John Gilligan:

NEUP in support of university nuclear R&D

John Gilligan has been the director of the Nuclear Energy University Program (NEUP) since its creation in 2009 by the Department of Energy's Office of Nuclear Energy (DOE-NE). NEUP consolidates DOE-NE's university support under one program and engages colleges and universities in the United States to conduct research and development in nuclear technology. The two main R&D areas for NEUP funding are fuel cycle projects, which include evolving sustainable technologies that improve energy generation to enhance safety, limit proliferation risk, and reduce waste generation and resource consumption; and reactor projects, which strive to preserve the existing commercial light-water reactors as well as improve emerging advanced designs, such as small modular reactors, liquid-metal-cooled fast reactors, and gas- or liquid-salt-cooled high-temperature reactors.

DOE-NE also offers scholarships and fellowships to attract the brightest students to nuclear technology and to support the nation's intellectual capital in nuclear energy–related engineering and relevant sciences, such as health physics, nuclear materials science, radiochemistry, and applied nuclear physics. The program also makes funds available for nuclear infrastructure at universities, such as research reactor upgrades.

NEUP provides about $60 million per year total for projects, scholarships, and fellowships. Most funding goes toward large and small R&D projects, which are funded over a three-year period.

From its creation in 2009 through 2020, DOE-NE has provided a total of $802.6 million in funding for its programs, which are:

- R&D,
- Infrastructure,
- Integrated Research Projects (IRPs),
- Integrated University Program (IUP) Scholarships and Fellowships, and
- Nuclear Energy Enabling Technologies (NEET) R&D.

Gilligan has been a nuclear engineering faculty member for more than 40 years, starting at the University of Illinois and currently (and for most of his career) at North Carolina State University. He said that all of the work involved with running NEUP is done under the direction of DOE-NE.

Gilligan talked about NEUP with Rick Michal, editor-in-chief of *Nuclear News*.

Where do you see NEUP going in the near-term and long-term?

For both the near-term and the long-term, we are here to implement the DOE's mission and objectives. In doing that, we work with national laboratories and industry to integrate what the universities can bring to the table. I think the real triumph of NEUP has been the integration of universities into the DOE mission along with the national labs and industry. It is something not seen in other federal agencies to the large extent that it is seen here. In that sense, NEUP is a model program.

For the near-term, there are issues that the DOE-NE is concerned about, and building reactors is one of them. Through NEUP, the work done for reactor design studies, new build research, and solving the problems that come in areas of R&D concentration are supported by R&D funding to universities. This year there were 42 work scopes, or areas of concentration, for funding. Work scopes define the work that DOE-NE needs to have done in order to build a Virtual Test Reactor, for example, or develop advanced reactor concepts or on a project involved with computational modeling aspects. The faculty at the universities are responding well to these near-term needs. The projects are funded over three years, with the results required within that time. The near-term objective that we have every year is to reach milestones and solve problems within that time frame.

For the longer term, we support the DOE-NE mission to make nuclear energy viable in the United States and to get the cost down, make things safer, make things more environmentally benign, and have a workforce that is highly trained. Not all students who receive IUP scholarships or fellowships go on to become nuclear engineers. In fact, nuclear engineers are only about two-thirds of the total number of students that are supported. The other third are mechanical engineers, electrical engineers, computer scientists working on cybersecurity, material scientists, chemical engineers, and so forth. A variety of disciplines are involved in making nuclear energy more successful.

NEUP Nuclear Energy University Program
U.S. Department of Energy

How do you apportion funds into NEUP categories each year?

Of the roughly $60 million that NEUP receives each year, we look to direct at least $40 million to R&D projects, which is the bread and butter of the program. Our funding from DOE-NE goes into five main categories. Fuel cycle is one of them and includes waste. Another is reactor concepts, which includes advanced reactors, molten salt reactors, high-temperature reactors, NuScale projects, compact reactors, microreactors, and things like that. The third category is for maintaining the standard light-water reactor fleet component of the program to solve problems related to the existing reactors. The fourth category is the Nuclear Energy Advanced Modeling and Simulation program, which regards specialized computational tools. The fifth category is the NEET program, which is a specialized, cross-cutting needs initiative related to materials, reactor control, cybersecurity, and a variety of issues.

Funding is spread out over three years, as I said, but we mortgage it up-front. For example, if it is an $800,000 project, we reserve that amount and then spread it out over a three-year period, appropriate to the funding level that is needed. We never go year to year not knowing if a project is going to be funded completely or not. If a project received an award in a past year, it is going to be funded for three years.

NEUP has an Integrated Research Projects program. How does an IRP differ from a standard R&D project?

A standard R&D project is funded at $400,000 to $800,000, which is the typical size of a project for three years. These R&D projects tend to be more focused on individual research objectives

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and not as comprehensive and without as many partners as an IRP.

In contrast, IRPs are much larger, at $3 million to $5 million over three years, and they tend to be more comprehensive. IRPs have a larger number of partners and perhaps more industry involvement. These projects have more DOE input during the management of the program because the funding is larger.

How do universities become aware of the R&D needs?

Initially, in the first five years of NEUP, we had to educate people about the needs of DOE-NE. Once it was understood what work DOE-NE was going to support, however, the universities became innovative in what was proposed, especially for infrastructure. There are no work scopes for infrastructure. It is whatever the needs are for university research reactors, including safety and security issues. Purdue University, for example, recently put in a new digital reactor control panel, the first of a kind in the United States and the first to be authorized for a license to operate by the Nuclear Regulatory Commission. In terms of general equipment, however, universities come to us usually with a research emphasis but combined with equipment needed for the classroom.

What is the timeline for NEUP funding?

The document that announces the solicitation, or funding opportunity announcement (FOA), is issued in mid-August of a year. We support that document with a webinar where we answer questions from the community. We introduce new concepts, new eligibility restrictions, and so on. The webinar includes federal program managers who talk about the scope areas. The aim of DOE-NE is to make the award announcements by the following June after the FOA is announced the previous August. Then the actual funding is made at the turn of the fiscal year on October 1, and so it is an annual process.

Can you talk about some individual success stories of projects funded by NEUP over the years?

DOE-NE has had several major successes through this program, which include commercialized technology, international partnerships, and student development. These include the Fluoride High Temperature Salt-Cooled Reactor being developed by Kairos Power, ongoing partnerships with the United Kingdom's Engineering and Physical Sciences Research Council, and numerous students who have become nuclear engineering faculty, national laboratory

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scientists, and entrepreneurs. Details about these success stories can be found on NEUP.gov on our Program Outcomes page.

Can you talk about the fellowship and scholarship programs?

We get well over 100 applications per year for the fellowships, and typically we can award only 30 of them, so it is very competitive. The program is highly selective. The applicants are the top students going to the top universities in the country. These students can pick and choose the kind of fellowship they want, and so we get students who really want to go into nuclear energy.

On the scholarship side, we get about 70 applications per year and award about 50 of them. The purpose of this program is to attract the best students at the undergraduate level into working on nuclear energy. They won't all go on to become nuclear engineers. They become engineers in a variety of disciplines who want to work in and support nuclear energy.

What is involved in the process for awarding NEUP funds?

The process that is in place now is a key part of the program. Going back in history before NEUP, there was a lot of lobbying going on by universities for DOE funding. There was no consistency in how funding was awarded. The total funding each year was minor, and it was tough and competitive for universities to get it. When NEUP was created, it was the first program to define the projects that were needed and to have technical and relevancy reviews by multiple reviewers. Now, once the reviews are done, each proposal is considered on its technical and relevancy merits by a panel of technical integration leaders and DOE leadership staff. A ranking order comes out of that, and the projects that are ranked the highest get awarded.

Is there a feedback process to the researchers who submit applications?

Yes, there is. There is a preapplication process and a full-application process, which in total takes about nine months for the complete evaluation to be completed. DOE-NE provides direct feedback to each application's principal investigator (PI) and its researchers so that they can understand how to improve their applications. The preapplication process is intended to allow PIs and researchers to gauge the interest that DOE-NE has and then to provide corrections to the full application before submitting it for funding consideration. Also, the whole review process is transparent in that for any application submitted, the PI receives the full comments made by the reviewers—both the relevancy and technical reviewers.

What are the requirements for a project once it has been awarded?

There is accountability. DOE-NE is accountable to Congress, the energy secretary, and others to deliver its milestones. NEUP is under that same accountability. Individual projects have a DOE manager who looks at milestones. The PIs for each project submit progress reports on such things as how the funds are being spent, the titles of the technical papers published in scientific journals, and the project's results along the way. Also, there is a technical person—usually from the national laboratory complex—who is helping to manage the project and has reporting responsibilities. Between those two reports submitted for each project, the milestones are looked at closely and the project's progress is monitored.

What about workforce diversity within the research projects?

We have tracked some categories and we have made progress in areas. DOE-NE is not an education-model institution, but we are concerned about the nuclear workforce and what it looks like. It is becoming more diverse, especially in

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having more women in nuclear engineering, both as students and especially as faculty. At least 25 percent of our fellowship winners are women, which is a high number compared with historic awards. Women are becoming leaders in industry and faculty at universities. Unfortunately, for underrepresented groups, we are still working on that. There has been some growth, but not as much as we would like.

NEUP has as executive committee. What role does it play?

The committee has no formal approval authority, and so it exists to provide feedback from university department heads on issues with the program or improvements that can be made. Its members are university professors whose projects have received funding in the past. The committee also is a tie-in to the DOE-NE Advisory Group that advises the assistant secretary of energy.

Has the COVID pandemic affected the program, internally and from what you have seen at universities using program funds?

I don't think it has affected us any differently than any other research program or student, faculty, or administrator. We are working from home for the most part. I think that most universities are doing their work. They are back in the labs doing the work while social distancing. Computational projects can be done from home. Publications are getting done. Regarding the completion of projects, DOE-NE has a strict eligibility requirement whereby a project must be finished before the university would be eligible for funding the following year. Because of the COVID situation, however, DOE-NE has realized that, in essence, the eligibility requirement would be punitive and unfair to the community. DOE-NE has now suspended its requirements for those applicants who require a project extension due to COVID-related incidents.

What highlights do you have personally from NEUP?

One of my joys over the years is the growth of all the nuclear engineering programs in the United States, doubling in size if not more. At one time we were probably down to 15 programs and departments. Now there are more than 30, and most of the big nuclear engineering programs have doubled in size in the recent past. That is a strength of NEUP's peer-review process. It provides validity, and that is very important in the academic world. And DOE-NE is satisfied with NEUP because it knows it is funding the best research and is contributing to the DOE-NE mission.

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