and I don't know if you do that exactly—$20M would go into all these areas.

Comment: For fuel cycle R&D, in the R&D section, he is making a swift calculation. We have to go through it individually and let you know what that would be. The information is in the slides; we didn't calculate it because it truly goes back to NE. They decide how to proportion it out. There is no absolute, "X dollars is going into R&D for fuel cycle."

Question: If each of the [R&D] awards is about $1.2M or $1.3M, then only about three of us can be awarded.

Comment: That's right. [For a maximum award of $1.2M, FCR&D would then give out ($20/$1.2) or ~16-17 awards for a budget of $20M.]

Question: Given that the simulation hub demands certain resources, are those subttracted from the overall NEUP program, or are they a separate part of the NE program?

Answer: I don't know the answer to that question. [The HUB is separate from NEUP dollars; it is not subtracted from the NEUP dollars, but those moneys are not "taxed" toward NEUP either.]

Question: The second question is, given that the simulation hub is predominantly putting money into simulations and not so much into experimentation, will there be any attempt to align with the experimental programs to help validate what's going on in the simulation hub? Will the program try to coordinate, or will we try to run this thing separately?

Answer: If it's under fuels, for example, and it's a valid proposal that makes a lot of sense, the answer would be yes, we would fund it. The hub is one unit. Which means we will fund it under fuel, or we will fund it under separations—other work that relates more specifically to our immediate needs. Under those guidelines, if you submitted something that would support what we are doing, the answer would be yes.

Comment: The hub is a specific activity related to multiphysics modeling of an LWR. So it's not part of Fuel Cycle R&D at all. Because the hub has a lot of university participation already, that $24M is not part of the base to calculate the 20 percent, nor will we ask for proposals associated with the hub. So the hub is not part of the NEUP program at all. As to the second part of your question, the hub is primarily modeling and simulation. We are planning to follow it closely to look at how we adjust our other programs to make sure there's a strong experimental component that supports the hub.

Question: So we should still be looking at what the hub is doing, and we can align our program?

Answer: Yes, exactly. Probably not now—it's just getting started—but we should be watching what the hub is doing.

Question: You had one slide that said nanoscale implantations. Can you elaborate on that?

Answer: That was in the area of fuels, I believe. You can use some nanoparticles to increase the conductivity of fuels; that would help in the safety case significantly. Let me give you an example: The company A123, which was founded out of an MIT research project, was putting nano-iron particles into lithium-ion batteries. That helped increase the current for both charging and discharging. We are interested in a similar type of model in fuels. Can you put something in a light-water fuel that can increase the conductivity, which means you can basically remove the heat faster, and you significantly increase the safety of the program? This would also be applicable for fast reactors.

SAL GOLUB – REACTOR CONCEPTS

Question: One side is DOE, and the other side is industry, and the interests of industry do not always coincide with what is being promoted by DOE (the government). Are there any thoughts going around on how to bring the two parties closer in terms of moving faster into the next-generation reactors?

Answer: Well, I would say the generic answer to that generic question would be, of course we want to build partnerships between DOE and industry, as well as our partnership with the university program. So we are all about collaboration; we're all about working together as a team. There are going to be divergent motives in some cases, but we are trying to work together.

Question: You mentioned advanced structural materials. Could you give us more details about that?

Answer: Yes. We did a preliminary down-selection of candidate advanced structural materials under the GNEP program for the advanced burner reactor, and that focused down to four steels including HT–UPS, which is a fusion steel, NF616, and I can't think of the other two alloys off the top of my head. But we have identified candidate alloys and of course we are

looking at other alloys for structural applications. We will get into that in more detail in the breakout session.

Question: Under the small modular reactor element of your program, development of helical coil steam generators is one of the R&D challenges. It strikes me as perhaps more of a suitable task for industry. So I was wondering if you could clarify: Are the elements that you put on those slides possible topics for proposals under NEUP? Or is it the full picture, including what industry will most likely have to perform?

Answer: Well, it's certainly not the full picture. It's illustrative examples, and we know for a fact that we're dealing with a compact reactor technology that requires small equipment and a small radius, and one way of approaching that is with helical coil steam generators. We know that industry is interested in it. When you combine traditionally leaky steam generators with the inside of a pressure vessel, you know you have to find better ways of fabricating and ensuring reliability. So that's one of the areas we will be looking at, but certainly not the only area.

REBECCA SMITH-KEVERN – NEET

Question: Safeguards by design. Would that be a part of the NEET program, or is that Fuel Cycle R&D? It seems like cross-cutting programs. And this would be working together with NNSA?

Answer: It is a cross-cutting program, yes. Our programs are designed to be complementary with NNSA's programs.

Question: Are the transformative nuclear energy concepts going to be led by labs primarily, those projects?

Answer: I don't think that's a foregone conclusion. I think they are going to be open to anyone.

Question: Collaboration, partnerships?

Answer: We would certainly encourage collaborations and partnerships

Question: You are looking for modeling and simulation. You are looking for us to apply the technology we learned from the aerospace industry. We are looking at extended fatigue life for aging aircraft, for example. We are looking at the property relation with microstructure. So we have the modeling with fatigue and the behavior of materials. So that's why I am asking about advanced structural material as well as simulation and manufacturer correlations. Where could my field fit into the NEET program? Maybe it's too specific, but I would like one example that can direct me.

Answer: It sounds to me like it could fit under any of those. Based on what you described, it could fit under materials. If it is mainly modeling and simulation, then it could fit under modeling and simulation, which does have a materials area.

Comment: There are some that cross modeling and simulation and materials. I believe the materials modeling piece is in the materials sector. I would encourage you to try to use both of them; I believe you will find that in materials.

Question: Are there going to be different calls for the NEUP-funded versus the NEET-funded materials work?

Answer: The current plan is that there will be a call under each program, so the NEUP materials call will be exclusive to universities under the rules of this program. We are looking at having a separate competitive solicitation under NEET.

Question: You talk about cross-cutting technologies that apply to different cross-cutting issues that apply to different technologies. But you could also think about cross-cutting in the sense of having a phenomenon that applies to different technologies, such as stress corrosion cracking, phase transformation of irradiation, that kind of thing. Are you thinking in cross-cutting issues of that sort, or even a particular technique that can be applied to different materials or different issues?

Answer: That was a debate that occurred when we formulated this program. I know that Dr. Miller was very involved in this discussion with Phillip Finck from INL when we developed the program. You can slice it this way or you can slice it that way. The decision was made; it seemed to make more logical sense—as well as being more explainable to Congress—if we cut it this way.

Comment: Materials is a part of almost every program we have. So materials is one of the most complex areas to manage. For that reason, we have assigned Sue Lesica in NE to be our materials coordinator. She tries to make sure that what we do in reactor concepts, what we do in fuel cycle, what we do in NEET complement each other and don't duplicate and overlap too much. We have to have a cross-coordinator within NE, and that's Sue Lesica.

Now the second thing about NEET: One of the issues we need to discuss in the NEET workshop is the following. Take materials, for example. Are we going to have 20 percent of the materials budget put in NEUP, and then universities do not compete for the materials part of NEET? Or do we do it the other way? In other words, which one are we going to have universities participate in: NEUP or NEET? If we do it the other way and put the 20 percent in NEUP, then NEET will only be approved for laboratories and industry, and universities will not participate in NEET. If we do it the other way, then it will be open to universities, national laboratories, and industry. That's one of the things that are going to be debated at this workshop. As Rebecca said, the assumption right now is that 20 percent will be taken from NEET and will be part of NEUP, and the rest of it will go to laboratories and industry.

Question: It seems like the way it is structured right now, you'd have to invent a new material rather than applying more fundamental techniques to existing materials to understand them better, which seems to be as viable an option.

Answer: I think that when the proposal goes out for materials under NEET and the NEUP proposal goes out, it will allow for all of these cross-cutting examples that you have described—in every dimension that's cross-cutting—materials tools that can be used for various applications…and also the examples you gave.

Comment: Also, that phenomenon that you mentioned may be under materials under LWR Sustainability.

Comment: LWR Sustainability is not a very profitable route.

Answer: That's because it didn't have very much money last year. This year we hope that it will be funded at around $25–$26M.

Question: For those of us who will not attend the workshop on Thursday, could you elaborate a little on the transformational nuclear energy concepts? Are we talking about reactors? If so, how is it going to be different from the advanced reactor concepts in the other program?

Answer: With transformational nuclear concepts, we ought to be thinking about the vision for 10, 15, or 20 years down the road. How do we get there in a shorter amount of time? Those are the kinds of questions we are trying to answer with the transformative. Those are the kinds of reactor concepts, but it covers the broad range of technologies.

Question: I have seen that collaboration between universities, industry, and national labs is encouraged. Is international collaboration with a strong partner overseas also encouraged?

Answer: I think that's a question for Marsha.

Answer: International collaborations are encouraged, but we cannot send United States tax dollars out of the country. You are more than welcome to have them as partners, and you are welcome to visit your partner on your NEUP program dollars, but you cannot pay them to participate in those projects. What you are judged on is your team. If they are collaborating with you and helping you perform that work and that makes a stronger proposal, then that helps you.

Question: Since all the NEUP money comes via contract now, if they do want to go on international travel, do they have to go through the DOE approval process?

Answer: You do have to be entered into the travel system that's maintained at the lab for all international travel because you are on a subcontract. That is a lengthy process. They like us to have three months notice ahead of time. You need to contact your TPOC. You do have to get approval to go on that foreign travel, even if you already have it in your contract.

BREAKOUT SESSION: MODELING & SIMULATION

DAN INGERSOLL'S PRESENTATION

Question: In your budget, what's the split between the first item and the next three items, the R&D items?

Response: Roughly, if we assume that we have $20M for the R&D part, the balance of that would be the design cert. part. So I'm planning on about a $20M R&D program to be split among those three. I would expect about 50 percent of that to be in the technology R&D; I would expect maybe 20 percent in advanced concepts; and then the other 30 percent in the assessment tools area.

Question: Have they blocked out what money is going to go to the matching funds? It appears to me that $50M could be easily chewed up by B&W alone.

Response: That's actually a very complex answer. The easy part of that is no, all of it will not go to cost share. Everyone is in good agreement that we want a base R&D program to develop the technologies and advanced concepts. So there will be an R&D program. I think $20M is probably not too far off the mark. There are some issues with cost share. These guys are moving along very quickly. While they would be happy to take money, there is a downside with taking DOE money, and it usually comes with all kinds of strings attached. And some of them are saying, "We don't want your money because we certainly don't want to jeopardize any intellectual property ownership of the design." So they really think they can bring these things on the market quickly on their own. There's a lot of negotiation going on there. It is not so obvious that they would soak up all that money.

Questions: This is more of a procedural question. Who is the point of contact for relevance and technical quality for proposals that are submitted in modeling and simulation related to SMR? Who do our PIs contact when someone tells them this is not relevant? I am looking at federal POCs and technical POCs. I am trying to make sense of the matrix and find out who has responsibility for judging.

Answer: That's a really interesting question, and it doesn't have the obvious answer you think it should have. Part of the issue is where the budget lines are headed. In FY11, the high-

performance modeling and simulation component of the SMR program will be funded out of the SMR program, and I will be the technical point of contact for that.

Comment: For those who don't have it, there is a handout available [online] that describes and defines who the technical point of contact is for each area.

Answer: I will be responsible for the SMR R&D, the technical coordination of the R&D program. Having said that, in the case of modeling and simulation, there is an entity called NEAMS, which is within the same branch at DOE. Folks like Rob Versluis, who is very much engaged in the NEAMS, will be the ones executing any modeling and simulation parts of the funded part of the program and NEUP. So in FY11, that will at least be shared by my oversight and probably Rob's oversight.

Answer: That's correct. Clearly modeling and simulation has its own set of advanced technologies associated with it in terms of advanced high-performance computers and hardware and modern software environments. But it's always applied in an area of nuclear energy—in this case, small modular reactors. So it's going to be judged by both sides, both advanced modeling and simulation (NEAMS) and the small modular reactor (SMR).

Question: My question was related to the matrix in the program description. How do we determine who the points of contact are for judging relevance and technical quality of the submitted proposals under modeling and simulation for SMR?

Answer: This will be true in all the major budget items. The modeling and simulation people will be involved and will be partnering with the "product owner," if you will—SMR in this case. The same would be true with advanced reactor concepts.

Comment: Based on the comments that Dr. Miller made yesterday, the technical quality will be a peer review. Faculty will do the peer review. Obviously the coordination will be done by people like Dan, but the technical peer review for both the pre-application and the full proposal will be done by peer review.

Comment: Just for clarity, if I could draw your attention to Fundamental Nuclear Studies… As we iterated our way through naming the bins, that should be reflected as Advanced Modeling and Simulation.

Question: Regarding the 20 percent for NEUP, in your particular program, will it come out of $20M or $50M?

Answer: It will come out of the $20 million. It would be part of the R&D program, so the cost share will come off first.

Question: A lot of the capabilities we will be developing in the modeling and simulation hub will be very synergistic or relevant to your program, particularly when it comes to generating data to validate high-fidelity models as well as things like natural circulation modeling and

passive safety systems. How do you see the two programs coordinating and interfacing? What is the expectation if there is an issue that is relevant to both programs?

Answer: We are having a lot of dialogues about that because it requires tight integration of product owner and the modeling and simulation discipline. We are just going to have to stay really well coordinated on that. Who actually will take the lead on a given effort will really depend on where the prioritization is. When I look at the urgent needs and high-payoff opportunities for technology on SMRs, while modeling and simulation are important, there are probably some things that are more important. I would anticipate it to be a $2–$3M component of my overall R&D program in SMRs. There's certainly a lot more money than that available to the hub, so they will be driven by your mission, your charter. I'll want to leverage what you're doing; hopefully you'll be able to leverage what's going on within the program. There's no concise answer except that it requires a lot of coordination. Given that I'm just down the hall from the person who will be very engaged in the hub, I think that will work okay.

Question: For those of us who are not part of the hub, how do we know we are not proposing something that's overlapping with the hub?

Answer: Do your homework. I think the description of the hub scope is pretty well defined. Keep in mind, the hub is a very focused effort. Over the next five years, they are focused on modeling and existing LWR. While some of the capabilities will ultimately pay off in small systems, I'm not anticipating a huge overlap initially.

Question: Under the NEET program element, there is another line out that says HUB.

Answer: That's just for housekeeping. It has to sit somewhere.

DAVID POINTER'S PRESENTATION

Question: Ultimately, to justify all of this program activity in terms of users, let's say reactor designers: Is there an overarching approach to uncertainty quantification that links the various scales? How do you transfer uncertainty from the atomistic scale all the way to the parameter models so you can justify to whoever gives you money why we need to do simulation and modeling work? What's the value of any academic interest in a particular program area? Ultimately, a designer has to certify, probably to the safety/license agency at some point. It requires some kind of an uncertainty framework that connects all the scales together in the physics realm.

Answer: Absolutely, and that was one of the things that was unique about the NEAMS program from the beginning was the fundamental cross-cutting component focused on verification of uncertainty quantification up here at the top. It's actually a fairly large component of the overall effort. Each of the IPSCs operate at around the $5M level, and each of the 3 primary enabling crosscuts, enabling computational technology, fundamental methods and models, and VUQ operate at about half of that. There is a significant investment that can take place in physics development in each of those activities, and the bulk of this work can focus on

uncertainty quantification. The methods for doing that are being developed in concert with physics development, so at this point there is not a clear directive to use this particular approach.

Question: To be clear, the value to the nuclear industry is that you can reduce safety margins to drive the cost of modern reactors down?

Answer: Absolutely. That's the driver, and that's why this uncertainty quantification part is so important. The approaches that are being taken there are development tools based on Bayesian methods for the integrated uncertainty quantification. There's a lot of focus on using derivative information from the codes that are running to drive those Bayesian tools so you're not wasting time exploring states that are not important. So there are a couple of components in developing that tools set, and they are being applied when they become available; but at this point, there's still some development time before there's a unified integrated UP program across all IPSCs.

Question: And NEAMS owns the responsibility of uncertainty quantifications?

Answer: Yes.

Question: On thermal hydraulics, you had a line on high-fidelity multiphase modeling, and it seemed to be in the context of a sodium fast reactor. I think you mentioned dust in gas-cooled reactors. Is there also an interest in things like combining volume of fluid level set with LES/DNS in the context of LWRs under NEAMS?

Answer: There is, and that's largely a consequence of the formation of the hub. There's a nearer-term driver for enabling these tools' development, and it needs to be extended to other reactor concepts—sooner rather than later, especially LWR concepts. The tools that have been developed for the SFR analysis really don't include the kinds of multiphase, particularly two-phase, boiling modeling capabilities that we would like. So there's definitely room for those types of activities.

Question: Also in the context of LWRs—because in the hub, in spite of the fact that the budget is high, there is not that much money allocated for the development of this particular method analysis.

Answer: The hub is such a short delivery time that there is no time for development of advanced modeling and simulation tools within the hub domain. The intention would be that NEAMS would provide some LWR capabilities in the nearer term. It would also be important for the SMR program.

HANS GOUGAR'S PRESENTATION

[Responding to discussion of the combustion of graphite dust under plausible circumstances and doing lab tests on the expected concentrations, etc., of graphite dust.]

Comment: The modeling challenge would be to take those tests and try to get the model that can be incorporated into the analysis so it's a combination of experiment plus modeling capability. If you can do that as a combined problem, then that would be nice.

Comment: Do you have all the facilities required to qualify fuel for an eventual commercial VHTR?

Response: It's thermal hydraulic validation of CFD codes. We are doing fuel qualification in our ATR right now. There are some overlap regions we are beginning to investigate, though.

Comment: Is the ATR being used for that?

Response: Yes, the ATR is the major facility for irradiation qualification. There are high-temperature furnaces at Oak Ridge and Idaho to do simulated safety testing of the fuel to simulate these long-term heat ups that take hundreds of hours. And those are the major facilities for the accident behavior, which is really the core of the story. Not so much the irradiation behavior. And there are plans to test large quantities of the fuel because of the statistical aspects of the fuel. So we need something like 300,000–400,000 particles in a population. It's easy to do in an irradiation with the volumes of the ATR but harder to do in furnaces just because they are smaller.

Comment: Regarding uncertainty analysis for long-term development: That area is just getting off the ground in many ways. We can do uncertainty analysis in strictly neutronics systems through ad joint methods and so on. Longer-term development of uncertainty analysis for reactor systems is an area of interest to NEAMS. For NGNP purposes, we have a much more near-term need to look at what parameters really affect safety in this reactor. Therefore, we are taking much more of an engineer's approach. There are some being thrown at this—seesaw techniques, some brute force light and hyperacute sampling methods, etc.…maybe some more clever approaches through ordered statistics and other engineering approaches that are being applied now. We are doing this now, but we are always willing to accept help in that area.

Question: Regarding the slide about the reactor analysis method: at the bottom was nuclear data, cross sections and so forth. Part of this is trying to figure out where this fits under funding. If it's transformational as opposed to evolutionary slow stuff, costs aren't cheap. None of the numbers I have seen would support it.

Answer: That's a very good question. If you're coming in with a multi-million-dollar proposal to expand or define a nuclear data set, the budgets don't exist in NGNP or NEUP right now to support that although it's in our plan. We'll have to look at that. If you have a proposal for generating data that is targeted at a specific system, maybe hypering up plutonium resonances, then there might be something that we can do to help you. The whole issue of nuclear data for advanced reactor systems is a difficult one to get our arms around because it is expensive.

Question: Who would be best to discuss it with?

Comment: Tony Hill from INL coordinates the NEAMS activity there, so he can speak to both.

Question: There are no x's on our matrix plan here that link Modeling and Simulation to Separations and Waste Forms. Are you saying that the program doesn't have a link there? Or are you saying that NEAMS will cover that issue?

Answer: No, I think certainly you will be able to find ample room in a lot of different work scopes. If we have this correct, there is nothing that would be specifically listed there.

BREAKOUT SESSION: SEPARATIONS, WASTE FORMS & FUELS DISPOSITION

PETER SWIFT'S, KEVIN FELKER'S, XIN SUN'S PRESENTATIONS

Question: You talk about durability of waste forms and corrosion rates and models, etc., but we don't have Yucca Mountain anymore. In what kind of environment are we supposed to be doing this? Are you going to talk about that and give us some boundary conditions?

Answer: That leads into our next presentation. That's what we're looking at in used fuel disposition.

[presentation]

Question: My first question is on metal alloy waste forms. By that do you mean the containers, or is this a new waste form category?

Answer: No, that would be new waste forms.

Question: My second question has to do with the increase in durability by an order of magnitude over the current reference. What's the current reference? Is it used fuel or borosilicate glass?

Answer: The current reference would be dependent not only on the form of [inaudible]… Used fuel would be very durable **(inaudible)**. The Yucca mountain current reference is probably not relevant here, but it would have been on the order of thousands of years for used fuel forms and tens of thousands of years for [inaudible], but with a large uncertainty band around that… I will offer the observation that in million-year performance, if the uncertainty in waste form lifetime is on a scale of thousands of years, it probably doesn't make much difference. On the other hand, if you push waste form lifetime out to the hundreds-of-thousands-of years scale, it does become important.

Question: My question is about proposals in the waste forms area. How interested are they in alternatives to glass? When I submitted proposals, two reviewers said it's a waste of time to look at anything other than glass. Is it really open?

Answer: I know there's a lot to be done with glass, but we are looking at alternative waste forms. One thing that's being looked at is different alloys. Can you take certain constituents out of the process and convert them to a metal waste form that's more durable than glass? I wouldn't give up on that.

Comment: It might just be a bias of the people that were there. And if a reviewer liked the concept, it doesn't mean that the proposal would have been funded. There are always reasons why something doesn't get funded. It's a question of whether this is really a viable research area, which means you're really pretty broad in what you're looking for. I'm picking up a lot more options than a couple years ago when things were closed. Even in nuclear waste host sites and such.

Question: Does your deep well concept change how you're looking at waste forms? Are you going to put the glass in canisters in wells? Are you going to put the glass in cement and let it hydrate in the well? What's your concept for the deep well, and does that change what form you might want it in: crystalline materials, ceramics versus metals versus glass?

Answer: Phenomenal concepts for deep bore hole disposal would be to rely primarily on the depth of the hole **(inaudible)** clay, concrete, and a highly saline groundwater **(inaudible)** In other words it wouldn't be unlike performance of waste forms. You need a wasteform stable enough to transport and lower down the hole. But I don't think you'd want to rely on the long-term stability of any nuclear material **(inaudible)**.

Question: What resources are going to be devoted to this call?

Answer: They don't know the breakdown yet. It's just the overall program. They haven't said, there's going to be this much in separation, there's going to be this much in….

First of all, the entire NE budget's up in the air. We do have a good sense of what the budget will be for each of the various campaigns, but there is not a direct correlation between that and the amount of money being allocated to university programs for those campaigns. For example, the current budget request has money for R&D, about $24M for used fuel; but that does not mean university programs will follow that **(inaudible)**.

Comment: Typically each year there is a major focus area, and I don't know what it is this year. Last year it happened to be in the separations area. But that doesn't actually get decided until DOE gives us the budget, which is usually a couple weeks before we make the selections. And then they see how many proposals are in each area, and they try to spread the funding out a little bit.

Question: It seems that we can propose a whole range of different things, which is great. The question is, what is the criteria going to be for evaluating these things? Because we could propose a waste form does not work in the environment that you have in mind. You can find any waste form that will behave very well in one range and then not well at all in another range. Are we going to have some guidance as to what conditions we are aiming for?

Answer: I don't know what the guidance will end up being. For those who want to look at proposals in the disposal area, there's good literature in the European community on different environments, French work **(inaudible)**. In laboratory work we're using the French work **(inaudible)**.

Question: So what I'm hearing is that anything is on the table.

Answer: I would suggest that proposals that are outside the range of law and international treaty should be **(inaudible)**.

Question: Regarding funding levels program-wise, is it stand-alone projects or how does it work?

Answer: We are currently not in line on the budget. We are funded out of NEET, especially cross-cutting. The program for FY10 is $38M. Just on modeling and simulation **(inaudible)**.

Question: How much money are we expecting for 2011?

Answer: We don't have that. We had $150M last year. Hopefully we'll get a significant amount of money to do what we need to do.

Question: Is your call going to part of NEUP or separate?

Answer: NEUP collects input from programs within NE, so we are part of that. So far all we have seen is the draft. I think all the stuff we sent will be incorporated. **(inaudible)**

Question: Are you funding different sizes of projects?

Answer: I don't think the cap on the dollar amounts for the projects has been determined yet. [All Program Supporting R&D projects are limited to a total request of $1.2M; Mission Supporting projects are limited to $600k.]

Comment: Everybody's asking about dollar values, and one answer is that 20 percent of the R&D that goes to the total budget for FCR&D **(inaudible)** is available for NEUP.

Comment: You have to understand that, from the total budget for FCR&D, they take out money for infrastructure, scholarships, fellowships…. and leave a certain amount in for R&D. That typically isn't determined until a couple weeks before the awards take place.

Comment: This year the R&D portion of the funds was $38M. Last year it was $42M. So it's going up.

Question: A budget question: There's a possibility to submit proposals for three or four years. Is there any advantage to picking one over the other? For some research, you need four years to do it.

Answer: I don't know. In 2009 it was a three-year program. In 2010 they did extend it to four years. I believe they felt that they couldn't necessarily get some of the big projects done in three years. I'm not sure what it's going to be this year. Obviously projects can be anything from a one- to the four-year period.

Comment: You don't get all the money at one time. You get a subcontract, you'll invoice the INL and NEUP program, we'll approve your invoices, and you'll get paid out. So your university contracts office will work with our contracts office.

Comment: The point is that if you have a three-year proposal for a million dollars, then that million dollars is set aside. They don't give you a million dollars in year one, they give it as you invoice for it, but it is set aside for that. They aren't going to come back next year and say "We had budget cuts; we can't pay you."

Answer: If you have a question about a proposal you want to submit–like, "Am I in the right area?" feel free to call us or your DOE contact. We'll be glad to help you out with that and give you our advice.

Comment: When the solicitation comes out, I would encourage you to submit questions on the website because it does help other professors that might have that same question. So rather than going to specifically to Marsha, if you would put those questions on the website so others could see the questions and get the answers, that would help.

BREAKOUT SESSION: SAFETY AND LICENSING

DON WILLIAMS' AND JIM PELTZ'S PRESENTATIONS

Question: Specifically, this relates to the second part of risk assessment. What is the connection with independent NRC programs and the DOE pushing these methodologies that ultimately have to go within the NRC?

Response: I think RELAP7 is an attempt to push the safety analysis code in a more probabilistic direction. I don't know what the outcome is going to be. I think Dr. Youngblood is hopeful that it is going to produce something that is useful beyond the current set of tools. I don't know that success is 100 percent guaranteed. This is a research activity identified by DOE. The NRC is aware of the work that is going on. I think they will probably just watch it. I don't know that they will invest any of their time and effort trying to develop something like it. That might change if they start seeing some promising results and they see a utility that wants to use that code as part of their justification for extending the plant life beyond 60 years.

Comment: As you know, NRC is already increasing the risk and form assessment, but it's not a regulatory requirement. But when the plants are relicensing, they are asking for the uncertainty analysis model of that.

Response: Yes, they want all the uncertainties quantified to the greatest extent possible.

Question: You mentioned aging and degradation of materials in the system and that we need to develop a model for this system degradation/aging. Are you looking at aging/degradation of component systems and the structure? Could you identify certain components or materials that are of the most interest?

Response: Based upon what I have seen of the program up to now, it seems very important to understand what's happening with the reactor coolant pressure boundary, particularly the reactor pressure vessel because it represents the greatest challenge. It may also be the greatest threat to extending these plant lives because that is a component that cannot be easily replaced. Being faced with having to replace a reactor vessel… That by itself probably changes the entire business case away from license extension to pursuing alternate generation sources. They want to develop models on all of those aging mechanisms with particular emphasis on components that can't be replaced. And certainly passive features that

are built in as part of the plant, that are part of the actual structure or part of the actual configuration of the plant. My understanding is that Jeremy wants to have a program to have all of that modeled to understand the aging mechanisms and predict how the aging process will go. The utilities are going to need that information to decide whether they want to commit the money to develop the licensing case and actually put the programs in place to operate these plants beyond 60 years.

Question: You mentioned we need to support the uncertainty quantification through IPSC. Could you specify certain components of this IPSC code?

Response: Right now there is the fuels code which is called AMP. ORNL, in conjunction with Idaho and Sandia, are putting together what we're calling the .9 version of the code. I believe it's modeled after a fast reactor-type system, HT9 being the cladding materials. They haven't really specified a specific fuel type—oxide versus metal fuels. In terms of uncertainty quantification for the code, it's just trying to develop that V and V plan. What are the methods going to be when you start trying to do that? At this level they're trying to put together a code, period. Building these other capabilities will come later. So to answer your question… It's a double-edged sword. You want to produce something that's complementary, that the program needs, but you don't want to be duplicative of the particular type of material you'd want to do. I think that's why we were trying to make this scope vague….

Question: …clean, reliable gas that's giving us power. I can see that ad coming from the gas industry. The other two are both in this area where there are problems with material failure and turbine failure. Just yesterday, another turbine problem shut the reactor down. So there are material issues. Now I agree that it's important to look at the reactor and safety-related issues, but what about balance-of-plant issues that are coming up? We recently heard that California has imposed some new regulations on cooling water, and last week we had to try to get some training for safety-related mechanical draft cooling power. Not very many are being used in the industry. Are we focusing on this in some way?

Response: I believe that we want to conduct a full scope review of all materials used. This program is just ramping up right now, and so we are focusing right now on reactor coolant pressure boundary and concrete and piping. That doesn't mean these other materials aren't important. Obviously, operating experience from the existing plants is going to dictate areas where we need focus. And if there are new reports of failures in the turbine system and other areas on the secondary plant side, we're going to consider that type of operating plant experience in dictating which materials we need to look at. In some, there may actually not be much to do. We may just simply say okay, this material has these limitations, so it needs to be replaced every so often or it requires this type of inspection program. If we can do research to demonstrate the viability of reactor pressure vessels, that's where the early money's going. But that doesn't diminish these other problems.

On the cooling side, California and New York are pushing the elimination of once-through cooling. Many plants this summer either shut down or had to back off, de-rate their power, because they couldn't meet the cooling water limits. Looking for alternative cooling technologies that lessen operating plants' exposure in that area needs to be an area of focus

under the economics and efficiency improvement pathway of our project. We may be interested in proposals in that area, and I think Dr. Hongbin Zhang may want to see something like that, so I appreciate you raising those points.

Question: In NEUP proposals, we can look at very specific components and their variability and then try to clarify their impacts on, say, RELAP7 predictability. But are we able to run the RELAP7 ourselves, or is it under development? Would that be done at INL rather than universities?

Response: My understanding is that RELAP7 is being developed at INL. The statement of need provided by Dr. Youngblood talks about key university research needs. It says the needs are related to development of improved approaches from modeling plant behavior and better understanding of the response of structures and components to aging and loads imposed by operating transients.

Question: It doesn't sound like we're expected to run the RELAP7 and assess these or characterize the sort of uncertainties in the predictions that are obtained as a result of running the code. But we're expected to characterize uncertainties in, say, the heat transfer coefficient or pump head curves? And that would be used as an input for the further development of RELAP7?

Response: Right. That would my interpretation.

Response: That is something that has separate effects…. **(inaudible)**

Comment: So DOE would be happy to see the universities consolidate and review the existing data and come up with a comprehensive set of guidelines for using the available existing separate effects tests and also develop/design new separate effects tests?

Response: Sounds like that could be interesting, yes.

Response: If you look at the various scope elements of modeling and simulation called out, there's one in materials modeling and there's one in separations and waste forms. They really do try to emphasize separate effects testing and the methodology development, so I think you nailed it right on the money in your summary.

Comment: We'd be interested in running these system analysis codes as well, but I guess since RELAP7 is still under development, it's going to take a few more years.

Question: I see. What about using RELAP5 then?

Response: I don't know enough about status of the work. I've heard Dr. Youngblood comment that if you don't take the RELAP7 approach, you end up with the RELAP5 + 2. I'm not really sure what the nuance is in that area.

Question: You were talking about materials aging, especially concrete. Seems that concrete already aged; I think the constituted models will be changed. Do we have to perform seismic reassessment of the entire power plant, for example, containment or shield building, all those, to protect the reactor?

Response: I am not aware of any seismic reassessment being undertaken as part of LWR Sustainability. I think what is being sought in the area of concrete is: Do we understand all of the aging mechanisms and effects of concrete, particularly concrete close to the reactors that are subject to high fluence levels for a long period of time? Certainly we have places like the Parthenon that have been there for quite a long period of time. There's plenty of concrete-like structures around, but if we're going to make the case to NRC that these plants can continue beyond 60 years, NRC's going to want to know what our database is, what our tests are, what substantive information we have to bring. There's going to be a particular interest in concrete and the reactor cavity.

Comment: If concrete is aging, the dynamic loading will be changing because of the changing stiffness and the natural frequency.

Response: Yes, that's in the materials area, the further demands from plant operations going this way. What's the overlap? What are the effects of the overlap? One question I've got is where is the licensing limit? When people talk about loads versus capacity versus margins, ask them where the licensing limit is. You'll get some very interesting answers. I don't think it's uniformly understood.

Question: I would like some clarification on the IPSCs. For example, Amsterdam hosts FRAPCON for fuels, lab, and waste handling. Is there any bookkeeping of these other codes that we're going to look into? Because now each code has slightly different phenomena and data set. How is this orchestrated? How do we approach this in terms of what codes we need to look into? Are they code models that we need to improve or assess?

Response: The outright answer to your question is, I'm not entirely sure. If you look at the IPSCs in terms of development, the fuels code is definitely the most mature effort under NEAMS. NEAMS is a new program, and so the reactors one is less so. They're looking at a variety...some of these components that model certain characteristics that they're trying to string together to get some sort of working framework… They haven't even really started looking at the separations and waste forms. In terms of for your first question—are they using existing codes and building on them—to some extent, yes, in several particular areas. That's evident in how the planning phase for the separations and waste forms. What parameters do we want to improve? You have that engineering level moving towards the high-fidelity models, like the subscale stuff working into making them more robust or more informative in certain parameters. To answer your question, I can put you in touch with people in those particular areas that will have definite answers, but….

Comment: There are a host of models, a host of codes. Can NEUP step in and say, "Look into this, assess these, improve these models," and give us something to focus on for research.

Response: It is wide open, and if you look at the hub **(inaudible)**…. They're going to assess what exactly they need as the foundational. In terms of what code they're going to improve on, they're looking seriously at AMP and whatever fuels code is developing. You would have to be in touch with the people in the campaign…

Response: In terms of uncertainty quantification, stuff tends to behave similarly regardless of whatever phenomenon you're looking into, especially with materials and at the sub-continuum level. With this scope, we're looking for the methodology and the separate effects experiments. I think that will limit you in terms of what codes you're using.

Comment: No, I'm not talking about the codes. Once you know what code it is, you know what models are in that. Otherwise, you have a host of models. For example, thermal conductivity, fuel interaction models. FRAPCON has one, and then there's the French code—they have their own database. So that's what I'm saying: we need to focus on the models themselves. The standard methodologies, standard techniques and uncertainty methodology, are there. We need to focus on the models that are being used out of the data sets that are being used. Can you give us some contact?

Response: I agree with you. It would be useless to propose something that's completely inconsistent with what certain IPSCs are using. For the particular areas, Rob Versluis is actually Modeling and Simulation. He would be able to help you with the fuels and reactors side of the house. Dan Funk would be able to talk to the Separations and Waste Forms codes.

Question: How many proposals will be accommodated in FY 2011 for LWR Sustainability?

Response: With the 15 percent plus the 5 percent direct-funded throughout the lab projects, we're contributing several millions of dollars to NEUP, so hopefully we'll have enough proposals to get our fair share of the funding too. But in terms of the number of proposals and the amount, I couldn't tell you. [For clarification, in FY 2011, the entire 20% allocation will be made to NEUP—no direct-funded project $$ will be subtracted.]

Question: For increasing safety margins and for future power up-rates in reactors, fuel assembly design is a very effective and important area of research. A better understanding of what happens to the actual two-phase flow and boiling in these fuel assemblies is probably a very important issue. Would that fit with this LWR Sustainability scope of work?

Response: It could fit. There were not any research needs identified, but it doesn't mean that a proposal can't be put in for consideration by the technical pathway lead.

Question: Regarding these codes, the biggest problem we face in practical life is that there is a small, elite group of people who really can run these codes. Any time anybody outside of that group ran RELAP5, say, they were probably going to have trouble. That's why people stopped trusting this and saying, "Show me the test data." Are we doing anything to improve validation? Is there any way to say the results that are predicted are reasonable for those with less experience running the code? Would you ascertain funding to make these codes more easily runnable?

Response: Yes. NEAMS is working on that very problem through that enabling computational technologies supporting element and the capability transfer supporting element. The challenge problems are a segue to answering some of those questions. If these codes are ever going to be licensed or used by industry, we're going to need some type of common user interface. Right now you need experts just to load the codes. The hub is working on that issue. There's also an effort this year to identify people—maybe designers or people who have input these problems—who could give us insights into where to focus. But there's not a lot of money in it.

Question: How can other industries be part of the LWR Sustainability program? If Purdue wants to be a part of that, how can we get access?

Response: Being part of the program would come through winning grants through NEUP or making proposals to the program or to the technical pathway lead who has some understanding of how your capabilities could be utilized as part of the program.

BREAKOUT SESSION: SAFEGUARDS AND NONPROLIFERATION

DAN VEGA'S PRESENTATION

Question: Is the focus on U.S. plants only, not proliferation/terrorism when we're selling or building reactors overseas?

Response: We're not in the business of developing systems to be used abroad, but we are acknowledging the fact that technology developed here can be emulated. So there is an aspect and there is an effect, but our goal is not to transfer sensitive nuclear material or anything of that nature. We're talking about U.S. fuel cycles.

Question: But these sensors and detectors are also of interest to the bad guys who are interested in spreading the stuff around. What would happen in the event someone shot something to you under that language? Do you have to connect it to a reprocessing plant or materials?

Response: You mean a forensics investigation? That's not specifically in our mission. In fact, there are certain NNSA activities that we have to make sure we're not treading on. We do co-fund projects with other agencies, and a lot of the technology developed could be used for both, but our mission statement just doesn't cover it right now. If tasked with such, it would be a process of finding out how to use these instruments for forensics and for after detonation analysis, spectroscopic analysis—MicroCal would be perfect for that. As it stands now, we don't get into that territory.

Question: The Department of Homeland Security runs a program, NNSA has some nuclear security program, we have DETRA… On all of these, where do you stand in terms of the information you just provided to us?

Answer: Most of the functions that you mentioned are somewhat outside of our scope. This instrumentation development is specifically for building a reprocessing or recycling facility or new reactor in the U.S. and not having to retrofit it afterwards to meet our own domestically imposed or IAEA-imposed requirements.

Comment: You might mention the joint roadmaps that we worked on with these agencies.

Response: NNSA at NA-22, Global Safeguards Research and Development, and our office have a joint effort that identifies the promising technologies for materials accountancy, regardless of what their end use is going to be—from a strictly technological standpoint, which are the most promising for delivering high-fidelity, quick, near-real-time measurements.

Question: Is your concentration on monitoring and accountability, or is spent fuel part of that as well?

Answer: Spent fuel is part of that, as the head-end part of a chop. Rather than taking destructive samples of the head-end and the dissolver, it would be a more accurate non-destructive assessment.

Comment: We in the NE office work very closely with the offices that have related missions, and we share ideas. If Dan Vega's office was going to fund a new project, it would have to have a connection to his mission area, which is material protection accounting and control for domestic future U.S. nuclear energy facilities. But if there is a technology that cuts across the boundaries, then it's quite likely that in the course of our joint roadmapping on these technologies, we could share that idea across agencies.

Question: You're looking for a comparison, for example, the risk of how we treat existing LWR fuel in our open cycle now versus how the pebble bed measures up?

Answer: It's not to evaluate different technologies against each other. That is eventually going to be part of the goal, but I think there is value in looking at certain risk factors.

Comment: Based on thinking so far, probably what we're looking for in the near-term is innovative new methods, which would only be applied later. Methods to quantify various pros and cons of different nuclear fuel cycles have been investigated since the 1970s, and they focused on a limited part of that risk equation. The emphasis will be on fundamental methods development that will alleviate the shortcomings in the work that's been done in the past. One example is consequences. That has not been looked at very carefully. The consequence that people have usually used in these kinds of studies has been success or failure, but it's a lot more complicated than that. The other part is the pi in the risk equation, the probability of an adversary attacking. The applications, particularly comparisons of systems, are also interesting, especially if a system is under active debate right now—like pyroprocessing in the Republic of Korea.

Question: Is IMPACT identified as part of NEUP or NEET?

Answer: IMPACT is a research program within FCR&D.

Question: But the risk assessment component is going to be NEET?

Answer: Right. The proliferation risk assessment has been pulled out for this year and moved into NEET as an enabling technology. But detection and monitoring are going to stay under IMPACT.

Question: So for NEET, I'm trying to envision the spectrum of backgrounds of people who would work on this—everything from nuclear engineers to political scientists. What type of expertise are you looking for?

Answer: We'd be happy with all of it. In fact, we think the expertise that is not necessarily from a nuclear engineer is what's most lacking. There are people who submit security studies, papers, Bayesian statistics, and Markovian models. All of those are quite welcome and, in fact, would be an important contribution to any such model because it would be a different way of approaching the problem.

Comment: I think the really strong proposals in this area will involve a partnership between people with real depth of subject matter understanding about nuclear systems, plus skills in innovative methodologies. For example, a mathematician who is working on game theory doesn't really understand proliferation and nuclear systems, so that person needs to draw on the resources of nuclear systems experts. Similarly, a nuclear systems person who has worked with these existing methodologies will probably have to cast a wider net and reach out to somebody in the math department or quantitative social sciences to bring in some fresh ideas and fresh methods.

BREAKOUT SESSION: MATERIALS

RICHARD WRIGHT'S PRESENTATION

Question: Are you also interested in coatings and mechanisms failure analysis of the coating on nickel alloy or steel?

Answer: No, I have almost no interest in coatings. In the engineering applications we're looking at, we have one program this year which is looking at aluminide coatings. One of the issues is tritium transport through a steam generator, for example, but it's really hard to envision much application for coatings in these systems.

Question: I have a question about the creep fatigue. Would you also share the specimen test that breaks during the test so that we can look at the microstructure to know the fundamentals?

Answer: Sure, that would be certainly doable.

Question: What specific materials are you looking for?

Answer: For the pressure vessel, we are principally interested in conventional pressure vessel steels 508 and 533, with some long-term interest in the modified 9-chrome 1 molly grade 91 steel. For the steam generator, our principle interest is alloy 800H. For the intermediate heat exchanger, at the higher temperature, our candidate material is alloy 617.

Question: You are not looking at composites or ceramics?

Answer: It's highly unlikely. Will (Windes) will talk a little about ceramics. We're very driven towards application pretty soon. In the long run, we might look at a composite control rod, for example; but it has limited applicability, and it's not in the first NGNP that we'd build.

WILL WINDES' PRESENTATION

Question: Can you give us a sense of what sort of porosity in any graphite block?

Answer: It is a combination. It goes from nanometer-size cracks down to almost crystallographic dimensions up to macroscopic millimeter-size cracks. It depends upon the grade of the graphite, as well as the grain size. Pores are also inherent in this. To fabricate

graphite, you take graphitic flour or a filler material and you mix it with a cold tar pitch and then you bake it. The baking of it volatilizes the liquids, which form a solid. The porosity it is a results of its holding onto those filler particles. You then re-impregnate it with the cold tar pitch, bake it out, and do this process up to four times. The efficiency of filling those pores decreases each time you impregnate it because the holes fill up. So not only do you have microcracks at the atomic level, but you also have large macroscopic cracks filling in the filler particles, and then you have pores. Finally, during irradiation there is pore formation after a turnaround occurs, so you get pores due to the microstructural changes in the graphitic crystallites.

The porosity varies from graphite type to graphite type. You can think of it as open porosity. Probably for these new graphite types, you're probably looking at about 80–85 percent.

Question: For non-destructive techniques, what is the thickness of penetration that you are interested in?

Answer: 50 centimeters.

Question: Would you be interested in acoustic emission evaluation?

Answer: Acoustic emission is one of the more promising techniques in our scoping study. If you're looking at the large cracks that occur during the baking process, acoustic emissions is perfect for picking that up. The thing we'd really like to see is whether you can turn acoustic emission around and look at things such as the modulus, which changes during irradiation. Can you actually come up with a technique to look at the thermal degradation of the conductivity in the CTE? Can you use it to look at a density variation in gradient from the outside skin of the graphite components to the inside? Can you actually get a two-dimensional porosity or density change from a one-directional beam? Acoustic is one of the things that can give us a lot more information from a single-line beam. We can reconstitute the scatter from that to either two-dimensional or three-dimensional.

Question: What is the most typical shape of the graphite components?

Answer: The fabricated bricks or billets are rectangular cubes that can be as big as 2 x 1 x 1 meters. The components of course are smaller. They can be irregular, but you're probably looking at dimensions that are about 50 centimeters in width, maximum.

Question: How interconnected is the porosity in the graphite? Would you expect the pores and the cracks to be filled primarily with helium?

Answer: It's open porosity for all these graphite types. What are they filled with? I don't know. The first few millimeters are going to have helium inside, but I think you're going to have nitrogen in the form of post-process air cooling that's going to be infiltrated into the structures. We know it's nitrogen because these graphite waste forms are carbon 14, which doesn't come from the graphite 12 activation—the activation comes from the nitrogen activation inside the pores of the graphite.

Comment: I think the helium goes all the way through. The nitrogen is in the graphitic structure, and the pores are filled with helium.

Question: For the non-destructive testing, are you looking for larger-scale testing or some sort of table-top lab-scale testing?

Answer: No preference, just prove the concept. What we would really like to see is an understanding of the technique right now, not necessarily the application.

JEREMY BUSBY'S PRESENTATION

Question: What is the buried piping? Stainless steel?

Answer: No, it is low alloy steel. There is not a lot of scientific meat to understand the degradation of low alloy steel, and the DOE effort may focus on preventative technology, like liners or coatings. That's probably something that industry is best equipped to handle. But we are going to perform a white paper analysis to figure out what's DOE-appropriate.

Question: The LWR Sustainability has very low NEUP funding. Have you thought about increasing that?

Answer: The funding that was available to NEUP for LWR Sustainability mirrored the funding that was available to LWR Sustainability overall. We are a very small program, but we are growing. We expect opportunities to increase proportionally with the budget.

Question: Are you considering uncertainty associated with material aging and degradation?

Answer: Meaning, do we really know what the margins are? That's a key point. As you extrapolate farther out from the known degradation modes, your uncertainty is going to increase dramatically. We are pushing for predictive modeling on a number of these degradation modes so we're able to understand what the uncertainty is and use those tools for a broad range of conditions.

Question: Stainless steel is fairly ductile under creep conditions relative to super-alloys. What is the ductility characteristic of these higher-strength materials?

Answer: It's extremely good. The HT–UPS material has creep strength that's about an order of magnitude greater than 316 stainless steel at considerably higher temperatures. It's quite ductile, forms very well, and should be radiation-tolerant. For the SFR it should work. It's just a matter of going through the steps, validating it, and making sure we understand how it ages.

Question: How did you define the design stress?

Answer: The design stress that is typically taken is one-third the creep retro-strength or one-half the yield strength at a given temperature, whichever is lowest.

Question: Which one is usually the lowest?

Answer: It depends on the temperature. You can look at the curve; there is usually a flat area where the yield stress is usually lowest and then it tails off. That regime is usually limited by creep performance.

STU MALOY'S PRESENTATION

Question: Is there going to be a list somewhere of the effort that has already been going on and where you specifically need help? Are there any particular areas that you feel are the most critical or that have already been covered well?

Answer: We were initially doing work on the engineered high-dose irradiated ferritic–martensitic steels like HT9 or T91. We don't have good high-dose irradiation data on the advanced ferritic–martensitic steels, and we clearly don't have it for newer oxide dispersion-strengthened alloys or in a whole new system that is titanium aluminide or something like that. We have good data on ferritic–martensitic steels out to, say, 200 dpa. We want to look at improved alloys, maybe microstructures on these ferritic–martensitic steels, or completely new alloys.

Question: You discussed a 200ºC increase on advanced alloy temperature capability. One way is using thermal barrier coatings. So are coatings in play?

Answer: Absolutely, anything you could think of could be in play. It could be coatings, multi-layers, ceramics embedded with metal fibers…the sky is the limit. Blue sky is the limit.

BREAKOUT SESSION: POWER CONVERSION

JIM SIENICKI'S PRESENTATION

Question: Where do you see research opportunities under NEUP beyond what is already being funded at Wisconsin and Rensselaer?

Response: One of my favorite areas is looking at the potential decomposition behavior of supercritical CO_2 when it's irradiated. You can't put the CO_2 inside of the reactor vessel where it's going to be exposed to neutrons and gammas. We would like to have some data where people actually irradiate the CO_2.

Question: The only area you see for proposals under NEUP would be radiation resistance of supercritical CO_2?

Response: I'm picking that as my pet area. I think a lot of R&D has been done, and in the future we would like a larger-scale demonstration, demonstrating technologies you would have for a full-size system.

Question: Regarding the efficiency versus temperature curve: If you extrapolate it down to 300ºC, which is the temperature for LWRs, you can get about 30 percent efficiency, which is similar to what we have now with the steam cycle. Has someone looked into coupling a supercritical CO_2 cycle to a LWR primary system?

Response: I'm not aware of anyone looking at coupling the cycle to LWRs, terrestrial power reactors. Perhaps that's something someone ought to take a look at. I think you're fighting the efficiency curve there because you can be as efficient with a Rankine cycle at those temperatures. Also, do you save something on cost?

Question: It seems like in this area, you're telling us if you're not working in the supercritical CO_2 area, you don't have a shot in the dark. Are you open to other advanced cycles and other concepts? Is there a budget for that?

Response: In my interpretation, this work scope is generic. This is asking for new advanced energy conversions systems. It's not mentioning supercritical CO_2 or any particular technology or working fluid.

Comment: We don't know how the budgets are sliced between the individual areas. It's not necessarily taken out of the power conversion area; it's taken off the top.

Response: This work scope talks about the goals. You should be able to provide electricity at the same or lower cost than LWR steam plants, i.e., you need to beat the current state of the art.

Response: In my interpretation, the supercritical CO_2 processes work scope is written to support the small-scale demonstration that Sandia's keeping up. At small scale, you've got very high losses due to windage, and you've got losses around the seals and the bearings. But modeling and simulation can provide insight into what those loss mechanisms are that would help people in interpreting the data that comes out of that demonstration.

Question: Are there any efforts on supercritical steam cycles?

Response: We took a look at that in the context of lead-cooled fast reactors a number of years ago, and there's a lot of interest in supercritical steam in Europe, particularly in Germany. We found that for a lead-cooled fast reactor, we could get about the same efficiency with supercritical steam as supercritical CO_2. So yes, there's interest. Super critical steam can offer improvements as well. For example, you could have just one turbine, rather than having a high-pressure, intermediate-pressure, and low-pressure turbine.

Question: What about LWRs and supercritical steam?

Response: There's a lot of development for supercritical water reactors in Europe and Japan. In the U.S., supercritical water was one of the six Gen IV concepts, and then it was dropped.

BREAKOUT SESSION: NEUTRONICS

HANS GOUGAR'S PRESENTATION

Question: I don't know how to reconcile this point about neutronics not being an issue and the slides for the NEA benchmark. Were these thermohydraulics effects that caused this spread?

Answer: Well, certainly that cusping you see in the top plot is a neutronic effect. In the PBMR calculation, the PBMR model of the core has a node, if you will, of about 50 centimeters in height. When you drag a control rod in that node, you're homogenizing the control rod over the whole node. Whenever you cross a node boundary, you stop homogenizing one block and you start homogenizing another one, and it leads to that unphysical cusping effect. So if you're going to develop a new nodal technique, you have to find a way of properly smearing that control rod over that partially filled block in order to get a smooth reactivity ramp when you pull out the rod. I'm not a hard-core nodal physicist, but I think that it can be done. We're still developing the techniques.

You can't really do transient analysis with just a kinetics code in this reactor. It's intimately tight up at the thermohydraulics when you've got a ΔT of 400ºC across the core with large, but very slow, changes in temperature. There are lots of places where you can inject uncertainties. If you're off just a little bit in the physics or in the initial conditions, the results can have this kind of spread. If you can come up with a better transient simulation code that retains that accuracy, that will give us a better confirmation of the tools that we are trying to put together.

Question: Do you really mean coupled neutronics?

Answer: In this one, yes. Now, the traditional method is a split operator. You do a neutronics calculation at this time step, maybe you have to do several time steps because neutronics are changing much more quickly. Then you throw the power densities over the fence to the thermofluids solver. We hope we can do a little bit better than that with the MOOSE code. The MOOSE application has implicit coupling of dynamics within a solver, but we haven't demonstrated that yet.

Question: How do we get that MOOSE code?

Answer: I'm not sure. The MOOSE is being used as part of this bigger modeling and simulation hub, to some extent. I suspect that if you would like to use it, it's just a question of setting up the appropriate licensing agreement with INL.

Question: I assume it is a framework?

Answer: Yes, it is a framework. It's not a neutronics hub. You write in the equations that describe your physics, whether it be neutronics or thermohydraulics or graphite or thermomechanics.

Question: So who would the contact be?

Answer: You can start with me, and I can hand you off to one of my colleagues.

Question: How is it different than what you do with SHARP?

Answer: The SHARP tool at Argonne is very similar to MOOSE. It's pieced together from a lot of open-source development activities. There are a few components that are developed specifically for the SHARP application, so it's available—just with nondisclosure agreements for certain components—through Argonne.

Response: There's also an OpenFOAM I know some academics are using, and that's certainly open-source code. That's why I say, don't spend a lot of effort building the next computational platform because there are some very good ones out there already. Concentrate on putting your physics into it and getting it to run efficiently.

Comment: If you build on one of those existing frameworks, down the road, it makes the job of integrating the tools you develop in the larger simulation frameworks that are being developed a lot easier, so we would certainly appreciate that.

Response: And you can compare your solver directly against other people's, or you can compare diffusion versus some higher-order transport technique. We encourage you to take advantage of the systems that are out there.

We've funded some nodal physics, nodal diffusion and related efforts in past NEUP cycles. We want to move away a bit from the basic core simulation and look at some of these things that contribute to overall uncertainties. Nuclear data, of course. Measuring cross sections in a way that is relevant to high burnup fuel. The U.S. ability to perform basic nuclear physics in support of the nuclear industry really needs to be rebuilt.

Question: Do you know who to contact to get detailed information about cross sections?

Answer: Tony Hill.

Response: On the NEAMS activity, Won Sik Yang and Chang-ho Lee at Argonne have started compiling a list of uncertainties they would like to better quantify.

Response: There was an overview publication a while back, but they've started compiling a more complete list as the projects developed. Pino Palmiotti published one report that had

contributions from a lot of people. It was an initial uncertainty sensitivity analysis of propagated uncertainties in these key nuclides through effect calculations as a first start…

Response: There have been more specific activities identified, but they're buried in other reports on neutronics code development. Mike Smith or Won Sik Yang should be able to help sort that out.

Comment/Question: It's true that cross-section generation is a major issue with VHTRs, but that's somewhat coupled to transport because if you start homogenizing, that's where you run into problems. So a high-fidelity transport that doesn't homogenize makes a big difference when it doesn't rely on having fission in your region to generate cross sections. It's true that diffusion is very good if you get the cross sections right, but that's a big "if," right?

Response: Yes, it is, but it's something that is understood and can be tackled. These reactors usually have a large inner reflector of graphite blocks and large graphite reflectors surrounding the core annulus. You can't generate cross sections for a single graphite block without a source of neutrons, so you can assume an individual block calculation has some uranium contamination. A more accurate treatment would be driven by the actual reactor annulus source neutron, a current source, and that gets into large multi-block assembly calculations, which we've started to do. Methods for homogenization of the block to support whole core diffusion are still being tested.

Comment: There's not really an interest in another n^{th}-order transporter code, but there is interest in acceleration schemes for those tools to help make them more usable for reactor analysis. There's also a need for whole core transient analysis reduced order, so there's a lot of commonality. I emphasize again that it's important to link to other methods. One of the keys for the NEAMS program in the next few years is to start dealing with some of the thermomechanical coupling. There's a lot of structural feedback that's important to the neutronics, and a key piece that hasn't been fully developed is gamma heating calculation capability at all levels of fidelity.

Question: One of the most challenging problems is the extreme hydrogen 80 of fuel, pebbles and particles. We've discussed that as a problem with more of a stochastic nature and adapting transport models to describe those situations… My understanding is that it hasn't been very successful. Is that regarded as a solved problem?

Answer: We've got a handle on it. There are some new approaches of handling the double heterogeneity of the fuel. Some of the traditional techniques, such as Dancoff factors, can do a pretty good job. Richard Sanchez has put together an interesting new approach to heterogeneity that's being tested in a couple of codes. It's an interesting problem but not pressing. It probably wouldn't attract a lot of funding.

Question: It appears that only the NGNP is interested in neutronics. The SMRs, the LWRs, and ARC do not have an "X" under neutronics. Can you explain that?

Answer: No, I cannot. These are usually high leakage cores. Maybe they don't have the solution but think they're pretty close.

Comment: With the other concepts, they're probably lumping neutronics under modeling and simulation rather than calling it out specifically.

Question: Did you all resolve the discrepancy between the different codes? Until you actually resolve that, I don't understand the expectation for that first new benchmark that you're proposing.

Answer: This is a soon-to-be-published or recently published result. This came at the end of a six- or seven-year international benchmark activity, and quite frankly, the number of people around the world who could perform this type of transient calculation is very limited. What that showed is, if you're really interested in licensing and NGNP, you have to start doing this up front to find out where the uncertainties are, where the differences in modeling are, what kind of effects it has on your core calculation. The experience of getting people together to try and do this with their own codes is very much a learning process for everyone involved. This one was spearheaded by PBMR in South Africa, and they realized the benefit early on because they knew they couldn't do it alone with just their own codes and submit a license application to the NRC. It was very successful in that it helped us to recognize a problem. There is not a comparable exercise in the prismatic world. To generate interest in basic understanding of our own modeling capabilities, we thought we needed to do something similar in the prismatic area. The first step in solving a problem like this is identifying the problem, and this benchmark is designed to do that.

Comment: That's my concern, is that you're going to end up with a figure like this…

Question: What is your timeline?

Answer: Under the Energy Policy Act of 2005, application for a license, preliminary safety analysis, etc., for the NGNP is to be submitted by the end of 2013. The data for validating the codes and methods don't exist yet, so it's that deadline that's driving our research and development into design methods and validation of codes. It's a very aggressive schedule.

Question: What is NRC's involvement in this?

Answer: They are actively involved. There was also a mandate in the Energy Policy Act for the NRC to develop the ability to accept and evaluate a license application when it comes in. This year the President is requesting about $100M for NGNP, and a slice goes right to NRC. They've got a small but enthusiastic group of people looking into the issues associated with licensing a HTR.

BREAKOUT SESSION: NUCLEAR INSTRUMENTATION AND CONTROL

DAN INGERSOLL'S PRESENTATION

Question: When you're talking about high-temperature fission chambers, what temperature range are you looking for?

Answer: The problem is trying to understand what is going to be the scope of our attention in the SMR program as opposed to the ARC program. Fundamentally, we see SMRs being developed that are LWR-based, so the temperature range in-core is 300–350°C. But we also see liquid metal-cooled systems that will tend to operate between 500–550°C, and then high-temperature systems, whether gas-cooled or salt-cooled, that would put you anywhere from 700–900°C.

Comment: I would like you to look at not only the regular operating temperatures but also what would happen during an accident. A LWR design would go up from 300°C to 900°C for the fluid temperatures. If you do the fuel, it might go up to about 2400° Fahrenheit (excuse the units). On the sodium reactors, you would start at 500°C, but during an accident, it could go as high as 900°C. On the gas-cooled reactors for the depressurization cool down, we would expect to go up to 1600°C. The limit on the fuel is about 1800°C.

Question: Is the pebble bed reactor still under consideration for this particular initiative?

Answer: Beds are still being considered. NGNP has its own separate budget line box. They will be focused largely on the gas-cooled systems, and they have a lot more money. If you have something specific to a gas-cooled system, you may want to submit to that category.

Question: The universal coolant-level sensor is a challenging task not only for nuclear engineering but for any other engineering. For your specific needs, what are the pressure range and temperature range? What kind of liquid is inside the vessel? What's the density?

Answer: These are primarily for the integral PWR systems, so the temperatures and pressures would be very similar to a traditional PWR system. We're talking 200 psi, operating temperatures in the 300–350°C realm, accident temperatures of 800–900°C.

Question: What are the current technologies used for the liquid levels at this moment?

Answer: I suggest that you look at the DOE small business website because there's a history there: the technologies, the references for the ranges, the types of instruments, the Rosemont

transmitters, why there are problems. Go to www.energy.gov and sort for SBIR, and you will see the site that says awards and solicitations. Look at that small business website for the 2009 solicitation. You can look for the Office of Nuclear Energy; they're cross-linked. This could provide you with ideas, not only for collaboration with small companies and with vendors, but also very specific areas where you can collaborate. All of the instrumentation human factors workshops that we've had have particular links.

Question: I heard that there was some agreement between DOE and DOD with respect to reactor development. I expect that the impact would be in the area of small reactors?

Answer: We've been engaged for some time with DOD. They have a lot of different energy needs, but the one we've been most involved in is powering their local domestic bases, which would be ideally suited for SMRs. I believe this was just an MOU that's been about three years in the making that says we're going to interact. We've been interacting.

Comment: There is a small reactor study that was put out by the Office of Nuclear Energy several years ago. If you want to hear the history of small reactors and the army's and navy's needs, it's there. That's a precursor to the current small reactor studies.

DON WILLIAMS' PRESENTATION

Question: Do you know the Oakridge or the Idaho external report number on the Seattle workshop reference?

Comment: That was the report from the Ohio State workshop where we had a number of asset owners. This workshop was on broad issues related to long-term operations sustainability of I&C systems for the existing fleet of nuclear power plants. The utilities did a very good job of identifying what really are the life-limiting factors related to I&C cabling. Some commercial nuclear power plants have shown that just implementing a digital RPS/RTS system can be as much as a steam generator replacement. They're also looking to achieve economy of scale with what they call fleet-wide operations. They're looking for technologies to help them with real-time data-mining to look across a fleet of plants. This is really the document where we define the future vision. We have a meeting in August with a number of asset owners to produce an industry vision document to serve for this program. We also had a workshop last month in Seattle on online monitoring. About 50–70 people participated: industry, labs, universities. Idaho's working on the workshop report. I think it's going to be finalized sometime at the end of August.

Question: Regarding I&C test beds, there was a program where they surveyed labs and universities and all kinds of other people…

Comment: It was an NRC contract, and I think the report is in a new reg/CR document. The NRC was using it for their research planning. The contact person there is Dr. Steven Arndt: StevenArndt@nrc.gov. Dr. Arndt is now in the regulatory side, but I'm sure we can figure out how to get the survey results to you.

One of the principal goals of that effort was to help NRC decide whether a dedicated R&D facility or a hub-and-spoke model would be most appropriate for regulatory research needs, for confirmatory types of research. Recommendations were that they should pursue a hub-and-spoke approach, utilizing all the resources of the country in a way that they could employ national laboratories, universities, in certain technical areas. The principal person behind that was Dr. Pete Lyons when he was a commissioner at the NRC. He's still very interested in seeing this hub-and-spoke model being employed. That's why, in the I&C area, we're taking the approach of investing in centers of excellence, rather than creating things from scratch, and leveraging the expertise and experience at universities and working with asset owners at the same time.

BRUCE HALLBERT'S PRESENTATION

Question: If you were going to look into your crystal ball, do you envision these SMRs to be multi-units at one site, single units at smaller sites, maybe controlled locally and monitored remotely in a fleet-wide-type system? All run by maybe one utility or several utilities having several fleets distributed?

Answer: Those are all possibilities, certainly the multi-module plants. Those are already in the works, the new scale, the BMWs. There will be multiple modules with very intimate sharing of infrastructure. But we're also seeing a lot of interest in one-of-type deployments to isolated communities, maybe a distributed network of these machines that are supplying high-temperature working fluids for oil shale recovery, things like that. That's the excitement about the SMRs: they open up nuclear power to a whole host of energy-intensive applications.

Question: Is one of the goals maybe collaborating with DOD so that you can get one of these built without having to go through some of the NRC-type regulations?

Answer: No. It will be regulated by the NRC.

Response: So it comes down to what particular application you're solving? If you're talking about independent powering of domestic power military bases, you would want to have it licensed by the NRC and you would want to leverage the commercial interest. If military chooses to have a very special application and it fits within the MOU, could we use nuclear power for operating bases? That's probably going to be a highly specialized application, and they may want to go a route more similar to the naval application.

Comment: DOD does have reactors in remote areas, and they're under the DOD orders.

Response: But that's not part of the SMR program as we envision it in the near term.

Comment: We are looking at wireless and fiber optics and things like that under small business. One issue has come up for BWRs: there are stability issues in the monitors, which becomes a several state point problem. This is for those of you who have BWR stability

capability with transient codes and instrumentation and control systems that could provide either fuzzy logic or some sort of neural net to look at how to do the monitoring. I'll give an example. If the sensor's degrading, and it's measuring this in your stability monitor, or your operation's dependent on what that signal is and you don't know it's out of calibration, or it's drifting, what does that mean? A robust system that could handle the instrumentation and controls issues and advancements for those sensors needs to also address what's happening with BWR stability issues. Companies are hesitant to advance I&C because of the stability issues.

Comment: One of the issues with the NRC with any type of digital technology is the interactions that occur between safety- and non-safety-related systems. It's hard to predict how those issues arise, though we have to be very sensitive to those types of issues in research. When we start developing a technology that we intend for implementation somewhere, we should start working closely with system vendors. If the vendor says, "I can't get the NRC to approve this technology," then it might be interesting for some uses, but we're really focused on nuclear power generation.

DAN VEGA'S PRESENTATION

Question: You discussed the difference between domestic and international. Domestic threats were theft and sabotage, and international threats were diversion, misuse, breakdown. Here it just says theft/sabotage. So can you clear that up?

Answer: The end use of these developments is a domestic program. But the development of this technology could have much broader implications later on. In fact, we do have more than one mechanism with NNSA, but we can't put that in our mission statement for specific work packages because it's not FCR&D. Theft and sabotage are more within the mission statement.

Question: You said you want real-time accountancy so you don't have to shut down as frequently, but industry experts will tell you that they have to shut down anyway to do other maintenance and upgrades to certain equipment, so how would the real-time accountancy benefit industry?

Answer: They could have fewer shutdowns to rebalance and re-zero their operations. If you have a real-time system running and if you have a better idea of where all your material is at any given time, there are fewer reasons to shut down. Even if you have scheduled shutdowns, you can change your standard operating procedures. So it's a combination of tools for the vendor and the regulator. In fact, the way we envisioned it, nationally they would actually share that data.

Question: How are you going to keep the costs reasonable for the new facilities? Will these technologies be integrated at the beginning to help keep the whole project or facility costs in check? Or are these going to be add-ons that significantly increase the costs?

Answer: That's the part of the IMPACT campaign, which is called Safeguards and Security by Design. It's been found time and time again in safety analogy that pre-conceptual design and conceptual design is the best time to do it. That's why we want to have industry engaged as much as possible. But at a university level, with this level of maturity, there's only so much you can do. These are very forward-thinking ideas. None of these are actually ready to be put into a plant.

Comment: Now some of you are going to say, "I don't have access to a power plant's assembly. How am I going to develop something?" If you can come up with your monitor, you may have a trigger reactor or reactor where you could measure it, but you haven't benchmarked it to say what the burn-up is. At the INL, we've taken an ATR series of the spent fuels and have done benchmarks to measure the burn-up pool side. You could also go to the High-Flux Reactor in the ORNL. So if you need a benchmark measurement or burn-up measurement device, we do have a means to check your device with our test reactors. Contact me or Todd Allen through the user facility.

Comment: And if you have data integration in an advanced concepts integration project, NNSA does maintain a spent fuel library.

Question: If someone were to propose to doing an online monitoring and accountancy system, would they be able to assume that they would have all the sense information from the plant?

Answer: Some things are sensitive, but regardless there is going to be an NRC requirement and an IAEA requirement. If you can't get the composition down to the level of granularity, then there's a disconnect between the industry and the regulator. But the nuclear material accountancy is such an important consideration that they're going to need to know, so they're going to have to share some.

Comment: You mentioned sensitivity material and the issue of U.S. graduate students versus foreign graduate students.

Comment: You need to be very careful about the applied technology issues.

Answer: The lab contact has lots of experience with all these issues. It would definitely behoove you, as part of your proposal, to have done your research and addressed what it is you need. Make sure your requirements are in your proposal.

BREAKOUT SESSION: REACTOR DESIGNS

DAN INGERSOLL'S AND CHRIS GRANDY'S PRESENTATIONS

Question: Under this program, is there a focus on any new reactors?

Answer: The design certification cost share part of the program is going to address the near term. That will be a competitive solicitation to commercial vendors for designs that could be brought to market by, say, 2015, which means we really need to be going into design certification in the next couple years. Those are most certainly going to be LWRs. We only know of three that could meet that: NuScale, the B&W mPower, and the Westinghouse IRIS.

Question: From the university perspective, which reactors are we looking at?

Answer: Near-commercial, which you're not going to impact much. Beyond that it's wide open. Every month I get an email from somebody with a new design.

Question: So we're not going to design a reactor; we are looking at probably some component of that. What would be the guideline?

Answer: I don't know. I don't want to see a new design that requires a lot of R&D that basically replaces a large element of an LWR. So what is the endpoint you want to offer? Is it a low-column machine? Is it an isolated economist machine? What is a highly innovative idea? This really is wide open.

Question: Are we inventing new reactors? Are we revisiting them? Can we propose concepts of a completely new system?

Answer: Yes. We have no preconceived notion of what those designs will look like or what functions they will address.

Question: What's the right strategy for partnering with some of the small reactor companies? Every university has a small reactor company as a partner and/or has their own private design. Is it a good idea to partner?

Answer: Think about it from the government's perspective. We're probably not going to support something that a specific vendor should be supporting. If it is specific to that design, then we're not going to fund that. On the other hand, sometimes vendors are backing a new different-looking component for reactors in general. So for example, working with a vendor that

uses a helical coil steam generator as an example of what you're trying to develop is fine. It is pertinent to a broader spectrum of designs.

Question: You had 19 concepts being proposed from the radius.

Answer: Yes. Three were selected: the integrated metallic fuel reactor, liquid salt-cooled fast reactor, and supercritical CO_2 fast reactor.

Question: If one wanted to submit a proposal on developing a component or a tool to analyze one of these three concepts that you just mentioned, would this be submitted to SMR? In the context of NEUP, what would be the best area? For example, I want to submit a proposal that sees how the supercritical CO_2 behaves in a radiation environment. Which one of the three NEUP areas should I submit to?

Answer: I can't answer that question. That type of proposal would support this area but also support perhaps the power conversion technology area.

Question: So how do we go about deciding?

Answer: Just read the call carefully. Actually, the call is still under development because of this very problem. We clearly need to figure out how to delineate the scope of the different areas. And we'll try to be as clear and as definitive as we can in the descriptions. Speaking from the SMR program, if it's just a reactor concept, say a supercritical CO_2 fast reactor, there's nothing in that that tells me it has to be a small reactor. Don't choose to make it small because you sense the popularity of small reactors. If you're proposing something that would require the reactor to be small, then the project ought to be part of the SMR program. A lot of the advanced concepts will probably end up in ARC.

Question: Could I ask about the budget?

Answer: That's still fluid. The SMR looks like it could come out around $50M, but $20–30M of that will be in design cost share and will be off the table.

Question: Is advanced energy conversion pretty much collapsed down into supercritical Brayton, or are we looking into other things, like liquid metal ranking, AMTEK?

Answer: NGNP is focused on the helium Brayton cycle, but we're focused on the supercritical CO_2 Brayton cycle. This call is basically wide open. If there's a space-type technology that could be used for other applications, then by all means propose it.

Comment: In general, we deliberately open up the option space for universities compared to the labs, which tend to be a little bit more focused and near term.

BREAKOUT SESSION: SYSTEMS ANALYSIS

HANS GOUGAR'S, DON WILLIAMS' AND BRAD WILLIAMS' PRESENTATIONS

Question: Are still focusing on deep burn? Or are you just coordinating with FCR&D?

Response: Right now it's more of a coordination. For another two months, it's officially a sidebar activity to NGNP; then it is being subsumed by the FCR&D program. However, it was originally proposed as an off-shoot of high-temperature reactor technology, and we maintain a very close R&D synergy with deep burn.

Question: Who is in charge of developing the framework for the fuel cycle simulator?

Response: Brent Dixon of INL would be the specific person. Cathy McCarthy is the director of the program.

Comment: Are you familiar with the framework work going on with NEAMS? The framework crosscutting area under NEAMS is integrating a lot of components that are at different scales for different applications. Crosscutting goes across the IPSCs, so there is an effort there for developing a framework to integrate the IPSCs. I think it would be valuable for you to interact with NEAMS in that area because you are trying to do the same thing at the computational level.

Response: At the fundamental level, but at the user end it's different. But we do need to work together. You're absolutely right.

Question: Does the systems model you're referring to include such things as cost analysis, safety, uncertainty?

Response: Yes, it does.

Question: In terms of the different elements, mining, enrichment, the whole process is included. It's not just the back end of the fuel cycle?

Response: Traditionally our focus has been on the back end, and it still really is the focus. But we are beginning to look at some of the front-end issues. This year we started a small activity looking at resource utilization. Mining, milling…under the new program these are gaining some more focus, but a small focus.

Question: What about cycles other than plutonium and uranium, such as a thorium cycle?

Response: Yes, we are looking at those. I mentioned fission–fusion hybrid using thorium. That's one example. Our fuels program has efforts ongoing in developing thorium fuels. Under the systems analysis campaign we are looking at different thorium options as well. It is actually a much larger focus this year. For university proposals, it would be acceptable for blue sky. Thorium fuel development could also fall under the fuels program.

BREAKOUT SESSION: NUCLEAR FUELS

DAVE PETTI'S PRESENTATION

Question: Before you were saying the design was sacrosanct, but now you are saying that it's okay to change that ceramic layer to something else.

Answer: For NGNP, it is sacrosanct. NGNP is too near-term. But for universities to explore and think about some new longer-term ideas, that's a useful thing to do in light of NEUP.

Comment: With the particle design, please note that we have the deep burn effort going on as part of NGNP, and waste in terms of getting rid of transuranics. Please don't duplicate there. Look at the actual fabrication and the materials. Don't just do the physics. Also, there will soon be an IAEA source book for how the fuel is made. Maybe we could put up the draft version. And the NRC contracted ORNL for characterization information, so that you can have that for information. We do have information to help you learn about our particle fuel.

Comment: There was a cheap teaching course for the NRC, and I believe that information will be available on the website somewhere.

Question: How much radioactive work can the universities propose? Can they work with surrogates, or do you absolutely want them to work with real materials?

Answer: Some of this stuff would obviously be surrogates because working with the real material is very difficult.

Question: So for the TRISO particles for the molten salt reactor, the high-temperature reactor, is there going to be a cross-cut area of research?

Answer: I don't know. It's in the ARC piece. I think this is open enough that it should allow it.

Question: When you mentioned measurement techniques, did you mean only for process monitoring?

Answer: We have to measure thicknesses, densities of all the wires, sphericity…those are the big ones. For defects, we do some acid techniques where we take a batch and burn it and dissolve it in acid. Some of these defects are looked for optically, missing layers, but if there were other techniques that would be more amenable to an inline process, then that would help.

We are still relying on the tried and true historical techniques because they provide that linkage and confidence. If you have a new technique, you have to benchmark it against the old one.

Comment: Look at the NRC new Reg. Dr. John Han and company did the characterization and the quality control document, and that is a public document for the NRC.

Comment: There's also been some work done in Europe with x-ray contrasting to look at densities and thicknesses, and we just finished a large IAEA round robin, and we believe that the x-ray technique has a bias in it. Seven or eight different countries participated in measuring some particles. That's not published yet in the CRP.

Comment: We also have a new SBIR that has been looking at plasma deposition instead of CVD processing. So if you are into trying to make tiny little particles with some deposition method, please talk to us before the solicitation comes out.

Answer: There were a lot of good proposals last year, particularly in the first area in fission products. The call is about the same as it was last year, so you could dust some of those off.

STU MALOY'S PRESENTATION

Question: Would targets be included in this? Fabrication of target materials?

Answer: Yes, fabrication of targets is included. Universities can help out only through some surrogate-type studies because it's very difficult to work with pure TRU materials.

Question: Could you just say a word or two about the issue regarding thermal transport, thermal conductivity?

Answer: If you don't have a good thermal transport across an oxide fuel, then it limits the maximum power at which you can run the fuel because of course the center of the fuel starts to melt. From an irradiation standpoint, as you build up defects in these fuel materials, especially in the ceramic-type fuels, something that starts off with a good thermal conductivity actually gets worse under irradiation. If we design fuels with better thermal conductivity, we improve the lifetime of ceramic-based fuels. In metal fuels the thermal conductivity is much better, but the melting temperature is much lower.

Question: You listed specific areas of research, but they are not all–inclusive, right?

Answer: Yes, it's not all inclusive. These are specific examples where we think we really need some help and where universities can help. But if your idea supports the descriptions of development of improved fuels for FCR&D, then it also falls within that bin.

Question: Characterization techniques are not in the example listing.

Answer: Characterization techniques are clearly an area that would help us in development of fuels if they can help us to better characterize our fuels before and after irradiation.

Question: Blue Ribbon Commission is looking into fuel cycle issues for the DOE. Is that going to impact the new fuels area? Obviously deep burn would reduce waste. Is that going to stimulate interest in new fuels that might come out of the Blue Ribbon Commission recommendations?

Answer: We are keeping abreast of discussions with the Blue Ribbon Commission. We are working with them as they look at specific fuel cycle options. Yes, they may suggest something that may push us into a different research direction altogether.

BREAKOUT SESSION: NUCLEAR PHYSICS

DAN VEGA'S PRESENTATION

Question: To do the cross-section measurements, do you actually need a facility?

Answer: You have to have existing facilities or, as part of the proposal, allocated time at LANSCE as part of the cost.

Question: Are there any isotopes that you are interested in?

Answer: In particular, the minor actinides and those we've looked at before. Personally, I would like to see fast reactor and not-as-well-understood minor actinide cross sections. Of course, a big portion of this is a sensitivity analysis telling us which are the most high-priority nuclides based on a nuclear system of our choosing or of your choosing.

Comment: We've always had issues with ion cross sections in the range of one to eight MeV.

Comment: To be perfectly honest, we're talking about having around $4.5M to $5M in our program—not for university programs, for our program. So maybe one proposal for nuclear data, nuclear physics, will get funded.

Comment: Under the NEUP coverage listed, this TPC project couldn't have been funded.

Response: I was actually under the impression that these presentations would be squeezed together. I don't anticipate that copying the TPC would be the way to go. It's a pretty wide collaboration at this point. I think people are looking for revolutionary ideas.

Question: Can you talk more about the nuclear theory you are interested in? How is it different from the nuclear theory budget in the Office of Science?

Answer: The only thing I can say is that it's nuclear theory for the nuclides we're interested in. I know the whole idea of nuclear theory is that it would be applicable to everything and you would start with the *ab initio* calculation and Sal Schrödinger's equation. The state-of-the-art models are perhaps not available to us, and we may be using old techniques. You know, we're not directing universities; we are asking for them to come up with smart ideas.

Question: Physicists love to measure iron 56, but those engineering people put natural iron in the reactor. Natural iron is a cheap target, but there are other isotopes there that affect the cross section.

Response: Yes, there are other isotopes in the steel, but 90 percent is iron 56. If you can resolve this first, then the others would be second order, in my opinion. I'm talking about ranges of one to eight percent difference, and that translates to fluxes on the order of twenty percent difference when it goes through the pressure vessel. It's a major issue because you have lots of iron all over the reactors.

Right now, in real operating reactors, we have resigned ourselves to a 10 to 15 percent difference that comes from iron that we cannot adjust. We have ample information. They have had 20, 30, 40 years of operation, they have all kinds of measurements. These measurements are being used to benchmark calculations to track for uncertainties. So, the NRC is comfortable with that because there is significant information, but if you want to go to a new system with a new regime, these things become important. In fusion, facilities is an area of concern.

Are you also looking at covariances? Covariance is an entire subject area in nuclear physics. It's refinement of the covariance matrices. Maybe that's implicit in the call. "Inter-reaction covariance data as a function," so maybe that's refining certain covariance matrices or maybe that's starting other ones.

Comment: We talk about steel because of the structural materials that we see in reactors. We do have PWRs and BWRs, but every other modified open-cycle system, every PBMR, every silicon carbide matrix is going to have its own complete different set of priority isotopes. The suggestion would be to look at that sensitivity analysis in the context of a particular design that would be within the mission of NE.

Response: Cross sections are hard, and most people don't want to put any effort into it.

Comment: If you look at the nuclear industry 30 or 40 years ago, they put a lot of money on cross-section measurement. There were so many facilities doing that, and then they reached a level and said, "Okay, we are fine. Let's build those things." And we are fine, per se, for operating reactors. The major issues are with the new systems and the new environments. And we don't have them. We don't have a facility to measure things and to test things. So, we've got to come up with a reasonable understanding. There has to be some investment in cross-section measurement.

Response: There are instances where modeling has crept back into the cross-section data.

Comment: You can have the best computer codes in the world, but you can get wrong inputs and wrong answers.

Response: The importance in nuclear data is the very base of the pyramid; everything else has to come from that. With that said, you can't study everything, and it becomes reward versus cost.

Comment: Actinides are a major issue, especially if you are talking about recycling and reprocessing. There are those that we don't know anything about.

Response: The fact that they have exceptionally complicated chemistries as well and f-electrons, multivalent cations and everything really cause problems.

Question: So is there still beam time available at WNR?

Comment: We do have sporadic accelerator times at LANSCE and other places, but every accelerator has that, from what I understand.

Question: As nuclear physics professionals, do any of you have suggestions about what the next few solicitations should include?

Response: Yes, the production of spigots for accountancy and certain isotopes that we can make with photons.

Comment: The trouble is I don't know what you need, and the people in this field have no idea what the capabilities of the detectors are today on some things.

Response: In the nuclear engineering community, the cross sections have been left to a very small group of people at the universities.

Comment: At this meeting last year, it was pointed out that the basic nuclear physics measurements had just been abandoned for years.

Response: There always has to be cross-section measurement, but certain types of cross sections are very difficult to measure. So if there are new ways of doing that and we as a community don't know about them yet, then that's not good. That would be something of importance. A new method of cross-section measurement would potentially be a very good proposal.

Response: Oftentimes similar techniques conducted with much better equipment yield better cross-section data. Advanced measurement techniques are supposed capture data faster and capture data and signals that would have been lost otherwise.

Comment: We can take 6,000 channels and digitizing them over 50,000,000 times a second and recording it, flat out, the whole time. We don't have to pause at all.

Response: I can even imagine a proposal being something as simple as a faster data acquisition card for use in a parallel plate avalanche counter.

Comment: And theorists may have something to say about doing single- and double-polarization experiments.

Response: With number of things in our measurements, such as the limitations on errors on some of our stuff with cork interactions, the limits are actually theoretical, not experimental.

Question: Obviously, we can't measure the whole range that you mentioned. There's Is there really a new physics model?

Answer: There's not anything that's looked at this level. We have moved away from some of the basic research aspects, like the quantum core dynamics, looking at the nucleus and such as that, because it's an intractable problem.

Comment: So the availability of massively parallel computing facilities has helped a lot and there are some very nice models for heavy nuclei, but the groups are small.

Question: Are you determining some parameters?

Answer: You can do that. There are interesting things going on with detailed study of the shape of the potential for a large nucleus, sort of nuclear medium calculations. You hit a proton or a neutron on the surface of the nucleus and then look at it recoil through the nucleus and look at how the medium modifies the properties of the proton or neutron as it scatters through the nucleus.