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SUBJECT:	ANS report: Nuclear's Human Element
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From: "ANS President" <president@ans.org>
To: "Chairman Dale E. Klein" <chairman@nrc.gov>
Date: Fri, Jan 19, 2007 8:45 PM
Subject: ANS Report: "Nuclear's Human Element"

Chairman Dale E. Klein
NRC Chairman

Dear Chairman Klein:

On behalf of the 10,500 members of the American Nuclear Society (ANS), we are pleased to provide you with a copy of "Nuclear's Human Element." This report was prepared by the ANS Special Committee on Federal Investment in Nuclear Education, a group comprised of distinguished leaders in nuclear education from industry, national laboratories, and universities. It outlines the critical need for continued federal support of the U.S. nuclear engineering education enterprise and provides a policy pathway to strengthen the partnership between the federal government and U.S. universities.

Nuclear science and engineering will play an increasingly pivotal role in addressing fundamental U.S. security and economic issues in the years to come. However, our success in tackling the challenges will be predicated on our ability to educate the next generation of nuclear professionals.

The ANS has been a longtime proponent of an expanded federal stewardship role in nuclear science and engineering education. With this report, we intend to intensify our efforts on behalf of this critically important issue.

We hope you will take time to review this document thoroughly and forward it to others. The information is also available on the ANS website at http://www.ans.org/pi/fine.

Sincerely,

Harold F. McFarlane, President, American Nuclear Society

Karl P. Cohen , Past President, 1968-1969

Larry R. Foulke, Past President, 2003-2004

Joseph M. Hendrie, Past President, 1984-1985

James A. Lake, Past President, 2000-2001

Don W. Miller, Past President, 1996-1997

L. Manning Muntzing, Past President, 1982-1983

Edward (Ted) L. Quinn, Past President, 1998-1999

Harold B. Ray, Past President, 2002-2003

Ronald C. Stinson, Past President, 1987-1988

James S. Tulenko, Past President, 2004-2005

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January 18, 2007

Dear Colleague:

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Ronald C. Stinson, Past President, 1987-1988

James S. Tulenko, Past President, 2004-2005 — James S. Tulenko

Leaders in the development, dissemination and application of nuclear science and technology to benefit humanity.

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Nuclear's Human Element

Defining the Federal Government's Role in Sustaining a Vibrant U.S. University-Based Nuclear Science and Engineering Education System for the 21st Century

A REPORT BY
THE AMERICAN NUCLEAR SOCIETY
SPECIAL COMMITTEE ON FEDERAL
INVESTMENT IN NUCLEAR EDUCATION

December 2006

FOREWORD

In its FY 2007 budget submission, the Bush Administration proposed the termination of the U.S. Department of Energy's (DOE) University Reactor Infrastructure and Education Assistance Program, which provides funding for research, faculty, students, and infrastructure at the nation's university nuclear engineering departments and research reactors. The DOE congressional budget justification offered the following rationale in seeking to terminate the program:

> "Since the late 1990s, enrollment levels in nuclear education programs have tripled. In fact, [undergraduate] enrollment levels for 2005 have reached upwards of 1,500 students, the program's target level for the year 2015. In addition, the number of universities offering nuclear-related programs also has increased. These trends reflect renewed interest in nuclear power. Students will continue to be drawn into this course of study, and universities, along with nuclear industry societies and utilities, will continue to invest in university research reactors, students, and faculty members. Consequently, Federal assistance is no longer necessary, and the 2007 Budget proposes termination of the University Reactor Infrastructure and Education Assistance Program."
>
> *U.S. Department of Energy*
> *FY 2007 Congressional Budget Request*
> *DOE/CF-004, Volume 3, Page 600*

This proposal caught many in the nuclear community by surprise. Notably, the DOE used current *undergraduate* enrollment rates to justify its decision, even though the program's historical rationale and funding patterns center on *graduate-level* education and research. Apparently, the Administration's decision to terminate the program was driven in some part by the need to fund other DOE priorities and was undertaken with the knowledge that Congress would likely restore funding through the appropriations process.

In fact, Congress has provided $27 million for the program in both the House and Senate versions of the FY 2007 Energy and Water Appropriations legislation. However, at this writing, the DOE is operating under a continuing resolution, and thus, the program's ultimate prospects for funding in FY 2007 and beyond remain uncertain.

What has become clear is the substantive "disconnect" between those who advocate for the termination of the DOE / Office of Nuclear Energy university program and those who support its continuation and expansion. The resulting debate has raised several fundamental questions. Should the federal government be involved in supporting university-based nuclear science and engineering education in the United States? If so, what are the ultimate goals of its involvement? How do we measure progress toward them? How should the federal program be structured? What is the right level of funding?

The American Nuclear Society (ANS) Special Committee on Federal Investment in Nuclear Education (the Committee), formed by ANS President Harold McFarlane in June 2006 and comprising seven representatives from universities, national laboratories, and industry, was charged with providing a larger context to the debate, addressing issues raised by both sides, and offering a policy pathway to achieve long-term sustainability of the U.S. nuclear education system.

The Committee has held several face-to-face meetings and teleconferences. Its members have conducted wide-ranging research on federal funding patterns and workforce trends and have interviewed numerous congressional and agency staff. The Charge to the Committee is provided as Appendix A, with its membership listed in Appendix B. Its findings and recommendations can be found within this report.

EXECUTIVE SUMMARY

Of all the major enabling technologies of our time, those developed through the application of nuclear science and engineering (NSE) have arguably the greatest potential to affect the world's economic prosperity and quality of life. As a result, the promise and risks associated with nuclear technology feature prominently in our current political, economic and security landscape.

For instance, it is generally recognized today that no effort to meaningfully reduce global carbon air emissions while avoiding widespread economic hardship can be successful without a significant expansion of nuclear power generation. Yet, there are notable engineering challenges, such as developing advanced, proliferation-resistant fuel recycling techniques and waste storage methods, which must be addressed before any "nuclear renaissance" can be considered sustainable beyond this century.

Conversely, the proliferation of nuclear weapons, either by unstable governments or terrorist groups, is one of the key threats to U.S. homeland security, and the federal government must continue its full-on scientific and engineering effort to develop new methods of detecting, deterring, and tracing the misuse of nuclear materials. Finally, while there are few cases of nations using their civilian nuclear programs to develop nuclear weapons since the advent of the Nuclear Nonproliferation Treaty, the possibility clearly exists.

Nuclear science and technology has also revolutionized diagnostic medicine and cancer treatment and has myriad other applications in everything from geology and archeology to fire alarms and food safety.

In short, regardless of differing opinions on the efficacy of using nuclear technology for a particular application, we all must acknowledge that nuclear technology will continue to be a critical focal point of U.S. national security, foreign, energy, and environmental policies for the foreseeable future. We must also recognize that our ultimate success in meeting these challenges will depend largely on the ability of the United States to educate and train a new generation of nuclear scientists and engineers.

Congress, first through the Atomic Energy Act of 1946 (Ref. 1) and then through subsequent legislation, has consistently recognized that stewardship of the U.S. NSE education system is a unique federal responsibility. Unlike other engineering disciplines, university-based NSE education programs do not have significant opportunities to obtain funding through other federal agencies such as the National Science Foundation (NSF) and the National Institutes of Health (NIH). As a result, U.S. Department of Energy (DOE) stewardship has been critically important in sustaining the faculty, students, and infrastructure needed to support a healthy U.S. nuclear education system. Yet, this lack of federal funding diversity has also left university NSE programs vulnerable to funding fluctuations within DOE's Office of Nuclear Energy (NE).

In the 1980s and 1990s, a combination of declining federal funding, enrollments, and industrial support caused a precipitous decline in overall U.S. NSE education capacity. In 1980, there were 65 nuclear engineering departments actively operating in U.S. universities; now there are 29. Similarly, the number of nuclear research and test reactors, which provide critical hands-on experience and enable multidisciplinary research, has declined more than 50% in the last 25 years, from 63 to 27 facilities.

Currently, it is estimated that almost one-third of the current nuclear workforce will reach retirement in the next 10 years. While reliable data are scarce, there is significant anecdotal evidence that the DOE, the national laboratories, other federal agencies, nuclear technology companies, and university nuclear engineering departments are currently experiencing or anticipate significant shortages of qualified U.S. NSE graduates.

The overarching conclusion of the American Nuclear Society Special Committee on Federal Investment in Nuclear Education (the Committee) is that a clear national interest exists for the federal government, primarily through the DOE, to continue to expand its stewardship of the U.S. nuclear education enterprise. Simply put, America's university-based NSE programs cannot continue to be leaders in the field without an active DOE university program.

The Committee also recognizes that the current set of metrics used to evaluate the performance of the DOE/NE university program is in need of improvement. The Committee provides some examples of an updated set of metrics that are more suited to the task.

Finally, the Committee makes six specific recommendations to the DOE and Congress:

1. The DOE should undertake a detailed NSE workforce study to determine the aggregate demand of nuclear-educated graduates in the next 5 to 10 years.

2. The DOE should revise the current university program, along the lines of what has been envisioned in the so-called "Chicago Framework," to make it more research driven, mission oriented, and peer reviewed.

3. Congress should retain a separate funding line for NSE university programs in the Energy and Water Appropriations Bill for FY 2007 and future years.

4. Congress should increase funding for university programs commensurate with the levels authorized under the Energy Policy Act of 2005 (Ref. 2).

5. Congress should enact and fund the DOE / Office of Science (SC) –administered "Nuclear Science Education" program included in S. 2197, the PACE-Energy Act (Protecting America's Competitive Edge), and S. 3936, the National Innovation Competitiveness Act.

6. In the longer term, the DOE should convene an interagency working group on NSE that provides high-level guidance on the overall structure of NSE university programs, as well as the technical thrusts of its solicitations.

NUCLEAR SCIENCE AND ENGINEERING IN THE 21ST CENTURY

The pioneering studies of nuclear physics in the late 19th and early to middle 20th centuries led to the birth of a new discipline: nuclear science and engineering. Since its beginning more than 50 years ago, NSE has enjoyed a special status in the United States and in the world as a field of study, owing to the consequential purposes for which the attained knowledge can be used. No other specific technical field of study provides its graduates with a body of knowledge that can be used for great benefit to the world in providing safe, reliable, environmentally benign power production and in advancing medical diagnoses or treatments, as well as providing the basic education that is used for security-related activities that can affect world peace and stability. Indeed, NSE is unique.

The Atomic Energy Act of 1946 (Ref. 1), as amended, recognizes the need for federal involvement in research, development, and training for NSE and assigns responsibility to the Atomic Energy Commission (AEC) for encouraging and overseeing these activities. For more than 50 years the AEC and its successor agencies, the Energy Research and Development Administration and the DOE, administered university-based programs of NSE research, development, and education. Republican and Democratic administrations and Congresses have consistently recognized the need to sustain these programs over the decades in support of both civilian and military programs of research and development (R&D) and human resources needs. The graduates of these programs helped lead and contributed to efforts in developing the nuclear arsenal that won the cold war as well as in developing the nuclear power industry resulting in 20% of electricity production in the United States today coming from nuclear power.

The situation in the world today is extremely complex as it relates to nuclear technology for both peaceful and security applications. After a three-decade period of essentially no new nuclear power plant construction in the United States and slow growth around the world, there is a renewed interest in nuclear-generated electricity. Many factors have contributed to this renaissance, including concerns about possible climate change due to carbon emissions; fundamental changes in the costs of nuclear-generated electricity due to significant improvements in safety and operating performance; government encouragement as manifested in, for example, the U.S. Energy Act of 2005 (Ref. 2); and energy security concerns driving nations toward more diverse electricity production portfolios.

At the same time, concerns about the potential malevolent use of nuclear technology have dramatically increased. Owing to concerns that a few countries may be using civilian nuclear technology as a cover to develop a weapons program, new ideas are being developed in the international security community to strengthen the Nuclear Nonproliferation Treaty. It is clear that the growing problems associated with the interface between nuclear weapons and nuclear power will increasingly require innovative technical and policy solutions and people who are literate, trained, and educated in nuclear processes.

The United States must have appropriate numbers of high-quality NSE graduates for the needs of government and national laboratories, particularly for nuclear security roles, and for industry to continue to contribute to the growth and strength of nuclear power as well as to the other many applications of nuclear processes (e.g., nuclear medicine and food safety). As such, the Committee has concluded that Congress's mandate in the Atomic Energy Act, which required the federal government, through the DOE, to be actively involved in supporting U.S. nuclear education, remains necessary and warranted today. Indeed, the Committee believes that it is in the economic and national security interests of the United States to remain at the forefront of nuclear R&D worldwide. **As a consequence, the U.S. government, and specifically the DOE, must serve as a steward for the national nuclear research and education enterprise.**

For the purposes of this study, NSE includes the disciplines of nuclear engineering, health physics, and nuclear physics of direct relevance to nuclear engineering, as well as nuclear and radiochemistry of direct relevance to nuclear engineering. For our purposes, nuclear engineering is concerned with the practical application of nuclear and radiation processes. In addition to energy from nuclear fission and fusion processes, nuclear engineering includes the production and use of radiation and radioisotopes in medicine, food processing, and industrial processes. It includes issues related to nuclear waste management and nuclear security, including technologies to protect against proliferation of nuclear weapons and nuclear material as well as against nuclear terrorism. It is based on fundamental areas related to the interaction of radiation with matter.

THE DOE ROLE IN US NSE EDUCATION

Although university-based NSE programs across the country receive support from various state and federal agencies as well as industry, there are very important differences when they are compared to other science and engineering disciplines. The understanding of nuclear processes in the core of a nuclear reactor is generally not a subject within the purview of the federal government's basic research funding agencies (e.g., NSF). This is due in large part to DOE's clear charter, dating from the Atomic Energy Act, as the principal steward of the U.S. nuclear education enterprise. Further, issues associated with the interaction of ionizing radiation with matter, biological and nonbiological, are generally ignored by funding agencies other than the DOE [the National Aeronautics and Space Administration's (NASA's) interest in radiation effects on humans in space is a notable exception].

It is true that university-based NSE programs often conduct research that is only somewhat related to nuclear processes and that funding for these activities can be obtained from basic research and mission-related programs across the federal government. For example, many nuclear engineering departments have substantial research activities in areas such as thermal hydraulics, materials science, and/or plasma physics. These research activities, all related to the practical applications of nuclear energy, may be funded by the NSF, the U.S. Department of Defense (DOD), the DOE/SC, and other agencies. But, to a large extent, fundamental nuclear process research cannot be addressed without the financial support of the DOE. For example, the support of computational methods development for neutron transport processes, a field that underpins nuclear reactor analysis, medical physics, and nuclear weapons design, is not available outside DOE/NE.

DOE support of graduate programs in NSE is particularly important. Because NSE is so complex and applicable in so many fields, today's undergraduate nuclear engineering program must cover a broad range of technical material. It is only in graduate school that an NSE student can focus on a particular application, e.g., design of new nuclear power plants, development of instruments to detect nuclear materials in shipping containers, new techniques for radiation treatment of cancer, etc. Many of the NSE positions in government agencies, national laboratories, universities, and medical facilities can be filled only by people holding graduate degrees. A graduate degree in NSE requires both study of advanced theory and research that involves practical application of theory in the student's area of specialization. That research, which is guided by a professor, typically requires specialized equipment and significant financial support. However, it serves two purposes. It is part of the student's training, but it also provides information of value to the sponsoring agency. Thus, DOE funding of NSE programs is important not only because it provides training for future essential NSE professionals but also because the results of the research can be immediately useful.

The Committee believes the Atomic Energy Act also requires the DOE to take a general role in nurturing and monitoring NSE education in support of the national interest. This role includes monitoring (a) the relationship between demand and supply of NSE graduates; (b) the NSE education infrastructure, including faculty, facilities, and equipment; and (c) the level and quality of research in NSE university programs. The DOE must provide financial support to sustain faculty, students, and infrastructure to the extent needed to assure a healthy NSE enterprise in the country.

On the other hand, the DOE NSE education support programs cannot, alone, provide the resources needed for a healthy and comprehensive national effort. University-based NSE programs must continue to aggressively seek and obtain research and education support from mission agencies, basic research funding organizations, national laboratories, and industry.

In short, the Committee believes DOE's stewardship role is to continuously monitor

the NSE education enterprise to ensure that it meets present and future national needs and to conduct a modest research, development, and education program, to appropriately augment other federal and industry supporting efforts, assuring the near- and long-term robustness and health of the discipline to address national needs.

DEMAND FOR UNIVERSITY-BASED NSE RESEARCH

University-based NSE activities lead to R&D results, as well as to graduates for government, national laboratories, and industry. In the R&D realm, there are challenges in energy security, nuclear security, and other fields. In the area of nuclear energy, there are new, DOE-funded initiatives in advanced reactors, in nuclear energy for hydrogen production, and in spent-fuel management. Advanced reactor programs include novel ideas in water-cooled, gas-cooled, and liquid-metal-cooled reactors. Research programs are directed toward fielding Generation IV reactors in the first half of the 21st century. In addition, there continue to be R&D efforts to demonstrate the tokamak and other plasma confinement concepts that could lead to a demonstration fusion reactor in the middle of the century. Nuclear energy can potentially be used to produce hydrogen for transportation applications in an economically feasible manner and there is a vigorous research program to develop high-temperature reactors for this purpose. A newly announced DOE program, the Global Nuclear Energy Partnership (GNEP), is intended to develop the systems, technologies, and policy regimes to allow recycling of used light water reactor fuel and, to a large extent, eliminate the actinides in fast-spectrum reactors in a way that enhances proliferation resistance. The resulting waste streams are envisioned to have characteristics that would lessen the demand for geologic repository assets. These and other DOE-funded research efforts will need to make great use of university-based NSE capabilities.

In the nuclear security arena, unclassified research needs are also varied and rich. In addition to assuring the safety, reliability, and security of the U.S. nuclear weapons stockpile, innovations are needed to detect and defend against the proliferation of weapons-usable nuclear materials. From systems analysis to new nuclear detector innovations and new approaches to analyze intelligence data, research opportunities abound. Defense against nuclear terrorism requires new approaches to border security and new methodologies to attribute nuclear and radiological contamination to a particular country or source. Federal agencies are specifically targeting universities for innovations in these fields. New attention is also being given to other applications of nuclear processes, especially to provide process heat. Potential applications vary from water desalination to recovery of usable petroleum products from oil shale and tar sands.

These needs will challenge university-based NSE programs to respond. One might think that with such challenges there is no need for support for NSE research from a DOE university program to supplement the effort. However, owing to the cyclic nature of such programs and the tendency in such efforts to focus on applied research as opposed to basic research, infrastructure support, and education, the Committee believes that maintaining a stand-alone program to support general university-based NSE research is a key component of the DOE stewardship mission.

DEMAND FOR NSE GRADUATES

The needs of many U.S. Government agencies, as well as medical, manufacturing, R&D, and energy industries, for educated nuclear scientists and engineers are widely recognized. The Nuclear Energy Institute (NEI) estimates that 26% of engineers working in U.S. nuclear utilities will be eligible for retirement in the next 5 years (Ref. 3). Unlike other sectors, the electrical energy generation industry cannot be readily outsourced overseas.

In addition, at least 4 DOE offices (Nuclear Energy, Civilian Radioactive Waste Management, Nuclear Security, and Environmental Management), 10 national laboratories, at least 27 utilities, and a large number of nuclear power vendors are expected to experience increased demand for NSE graduates within the next 10 years.

Also, an increased number of NSE graduates are now being sought for other federal agencies in addition to the DOE, including the U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), the U.S. Food and Drug Administration, the U.S. Department of Agriculture, NASA, the U.S. Department of Homeland Security (DHS), many agencies of the intelligence community, the Defense Threat Reduction Agency, and every uniformed service.

NSE human resources requirements also exist in the nuclear medical research, nuclear medicine, and medical physics communities, as well as in many other non-energy users of nuclear scientists and engineers.

Further stressing the limited human resources pool, many university nuclear engineering departments are seeking new faculty members and department heads, including the newly formed Nuclear Engineering Department at Idaho State University.

When conducting its research, the Committee found nearly uniform anecdotal evidence that the current production rate for NSE graduates is not sufficient to meet demand. For example, one division at one of the national laboratories has recently (unsuccessfully) sought 100 nuclear scientists and engineers, and Westinghouse, General Electric, AREVA, and the NRC are attempting to hire hundreds of engineers per year, many of them nuclear, from too small a pool of candidates. Recognizing the looming shortages, several federal agencies have established or are in the process of establishing NSE fellowships and scholarships and/or NSE research programs [e.g., DOE / Office of Civilian Radioactive Waste Management (OCRWM), DOE / National Nuclear Security Administration (NNSA), NRC, and DHS].

However, the Committee found it difficult to quantify the aggregate national human resources requirements because while the nuclear energy industry has conducted extensive studies of its needs, no comprehensive analysis of requirements for nuclear-educated graduates for all fields has ever been completed.

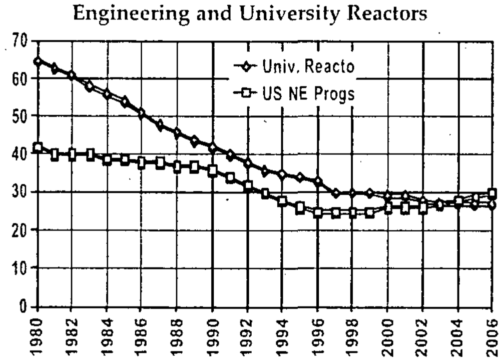
As such, the Committee believes the DOE, in keeping with Section 1101 of the Energy Policy Act of 2005, should conduct a comprehensive study of the nation's requirements for production of nuclear scientists and engineers as soon as possible. This study should also be repeated/updated periodically, on the order of every few years. Such studies are a critical component of the DOE NSE stewardship role.

STATUS OF THE US NSE EDUCATION ENTERPRISE

Given the clear demands to be placed on the U.S. university-based NSE enterprise, it is important to look at its present overall condition. As will be seen, the enterprise has strengths, weaknesses, and vulnerabilities, and the Committee believes the DOE should be actively involved in monitoring its capacity and capabilities as part of its stewardship role.

Nuclear engineering programs and departments were formed in the late 1950s and 1960s from interdisciplinary efforts in many of the top research universities, providing the human resources for this new technical discipline with an initial emphasis on fission reactor engineering. In the same time period, many university nuclear reactors were constructed and commenced operations, providing key facilities needed for research as well as education of students engaged in this profession. Since the 1960s, U.S. universities have led the world in this technology with a commitment to furnish the necessary human resources and the associated infrastructure.

Figure 1: History of U.S. Nuclear Engineering and University Reactors



In the 1990s the number of NSE programs at the undergraduate and graduate levels declined precipitously, particularly in the latter part of the decade, as Fig. 1 indicates. The closures of these programs and departments were linked to the declines in enrollment of undergraduate and graduate students as well as in the research support from federal and industrial sources. Another feature compounding this problem is the aging nature of nuclear engineering faculty. More than two-thirds of current U.S. faculty are 45 years or older, and the rate of new faculty hiring diminished by more than 10% through the late 1990s.

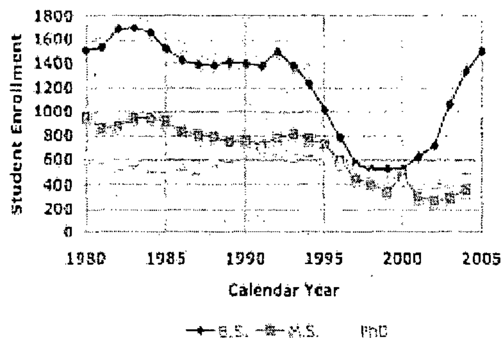
Today, the demand for nuclear-educated personnel is again on the rise. The enrollment in NSE university programs has increased dramatically in response to this demand (see Fig. 2), although even with this increase the mismatch between supply and demand will become more severe without continued and growing DOE support.

STATUS OF US RESEARCH REACTORS AND OTHER FACILITIES

University research reactors have a long history of supporting research and education in nuclear science and technology. They also enable multidisciplinary research in other fields such as physics, chemistry, biology, medicine, epidemiology, environmental science, material science, fluid mechanics, geology, archeology, paleontology, forensic science, human factors, and many other fields.

The history of research reactors in the United States closely parallels the rise and decline of the number of academic programs in the NSE discipline described above. During the 1960s and 1970s, many universities developed nuclear science facilities for research and training activities, including a significant number of research reactors. These facilities enabled students to obtain important hands-on understanding, familiarity, and respect for the unique requirements and challenges related to working with nuclear reactors, radioactivity, and radiation. These facilities also enabled students to learn about radiation protection, radioactive materials handling, and other reactor-related skills.

Figure 2: Historical Comparison of Nuclear Engineering Student Enrollments



Hands-on understanding and respect are essential to the education and training of future nuclear scientists and engineers. An early introduction into the "nuclear safety culture" has been a vital part of the education of nuclear engineers, health physicists, and nuclear scientists for more than 50 years. Access to state-of-the-art research tools and instrumentation is important training for students at all degree levels including those studying for associate, baccalaureate, masters, and doctoral degrees. Access is also important to the training and education of postdoctoral researchers, especially if they have not been introduced to the unique requirements of NSE during their prior studies.

The National Organization of Test, Research, and Training Reactors (TRTR) has chronicled the decline in the number of research reactors for more than two decades. The data, as seen in Fig. 1, show that over the past 25 years, the number of university- and nonacademic-based research reactors has fallen from 63 facilities to the current number of 27 research reactors. TRTR has worked with the DOE over the years to establish and maintain programs that assist universities with reactors to provide local support to and engagement of their various constituencies. DOE's Reactor Sharing and University Reactor Instrumentation programs were developed in order to support these important facilities and capabilities. The Committee believes that future DOE NSE programs must continue to monitor these facilities and provide support to assure long-term strength of the national NSE education infrastructure.

SCOPE OF THE PRESENT DOE/NE UNIVERSITY PROGRAM

The current DOE/NE university program is comprehensive in scope, providing fuel services for research reactors, basic research grants, support for industry matching grants, infrastructure support, fellowships and scholarships for students, and partnerships to share reactors with other universities and industries, and it includes minority-serving institutions in the national NSE education enterprise. The program has been cyclic in funding, growing from virtually zero a decade ago to $27 million in FY 2006. As earlier stated, the program has been critical in sustaining NSE as a discipline and must be maintained. Program details are available at:

http://www.ne.doe.gov/universityPrograms/neUniversity2a.html.

Comparison of Present Federal Investment in NSE Compared to Other Disciplines

Although university-based NSE education programs receive financial support from a wide range of federal agencies as well as industry, there are very important differences when compared to other science and engineering disciplines. Most notably, core NSE research thrusts are generally not funded by the other federal research funding agencies (i.e., NSF, NIH, DOD, NASA, etc.) because they are viewed as the exclusive jurisdiction of the DOE, as set forth in the Atomic Energy Act. Recent statistics bear this out. The American Association for the Advancement of Science (AAAS)-NSF survey in 2004 for basic R&D at universities indicates that engineering disciplines other than NSE receive a minor fraction of their R&D funding from the DOE, in comparison to other federal agencies; i.e., less than 10 to 20% is due to the DOE for all other engineering disciplines compared to 40 to 60% for NSE programs as noted below.

Although university-based NSE programs often conduct research that is somewhat indirectly related to nuclear processes, funding for these activities is obtained primarily from basic research and mission-related programs within the DOE. The Committee performed a survey of leading NSE programs for the same time period as the AAAS-NSF statistics in 2004. As Table 1 indicates, a majority of the funding for nuclear engineering programs is derived from the DOE and from the DOE/NE university program in particular. Although the overall fraction varies to some greater or lesser extent for any individual institution, it is substantial in comparison to other engineering disciplines.

Table 1 — 2004 Statistics on Nuclear Engineering Programs

	MIT	Univ of Michigan[a]	Univ of Wisconsin[b]	Purdue[c]	Texas A&M[d]	NC State	Univ of California, Berkeley	Penn State	Average
U.S. News and World Report rank (2005)	1	2,3	2,3	4,5	4,5	6	7,8	7,8	N/A
No. of full professors	12.5	11	12	7	10	6	4.5	8	9
No. of associate professors	2	3	4	3	2	3	2	1	2.5
No. of assistant professors	1	0	4	2	4	2	1	0	1.75
Total faculty	15.5	14	20	12	16	11	7.5	9	13
No. of undergraduates	48	97	100	120	209	132	53	105	108
No. of BS degrees awarded	9	16	8	23	23	10	9	31	16
No. of graduate students	100	85	58	60	79	50	55	47	63.3
No. of MS students	51	17	24	25	46	30	22	24	30
No. of MS degrees awarded	26	34	6	6	7	7	5	5	12
No. of PhD students	49	68	34	35	33	20	33	23	37
No. of PhD degrees awarded	15	16	8	6	1	4	2	2	6.75
No. of students/faculty	9.5/1	13/1	9/1	15/1	18/1	16.5/1	14.4/1	16.8/1	13.8/1
Total research ($M)	$7.8M	$6.7M	$10.5M	$3.3M	$4.2M	$3.9 M	$4.1 M	$4.44 M	$4.8M
Federal government ($)	$4.1M[e]	$6.1M	$10M	$3.0M	$430K	$3.4 M	$3.7M	$4.08 M	$3.9M
Industry R&D ($)	$2.02M	$300K	$500K	$270K	N/A	$272 K	$58K	$245K	$532K
Other dollars	$943K	N/A	N/A	$30K	$0	$200 K	$887K	$141K	$404K
Percent DOE/NE research dollars	53%	46%	25%	54%	45%	88%	44%	50%	
$K/FTE Faculty	$400K	$443K	$525K	$275K	$262K	$373 K	$542K	$488K	$389K

[a]University of Michigan data from combined Nuclear Engineering and Radiological Physics Department.
[b]University of Wisconsin data from the Department of Engineering Physics, includes nuclear engineering (15 of 20 faculty and $9.5 million of $10 million for nuclear engineering).
[c]Purdue data from School of Nuclear Engineering.
[d]Texas A&M data from combined Nuclear Engineering and Health Physics Departments.
[e]MIT data for Federal Government does not include the Plasma Fusion Center at about $20 million.
Additional data on DOE/NE funding fraction from Florida (50%); RPI (65%); Oregon State (57%); and University of Missouri, Columbia (68%) from DOE/NE.

In short, no other engineering discipline is as reliant on DOE research support as nuclear engineering. As such, fluctuations in DOE funding inevitably have a tangible, even disproportionate, impact on both university-based NSE education and research programs in the U.S. nuclear education enterprise as a whole. These university-based research programs provide new science and engineering results as well as provide the technical human resources so critical to the nation.

FUTURE FEDERAL INVESTMENTS IN NSE

The university-based NSE community is responding rapidly to the new challenges and opportunities to participate in research and provide newly educated scientists and engineers to the many agencies and industries participating in nuclear energy and nuclear security. Some of these new research efforts are supported by mission agencies including DOE/NE, DOE/NNSA, DOE/SC, and NRC. However, the Committee firmly believes that the DOE must play an integrative role to fulfill the stewardship charter envisioned in the Atomic Energy Act.

This begins not only by maintaining the DOE/NE university program but also by expanding its scope and funding. The program should monitor the mission-directed university-based NSE research effort to assure that the overall strength and health of the enterprise are maintained. Program personnel should also be watchful for trends that might make the research portfolio unhealthy. For example, one might easily imagine that the overall portfolio might be very much skewed toward near-term, applied research efforts, with little support for the long-term, basic research needed to further understand basic nuclear processes of importance to applications in the future. A separately funded NSE university program should support such mission-relevant, basic research efforts, as needed, to augment the mission-directed research efforts.

In addition, in the long run, the mission-directed NSE research efforts of the nation will need a healthy NSE infrastructure. This need includes a healthy and reasonably sized fleet of university-based reactors for research and NSE education. These reactors can obtain some funding through efforts on the part of their directors to seek federal, state, and private funding. However, experience has indicated that an important role can be performed by the DOE in monitoring these reactors and establishing peer-reviewed grant programs to support them. Support from the DOE for the nuclear fuel for these reactors is also required.

Another role derived from the Atomic Energy Act is to monitor the national educational programs in NSE to assure that the supply and demand of graduates is reasonably balanced. This will require periodic surveys, conducted by the DOE, to assess supply and demand. It is expected that university administrators, working with a wide array of funding sources, would keep the faculty and teaching infrastructure up to a level to meet the demand for graduates. However, given the fact that many fellowship and scholarship programs typically do not support NSE students, DOE programs are critical in attracting students into masters- and doctoral-level programs. Diversity of graduates has also been enhanced by DOE NSE education programs targeting minority institutions. Such efforts will likely be required for an indefinite period in the future.

DOE NSE university programs can be funded through a number of methods. One suggested approach is to "tax" the mission-driven programs in DOE/NE to support an effort that would be centrally managed by a director. This has the advantage of keeping the university-based effort closely aligned with the nuclear energy programmatic research effort. However, the broad array of "users" of NSE talent, including the nuclear security community, makes it inappropriate for the nuclear energy programs to be solely taxed. The NSE education customer base goes far beyond DOE/NE and, in fact, even goes beyond the DOE. A separately appropriated line item is a much better approach. In the long run, the program must take account of the long-term research and education needs of a broader constituency than DOE/NE. Additionally, if the program is funded through a tax, the Committee is concerned that it will become more near-term oriented than is consistent with DOE's long-term stewardship responsibility. The Committee is convinced that a separate line item is needed to support the stewardship responsibility.

The need to monitor and support university-based NSE research and education efforts, consistent with the Atomic Energy Act, requires a continuous federal government stewardship effort. Given the fact that NSE research and education serve a wide variety of government agencies including DOE, DOE/NNSA, DOE/SC (especially the fusion program), NRC, DHS, NASA, DOD, and others, it does not necessarily have to be resident within DOE/NE. The principal argument for keeping the program in DOE/NE is historical. In recent years, the effort has been quite effectively conducted from that office. On the other hand, given the breadth of needs for research products and graduates, to include nuclear security, an argument can be made to place the program in NNSA. Another point of view is to place the program in DOE/SC, which is charged with serving all the DOE mission agencies.

It is the recommendation of the Committee to retain the present structure for the near term in order to minimize disruption. However, in the midterm (next few years), it is suggested that a DOE intra-agency advisory committee be formed to provide long-term guidance to the DOE/NE program. Under this scenario, the DOE/NE program managers would periodically seek the Committee's advice on program structure and funding solicitations. The Committee would include representatives from DOE/NE, NNSA, SC, OCRWM, the Office of Environmental Management, and perhaps others. Although the research portfolio in the midterm should continue to focus on the DOE/NE long-term research needs, the budget of the program should be increased, over time, to better reflect the research needs of the other DOE offices. Participation in the intra-agency committee would have the added benefit of allowing better coordination of the university-based, mission-driven NSE research efforts of each of the DOE offices. In the long term, a governance mechanism is needed to include the needs of offices outside of DOE including NRC, DOD, DHS, NASA, and others.

In addition to the current DOE/NE university program, the concept of a separate and broader federal NSE program, run by the DOE/SC, has gained significant traction in the U.S. Senate as part of the legislative effort to enact the recommendations of the "Rising Above the Gathering Storm" report.

S. 2197, the PACE-Energy Act (PACE standing for Protecting America's Competitive Edge), authorizes a new "Nuclear Science Education" program designed in the words of the legislation "to address the decline in the number of and resources available to nuclear science programs of institutions of higher education; and ... increase the number of graduates with degrees in nuclear science, an area of strategic importance to the economic competitiveness and energy security of the United States." (The term "nuclear science" as used in S. 2197 is defined to include nuclear engineering.) S. 2197 would create competitively awarded grant programs for (a) new university-based nuclear engineering programs, (b) expansion of existing programs, and (c) talent-based scholarships. S. 2197 authorizes $20 million for the program in FY 2008, rising eventually to $50 million in FY 2011. The program would be overseen by DOE/SC through the Director of Mathematics, Science, and Engineering Education (a position created by the legislation and appointed by the DOE undersecretary of science).

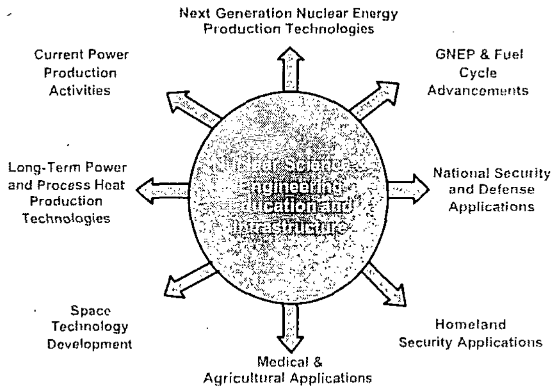
While S. 2197 was not enacted during the 109th Congress, it has been incorporated into S.3936, The National Innovation Competitiveness Act, which was introduced by Senate majority leader Bill Frist (R-TN) and minority leader Harry Reid (D-NV) and has 40 bipartisan cosponsors. The Committee has been told that "competitiveness" legislation will receive a high priority in the 110th Congress. This proposed legislation is consistent with the Committee's view of the long-term future needs of NSE education, and the Committee supports its enactment.

Finally, the Committee recommends that federal agencies requiring university-based NSE research (including DOE/NE, DOE/NNSA, etc.) continue their efforts to include universities in their mission-driven programs. Often, this should include separate solicitations for university involvement so that direct competition with national laboratory researchers does not occur. In addition, national laboratories should aggressively reach out to university NSE programs to augment their unclassified research efforts as well as to provide easier access to the future laboratory NSE workforce.

RECOMMENDED STRUCTURE OF FUTURE DOE/NE UNIVERSITY PROGRAM

The university community, nuclear industry and national laboratories have each expressed deep concern over the proposed cancellation of the DOE/NE university program. The DOE responded by convening a group of university, national laboratory, and industry leaders in October 2006 to discuss new directions for university programs and develop the conceptual framework for a new DOE university NSE program. Many of the ideas of this workshop are consistent with the views of the Committee and are endorsed by it. We refer to the results of this workshop as the "Chicago Framework."

Figure 3: NSE Workforce Drivers



Participants in the workshop generally agreed that the overarching goals of the DOE NSE education program are to support the DOE missions, both current and long term, and to help prepare a highly educated, diverse workforce. As depicted in Fig. 3, demand for NSE graduates extends beyond nuclear energy and security into other areas such as nuclear medicine, food safety, environmental protection, and waste management.

Overall, the Chicago Framework would create a stronger research orientation and peer-review component for the program while maintaining essential support for an expanded NSE student population and properly equipped nuclear teaching/research facilities. Specifically, the separately funded university program should be research driven. It should include both mission-driven applied research and mission-relevant basic research. The new program should include peer-reviewed, multi-university, larger elements (partnerships) focused on larger research topics as well as smaller, principal investigator-driven elements. For the long term, the infrastructure (e.g., research reactors) must be kept strong. Such support should be included in the mission-relevant component of the research effort as appropriate. The effort also should include a fellowship/scholarship component. The program must be mindful of the need for inclusion of larger and smaller universities, including the important mission of serving historically underrepresented minority communities.

The Chicago workshop discussed at length various approaches that have been successful in other academic research enterprises by the NIH, NSF, and other parts of the DOE. The consensus was to follow (model the NSE program after) proven, successful models and processes used in other federally funded programs that support university research.

Examples include the following:

- NSF science technology centers or engineering research centers
- NSF materials research science and engineering centers
- DOD multidisciplinary university research initiatives
- DOE science centers under the Office of Basic Energy Science
- DOE Nuclear Energy Research Initiative research program and single investigator Nuclear Engineering Education Research program.

The workshop developed an overall structure that would provide a wide range of flexibility for various university teams as well as individual investigators. A broad set of guidelines was developed, but it was felt that details would be developed via input from future DOE research workshops. Two general funding models emerged as consensus paradigms for the future.

1. NSE Research Partnerships would have many, if not all, of the following attributes:

- DOE mission focused (could address nearer- or longer-term needs)
- long-term funding profile (nominally 5 years renewable)
- support the needed research infrastructure, education, outreach, minority-serving institutions
- student support (research assistantship, student fellowships)
- national laboratory involvement (highly desirable)
- encourage industrial collaboration (flexible matching funds)
- allow for seed research projects
- multi-institutional and can be interdisciplinary in nature
- average award amount $1 million to $2 million/year.

2. Single institution/investigator projects would have many, if not all, of the following attributes:

- addresses key DOE research needs relative to key programs
- short-term funding (nominally 3 years and renewable)
- support the needed research infrastructure
- allow for young investigator awards based on research topics
- involve innovative as well as basic research topics
- could involve investigators at other institutions
- average award amount $100,000 to $300,000/year.

GOALS AND METRICS FOR FUTURE DOE/NE UNIVERSITY PROGRAM

The overarching goals of the DOE NSE education program are to support the DOE missions, both current and long term, and to prepare a highly trained, diverse workforce to meet the nation's energy and security needs along with needs related to other applications of NSE including nuclear medicine, food preservation, environmental protection, and waste management. However, the DOE has not succeeded in defining an appropriate set of metrics and milestones for the program as part of its responsibilities under the Government Performance and Results Act. The Committee has developed some suggested outcome/output metrics that the DOE should consider using in the future and recommends that the DOE review its goals for this program on a regular basis in order to maintain continuous improvement and sustained, long-term excellence.

Goal 1. Address critical DOE mission needs, both current and long-term: If university research programs are to provide continuing and effective support of DOE missions, they need to maintain core competencies and state-of-the-art facilities. The core competencies and facilities should be developed with the flexibility required to support not only the current DOE missions but also those that could evolve as national priorities or external threats change. In a rapidly changing world, there is not time for researchers to develop a new area of expertise or to build new facilities to meet each new challenge. In addition, to ensure that the university research programs remain well aligned with the DOE missions, partnerships between university programs and national laboratories should be sustained. Although in the near term, DOE/NE mission needs should be paramount, as funding for the program increases, the needs of other DOE mission offices should be considered as well. Suggested metrics to assess both short- and long-term success in meeting this goal are provided.

> *Metric 1A.* Demonstrate a flexible, robust, long-term model for university research in support of DOE missions. Establish the program immediately, revise it as necessary (with guidance from results of periodic assessments), and have an efficient, effective program in place within 5 years (long term).
>
> *Metric 1B.* Hold annual workshops for university researchers to discuss short- and long-term DOE missions and specific needs for university support of those missions. Publish proceedings of the workshops. Issue Requests for Proposals (RFPs), review proposals, and make awards on a competitive basis (annual).
>
> *Metric 1C.* Ensure that research projects and partnerships supply deliverables on time and that the results impact technology development of importance to current or potential future DOE missions (annual).
>
> *Metric 1D.* DOE mission program managers conduct periodic (~3-year) reviews of university research programs to identify gaps between results of those programs and mission needs. Results of the gap analysis will be considered when plans are developed for the annual workshop for

university researchers (see Metric 1B).

Metric 1E. Identify successful university partnerships with national laboratories and industry and build or strengthen other such partnerships based on the lessons learned from the successful ones (long term).

Goal 2. Address workforce needs for all nuclear sectors (industry, national laboratories, universities, and government agencies—federal, state, and local—along with the organizations they oversee): The demand for professionals well versed in nuclear technologies is growing rapidly. These professionals are needed throughout the U.S. government (e.g., DOE, NRC, EPA, NASA, Defense Intelligence Agency, and DHS) as well as in the nuclear power industry, nuclear medicine, and other related organizations. Training of sufficient numbers of these professionals is critical to national security, energy security, and public health and safety. Metrics for Goal 2 are designed to measure success in preparing adequate numbers of these professionals.

Metric 2A. Monitor the number of students enrolled in university NSE programs and ensure that the DOE NSE education program support levels are sufficient to provide the number of graduates per year over the next several years sufficient to meet the needs of all nuclear sectors (long term).

Metric 2B. Study demographics of university NSE programs and include language in the RFPs that encourages the workforce diversity required by all nuclear sectors (long term).

Metric 2C. Verify that a large fraction of each year's graduates from university NSE programs is employed in the nuclear sectors identified in Goal 2 (annual).

Metric 2D. Conduct periodic (e.g., 3-year) surveys to ensure that graduates have the skills nuclear sector employers require.

Metric 2E. Monitor the NSE education infrastructure and provide funding support as required (e.g., research reactors) to ensure the strength of the capability to support education in the long run.

SUMMARY OF COMMITTEE RECOMMENDATIONS

Recommendation #1: The DOE should undertake a detailed NSE workforce demand survey.

As part of its NSE stewardship responsibility, the DOE must continually monitor the demand and supply of NSE personnel in the country. This is especially important given the significant demand for NSE talent to serve as employees of the federal government and its contractors (e.g., national laboratories). It is clear that there is presently a paucity of reliable data on the aggregate demand for NSE professionals, especially at the graduate and postgraduate levels. While the NEI has done a commendable job in aggregating demand estimates for future industry workforce needs, especially in the area of undergraduate and technical degrees, we could find no comprehensive assessment of the needs among the relevant federal agencies (DOE, DOD, NRC, NNSA, U.S. Navy, DHS, NIH, and national laboratories). The Committee is especially concerned that these agencies will have an intense need for masters and doctoral NSE graduates as efforts to develop advanced nuclear fuel recycling technologies, advanced reactor designs, and next-generation nuclear detection equipment accelerate in the coming years.

Therefore, the Committee recommends that the DOE undertake comprehensive, ongoing assessments of future aggregated NSE workforce demand. This survey should include all levels of postsecondary education and all nuclear-related employment sectors. However, because advanced NSE-related masters and doctoral programs are particularly "demand insensitive" and vulnerable to the harm induced by federal funding uncertainty, the DOE should pay particular attention to the demand for advanced degree graduates, especially in federal "customer" agencies. The Committee also believes that while the DOE is uniquely positioned to coordinate such a survey, it will likely have to bring in outside experts for data gathering and analysis activities.

Recommendation #2: The DOE should revise the current university program along the lines of what has been envisioned in the "Chicago Framework."

The DOE responded to the contretemps over its proposed cancellation of the DOE/NE university program by convening a group of university, national laboratory, and industry leaders to develop the conceptual underpinnings of a new DOE university NSE program. This framework seeks to create a stronger peer-reviewed, research-oriented program, while maintaining essential support for an expanded U.S. NSE student population and properly equipped nuclear teaching/research facilities.

While the critical task of migrating this framework into a workable program remains undone, the Committee believes the overall approach is sound. The Committee urges Congress and the DOE not only to move forward with its implementation but also to ensure that DOE program managers are given sufficient flexibility to make ongoing refinements in order to address emerging unforeseen issues. The Committee also believes that full participation of the proposed Interagency Working Group in program transition and solicitation development activities is absolutely essential to ensure that the "end-user community" needs are well represented.

Finally, the Committee urges the DOE to approach the task of transition with great care. While the new programmatic structure promises to bring a more outcome-oriented approach to funding research, education, and infrastructure at university-based NSE programs, the DOE must resist the impulse to rush the changeover in FY 2007. The Committee believes that a more deliberate pace—with transition activities complete in FY 2008—is prudent and advised.

Recommendation #3: Congress should retain a separate account line for the DOE/NE university program.

As a result of DOE's proposed termination of the DOE/NE university program, some have suggested that funding be provided by creating a set-aside in DOE/NE's main research programs (Advanced Fuel Cycle Initiative, GNEP, etc.), funded by a tax on programs, and eliminating the separate University Reactor Infrastructure and Education Assistance program in the Energy and Water Appropriations Bill. While such a move has advantages, it would not serve the long-term interests of the DOE, other national users, or the universities.

The Committee supports a modified, competitive university program that has a near-term research component, a long-term research component, a long-term infrastructure support component, and a fellowship/scholarship component. These components would be embedded in larger partnerships as well as smaller single investigator projects. The research components should meet the programmatic needs of DOE/NE and, with increased funding, meet the needs of other offices that are customers of NSE research products (e.g., DOE/NNSA).

However, because of the stewardship responsibilities discussed in this report, the NSE university program must be balanced, comprehensive, and enduring, arguing for consistent funding. The Committee firmly believes that Congress should retain funding for DOE/NE through a separate budget line in the Energy and Water Appropriations Bill.

Recommendation #4: Congress should fund DOE/NE university programs at the level authorized under the Energy Policy Act of 2005.

For the last three fiscal years, Congress has provided $24 million to $27 million in funding for DOE/NE university programs. This funding has been sufficient to maintain the current program. However, as the nuclear enterprise grows and the needs of other agencies (e.g., DOE/NNSA) for NSE human resources and university-based research are considered, the program funding must increase. The Committee notes that the Energy Policy Act authorized $50.1 million in FY 2008 and $56 million in FY 2009 for DOE/NE university programs, which is significantly higher than the current appropriations level. The Committee believes the levels in this Act are appropriate. Additional funding will eventually be needed for the NSE university programs to be responsive to the needs of other offices and agencies (e.g., DOE/NNSA).

Recommendation #5: Congress should enact and fully fund the DOE Office of Science–administered "Nuclear Science Education" program included in S. 2197, the PACE-Energy Act, and S. 3936, the National Innovation Competitiveness Act.

This act, which was considered by Congress in 2006, should be reconsidered in 2007. As discussed in the body of this report, the proposed program would strengthen long-term federal support of NSE in a manner consistent with the Atomic Energy Act. The funding authorization included in the PACE-Energy Act would increase overall program funding from $20 million in FY 2008 to $50 million in FY 2011. In addition, by placing the program in the DOE/SC, it provides an organizationally neutral location, better meeting the needs of the many consumers of NSE research and human resources. The Committee also notes that this program would complement the existing DOE/NE program and is not designed to replace it.

Recommendation #6: The DOE should establish an interagency working goup on NSE that provides high-level guidance on the overall structure of NSE university programs and the technical thrusts of their solicitations.

The NSE education program must support the needs of the wide range of "consumers" of NSE graduates and must, as additional funds become available, address NSE research needs broader than those of DOE/NE. Therefore, it is critically important that the federal agencies who are "consumers" of NSE graduates have a more formalized role in highlighting future NSE numerical workforce needs and specific skill set requirements. As such, as soon as practical, the Committee recommends establishing a DOE intra-agency committee to coordinate the research and education needs across DOE offices (e.g., DOE/NE, DOE/NNSA, DOE/OCRWM, etc.). In the longer term, the Committee recommends the creation of an interagency working group on NSE research, education, and workforce development. This working group would inform DOE/NE university program solicitations to ensure that the scope and nature of government-wide technical workforce (and, eventually, research) needs are being adequately addressed. It would also help coordinate the federal government's responsible portion of the NSE workforce survey outlined in Recommendation #2. Finally, the working group would serve as a hub in coordinating the technical thrusts of the various NSE-related expenditures in other federal agencies, so that the overall federal investment in NSE is properly targeted. DOE/NE will become the steward of industry and university needs in this process.

The Committee is aware of several such groups operating in other areas of government, including the Interagency Working Group on Nano-Science, Engineering and Technology, and believes at this juncture that the DOE could convene such a group without specific legislative authorization.

1. "Atomic Energy Act," U.S. Government (1946).
2. "Energy Policy Act of 2005," U.S. Government (2005).
3. "NEI 2005 Workforce Survey," Nuclear Energy Institute (2005).

APPENDIX A. COMMITTEE CHARGE / MEMBERSHIP

Committee Charge

"The Special Committee on Federal Investment in Nuclear Education is charged with developing a conceptual framework for future federal investments in nuclear science and engineering education. The Committee shall review current U.S. Department of Energy (DOE) programs aimed at educating the next generation workforce; make recommendations on the optimal programmatic structure of these programs; and, propose a set of appropriate metrics by which they can be evaluated for effectiveness. The Committee shall submit a written report to the ANS President no later than December 13, 2006."

Committee Membership

Warren "Pete" Miller *Chair*	Research Professor and Associate Director, Nuclear Security Science and Policy Institute, Texas A&M University, Los Alamos National Laboratory (Retired)
Denis Beller	Research Professor, Materials and Nuclear Engineering Program, University of Nevada, Las Vegas
Michael Corradini	Chair, Engineering Physics, University of Wisconsin
James Duderstadt	President Emeritus, University Professor of Science and Engineering, The University of Michigan
Audeen Fentiman	Associate Dean of Engineering for Graduate Education, Professor of Nuclear Engineering, Purdue University
Marvin Fertel	Chief Nuclear Officer, Nuclear Energy Institute
Andrew C. Klein	Director, Education, Training and Research Partnerships, Idaho National Laboratory
Craig H. Piercy *Staff Liaison*	Washington Representative, American Nuclear Society

APPENDIX B. TABLE OF ACRONYMS

AAAS	American Association for the Advancement of Science
AEC	U.S. Atomic Energy Commission
ANS	American Nuclear Society
BS	Bachelor of Science (degree)
DHS	U.S. Department of Homeland Security
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/NE	DOE Office of Nuclear Energy
DOE/SC	DOE Office of Science
EPA	U.S. Environmental Protection Agency
GNEP	Global Nuclear Energy Partnership
NASA	National Aeronautics and Space Administration
NEI	Nuclear Energy Institute
NIH	National Institutes of Health
NNSA	National Nuclear Security Administration
NRC	U.S. Nuclear Regulatory Commission
NSE	nuclear science and engineering
NSF	National Science Foundation
OCRWM	Office of Commercial Radioactive Waste Management
R&D	research and development
RFP	Request for Proposal
TRTR	National Organization of Test, Research, and Training Reactors

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Options

Expiration Date:	None
Priority:	Standard
ReplyRequested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard

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Message is eligible for Junk Mail handling
This message was not classified as Junk Mail

Junk Mail settings when this message was delivered
Junk Mail handling disabled by User
Junk Mail handling disabled by Administrator
Junk List is not enabled
Junk Mail using personal address books is not enabled
Block List is not enabled