May 16, 2016

The Honorable Harold Rogers
Chairman, Committee on Appropriations
United States House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

On behalf of the U.S. Nuclear Regulatory Commission (NRC), I am providing the enclosed report on the Integrated University Program (IUP) in response to the request in the Joint Explanatory Statement accompanying the Consolidated and Further Continuing Appropriations Act, 2015 (Public Law 113-235). In particular, the Joint Explanatory Statement stated that: the NRC, "in consultation with the Department of Energy's Office of Nuclear Energy and industry, is directed to review the Integrated University Program with regard to its effectiveness and recommend any changes necessary to maintain its efficacy in ensuring that the Nation continues to have a sufficient nuclear workforce. The study should include any specialized areas that may require training beyond that which is necessary for the general nuclear workforce."

Please feel free to contact me or Eugene Dacus, Director of the Office of Congressional Affairs, at (301) 415-1776, if you have questions or need more information.

Sincerely,

/RA/

Stephen G. Burns

Enclosure:
As stated

cc: Representative Nita Lowey

<u>Identical letter sent to</u>:

The Honorable Harold Rogers
Chairman, Committee on Appropriations
United States House of Representatives
Washington, DC 20515
cc: Representative Nita Lowey

The Honorable Thad Cochran
Chairman, Committee on Appropriations
United States Senate
Washington, DC 20510
cc: Senator Barbara Mikulski

REPORT ON THE INTEGRATED UNIVERSITY PROGRAM

UNITED STATES NUCLEAR REGULATORY COMMISSION

Enclosure

I. Purpose

The Joint Explanatory Statement accompanying the Consolidated and Further Continuing Appropriations Act, 2015 (Public Law 113-235) stated:

> A recent report by the Department of Energy's Office of Nuclear Energy concluded that the nuclear energy workforce is more stable than it has been in several decades, noting that this is due in part to established programs that drive interest in the field. In light of current circumstances, the Nuclear Regulatory Commission, in consultation with the Department of Energy's Office of Nuclear Energy and industry, is directed to review the Integrated University Program with regard to its effectiveness and recommend any changes necessary to maintain its efficacy in ensuring that the Nation continues to have a sufficient nuclear workforce. The study should include any specialized areas that may require training beyond that which is necessary for the general nuclear workforce.[1]

In response to this language, the U.S. Nuclear Regulatory Commission (NRC) consulted with the Department of Energy's Office of Nuclear Energy (DOE-NE) and industry, reviewed the Integrated University Program (IUP) and prepared this report.

II. Background of the Integrated University Program

The Omnibus Appropriations Act, 2009 (Public Law 111-8) established the IUP between the NRC, DOE, and the National Nuclear Security Administration (NNSA).[2] The act authorized the appropriation of $45 million per year from fiscal year (FY) 2009 to FY 2019, with $15 million for each agency. Of that, $10 million is to be used for university research and development in areas relevant to the respective organization's mission and $5 million to support a jointly implemented Nuclear Science and Engineering Grant Program to fund multi-year research projects that do not align with programmatic missions but are critical to maintaining the discipline of nuclear science and engineering. After initial consultation, the three agencies decided that "jointly implemented" would be accomplished as a coordinated effort. Each agency would independently manage its own portion of the program, but coordination would be done to eliminate duplication or overlaps, and to ensure coverage of nuclear science, engineering, and related technical areas. Coordination is done through semi-annual meetings between the NRC, DOE, and NNSA.

The DOE portion of the IUP provides scholarship and fellowship grants to support training of engineers and scientists in nuclear engineering, nonproliferation, and nuclear safeguards missions. The objective of the program is to sustain a future workforce for nuclear engineering research and development.

The NNSA portion of the IUP supports basic research of direct impact to proliferation detection mission requirements. It bridges the nuclear nonproliferation knowledge bases in academia and

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[1] 160 CONG. REC. H9307, H9722 (daily ed. Dec. 11, 2014).

[2] The previous year, in FY 2008, $15 million was shifted from DOE to the NRC to administer grant programs for faculty development, fellowships, and scholarships, including scholarships to trade schools and community colleges.

the NNSA laboratory system and provides a source of trained nuclear nonproliferation technical expertise for the NNSA laboratory system.

III. The NRC's IUP Grant Program

The NRC's IUP is comprised of three programs: (1) faculty development, (2) scholarships and fellowships to 4-year institutions, and (3) scholarships to trade schools and community colleges.

Faculty Development

Funding under this program supports tenure track faculty members during the first 6 years of their careers and new faculty hires in fields related to nuclear energy, such as engineering, health physics, radiochemistry, probabilistic risk analysis, and other academic areas. The program could include support for developing proposals for research and initiating or continuing research projects in their areas of expertise.

From 2009 through 2015, the NRC has funded over 90 individual faculty development grant awards, obligating more than $39 million that supported over 100 tenure track faculty.

Scholarships and Fellowships to 4-Year Institutions

Funding under this program includes support for education in nuclear science and engineering, to develop a workforce capable of supporting the design, construction, operation, and regulation of nuclear facilities and the safe handling of nuclear materials. The NRC awards grants directly to accredited U.S. institutions of higher education and not to individual students. Therefore, the institution is responsible for selecting the students. As a condition for receiving scholarships or fellowships, student recipients must demonstrate satisfactory academic progress in their fields of study, as determined by criteria contained in the funding opportunity announcement and as established by the NRC.

The nuclear-related disciplines supported by this funding are intended to benefit the nuclear sector broadly. Upon completion of the academic course of study for which the assistance was provided, student recipients are required by service agreement to engage in employment by the NRC for a period equal to the period for which assistance was provided. Section 243(c)(2) of the Atomic Energy Act of 1954, as amended, allows the NRC to establish criteria for the partial or total waiver or suspension of any obligation of service or payment incurred by a scholarship or fellowship student recipient. For scholarships and fellowships awarded under the IUP, the NRC has been directed by Congress to make generous use of the waiver.[3] The NRC exercises general use of the waiver by permitting employment in the nuclear industry as opposed to solely with the NRC. The NRC also reduced the amount of service time required as part of any service agreement (from at least 1 year of service for every year or partial year of assistance received to 6 months of service required for every year or partial year of assistance received). A narrower waiver of this requirement may be granted by the NRC to recipients in appropriate circumstances, such as those who provide documentation indicating they made a good-faith but unsuccessful effort to secure nuclear-related employment, experienced personal hardship, or began nuclear-related employment but were subsequently involuntarily separated other than for cause. Military service does not waive the service obligation, but service can be deferred for this reason.

[3] 153 CONG. REC. H15741, H15953 (daily ed. Dec. 17, 2007).

Most 4-year institutions have reported that scholarship and fellowship recipients have been successful in finding employment in the nuclear industry, Federal Government agencies (such as the NRC, DOE, or NNSA), national laboratories, State or local agencies, or academia in nuclear-related fields. The NRC has hired some of these recipients for the agency's own entry-level Nuclear Safety Professional Development Program (NSPDP), which is for recent graduates with a bachelor's, master's, or doctoral degree and strong academic records in nuclear-related disciplines that support the agency's mission. In FY 2015, 8 out of 25 (32 percent) of those hired for NSPDP were grant recipients; in FY 2014, 10 out of 38 (26 percent) were; and in FY 2013, 5 out of 25 (20 percent) received grants.

From 2009 through 2015, the NRC awarded 166 scholarship and fellowship awards to 4-year institutions, totaling over $47 million.

Trade School and Community College Scholarships

Funding under this program includes support for education in nuclear science and engineering, to develop a workforce capable of supporting the design, construction, operation, and regulation of nuclear facilities and the safe handling of nuclear materials. The NRC awards grants directly to accredited U.S. institutions and not to individual students. Therefore, the institution is responsible for selecting the students. As a condition for receiving trade school and community college scholarships, student recipients must demonstrate satisfactory academic progress in their fields of study, as determined by criteria contained in the funding opportunity announcement and as established by the NRC. Trade schools and community colleges must be post-secondary educational institutions or programs accredited by an accrediting agency or State approval agency recognized by the U.S. Secretary of Education or be registered apprenticeship programs. The nuclear-related disciplines supported by this funding are intended to benefit the nuclear sector broadly. As noted above under Scholarships and Fellowships to 4-Year Institutions, the same service agreement requirements apply to trade school and community college scholarships.

Consequently, the NRC requires student recipients of trade school and community college scholarships to serve 6 months in nuclear-related employment for each full or partial year of academic support. The employment may be with Federal agencies, State or local agencies, DOE laboratories, nuclear-related industry, or academia in the recipients' sponsored fields of study. A waiver of this requirement may be granted by the NRC to recipients in appropriate circumstances, such as those who provide documentation indicating a good-faith but unsuccessful effort to secure nuclear-related employment was made, experienced personal hardship, or began nuclear-related employment but were subsequently involuntarily separated other than for cause.

From 2009 through 2015, the NRC awarded 63 scholarship awards to trade schools and community colleges, totaling approximately $8 million.

IV. NRC Grant Evaluation

In 2014–2015, the NRC conducted an independent survey of its grant program. The survey evaluated all grantees receiving NRC funding during 2007–2011. Some key findings of the survey evaluation are summarized below.

Of the responding grantees, the top three challenges facing the nuclear workforce include: having the skilled workforce when needed (31.5 percent); aging workforce (28.2 percent); and reduced building of new nuclear power plants (21.8 percent).
Eighty percent of grantees believed that the NRC funding helped them to address future workforce needs.

Faculty Development

Approximately 50 percent of grantees indicated a focus area of the supported research in nuclear engineering. Over 80 percent responded that the funding supported research, the findings of which were published in peer-reviewed scientific journals. Responses indicated that over 200 articles were published.

Scholarships and Fellowships

The survey found that the top fields of study for scholarships were mechanical engineering, nuclear engineering, and electrical engineering. The top fields of study for fellowships were nuclear engineering, health physics, and mechanical engineering.

Approximately 90 percent of grantees that funded scholarships reported that it took less than 6 months for those students to gain relevant employment. Approximately 77 percent of grantees that funded fellowships reported that it took less than 3 months for students to gain relevant employment. The survey highlighted that 34 percent of these students achieved relevant employment before graduation.

Trade Schools and Community College Scholarships

The survey revealed that the top fields of study for trade schools and community college scholarships were maintenance technician, nonlicensed operator, and radiation protection technician. Further analysis discovered that more than 76 percent of NRC-supported students obtained a 2-year associate degree or certificate.

V. Nuclear Energy Institute Workforce Efforts

As the national policy organization for the U.S. nuclear industry, the Nuclear Energy Institute (NEI) represents over 350 member organizations, including utilities, suppliers, architect firms, and academic institutions. NEI and the nuclear industry share common interests by ensuring the next generation of nuclear craft workforce are well trained to meet the demands of the industry.

In 2015, NEI conducted its annual Nuclear Workforce Survey, collecting information from nuclear utilities on the status of the nuclear industry workforce, including demographics, hiring, education trends, and specialized areas of need with respect to nuclear-technology-related or nuclear-craft-related areas.

The survey found a rise in the number of workers being hired from the 28 to 32 and 33 to 37 year-old cohorts, while the number of employees in the 48 to 57 year-old group continued to decline. This trend is true across the commercial nuclear industry, among both nuclear utilities and nuclear suppliers, each of which comprises about 50 percent of the commercial nuclear sector workforce. The survey represented 100 percent of the industry's 23 nuclear utilities, as well as nine major supplier companies. With the closure of five reactors in the past few years,

there has been a decline in overall utility staffing levels, from about 62,000 in 2013 to about 57,000 in 2015. However, nuclear utility companies continue to hire new workers to staff operating reactors. The industry has particularly succeeded in balancing the workforce in the utilities' operations departments, where the age distribution is relatively flat, with a slight increase because of younger operators-in-training and a slight dip in mid-career professionals who are filling leadership positions in other departments. The overall result is a "sustainable, healthy pipeline" of nuclear operators, according to NEI's Senior Manager for Strategic Workforce Planning.

NEI's Nuclear Uniform Curriculum Program (NUCP) addresses nuclear tradecraft workforce needs by working with the nuclear industry, community colleges, and trade schools to establish regional training programs with an emphasis on addressing regulatory utility needs. Many of NUCP institutions receive support through the NRC trade school and community college scholarship program. The South Texas Project Nuclear Operating Company (STPNOC) reported a significant impact of the NRC trade school and community college scholarship program, coupled with NEI's NUCP. As part of its ongoing workforce development efforts, STPNOC recently brought on board 24 entry-level apprentices. Some of the new employees were part of the NRC trade school and community college scholarship program. This update provides further evidence that the NRC's and nuclear industry's efforts to build a pipeline of knowledgeable candidates ready to work in the nuclear industry are providing a return on investment.

Coincidentally, NUCP institutions indicate that the scholarships received have stimulated the local economy as individuals graduating from these 2-year institutions obtain well-paid jobs in nuclear-related fields. The NRC trade school and community college scholarship program has local and national impacts in providing the workforce needed over the next several years to meet existing demand in the nuclear sector.

VI. Oak Ridge Institute for Science and Education Data

Oak Ridge Institute for Science and Education (ORISE) collects data on enrollments and degrees in science and technology fields of study for the NRC and other Federal agencies. For purposes of this report, the NRC reviewed ORISE nuclear engineering and health physics enrollment and degree data from 2009–2014. The ORISE report entitled, "Nuclear Engineering Enrollments and Degrees Survey, 2014 Data," includes degrees granted between September 1, 2013, and August 31, 2014. It can be noted that, since the establishment of the IUP in 2009, the number of degrees granted in nuclear engineering has increased overall.

Nuclear Engineering Degree Data

The information in the table below is from this ORISE report.

Nuclear Engineering Degrees				
Year	**B.S.**	**M.S.**	**Ph.D.**	**Total**
2014	627	322	169	1118
2013	655	362	147	1164
2012	610	333	119	1062
2011	524	277	113	914
2010	443	303	113	859
2009	395	233	87	715

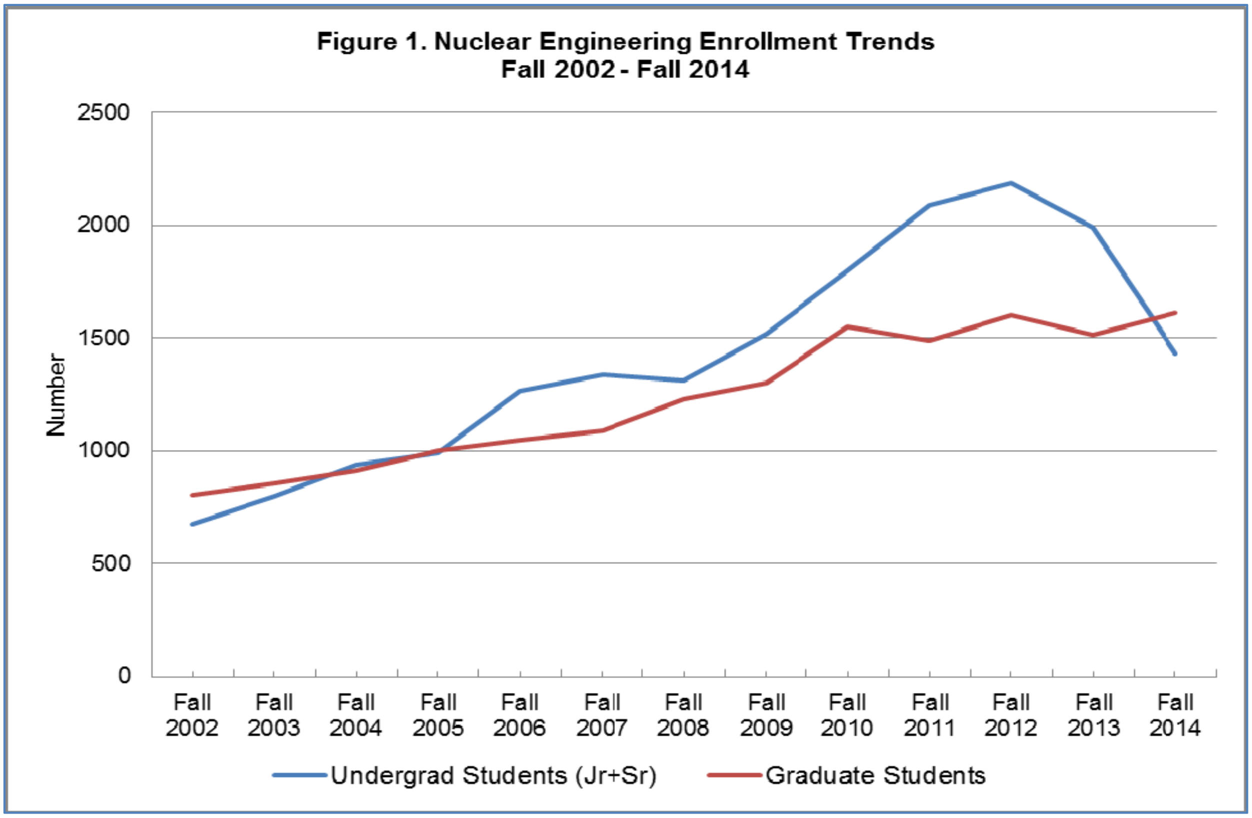
According to the report, 627 students received Bachelor of Science degrees (B.S.) with majors in nuclear engineering in 2014—a 4-percent decrease from 2013. However, the number of B.S. degrees reported in 2014 is significantly greater—nearly 60 percent more—than the number reported in 2009. Despite the ORISE data showing a decrease from 2013 to 2014, the numbers remained at a relatively high level comparatively.

The report also indicated 322 students received master's degrees (M.S.) with majors in nuclear engineering in 2014—an 11 percent decrease from 2013. However, the number of M.S. degrees reported in 2014 increased by 38 percent more than the number reported in 2009, when the IUP was established. The number of doctorate degrees (Ph.D.) has consistently increased considerably, up 95 percent since 2009.

Currently, the annual supply of new nuclear engineering graduates available in the labor market is approximately in balance with the annual number of job openings available for new nuclear engineers, including opportunities for nuclear engineering graduates in non-nuclear engineering occupations. The major consideration over the next few years is the future rate of development of nuclear electric power in the United States and abroad, along with attrition rates of currently employed nuclear engineers and growth in opportunities in health care and the broader economy. There is growing concern that increased job opportunities for nuclear engineering graduates in non-nuclear engineering occupations in the broader economy, coupled with lower total enrollments in nuclear engineering degree programs, could potentially create an imbalance between the supply of new graduates and the number of job openings.

Nuclear Engineering Enrollment Trends

From 2009 to 2012, the enrollment of junior and senior nuclear engineering undergraduates has increased noticeably. Although trends show an apparent decline since 2012, levels appear similar to 2009. Fueling this likely trend is the report of declines from three out of every four nuclear departments surveyed. Graduate enrollment in nuclear engineering has increased and remains at a relatively high level.



<u>Health Physics Degree Data</u>

The ORISE report titled "Health Physics Enrollments and Degrees Survey, 2014 Data," includes degrees granted between September 1, 2013, and August 31, 2014. The information in the table below is from this ORISE report.

Health Physics Degrees				
Year	**B.S.**	**M.S.**	**Ph.D.**	**Total**
2014	67	81	10	158
2013	88	86	14	188
2012	82	91	15	188
2011	64	85	5	154
2010	62	89	15	166
2009	77	83	9	169

In 2014, the number of health physics degrees granted was 12 percent below the reported number from 2009. The M.S. degrees are 2-percent lower, with a slight increase in Ph.D. degrees. It is suspected the decreases could be attributed to closure of health physics programs.

It is likely that the number of job openings for new graduate health physicists will continue to exceed the number of new graduates available in the labor support through 2016. Relatively ample job opportunities and increasing entry-level salaries for health physicists over the next

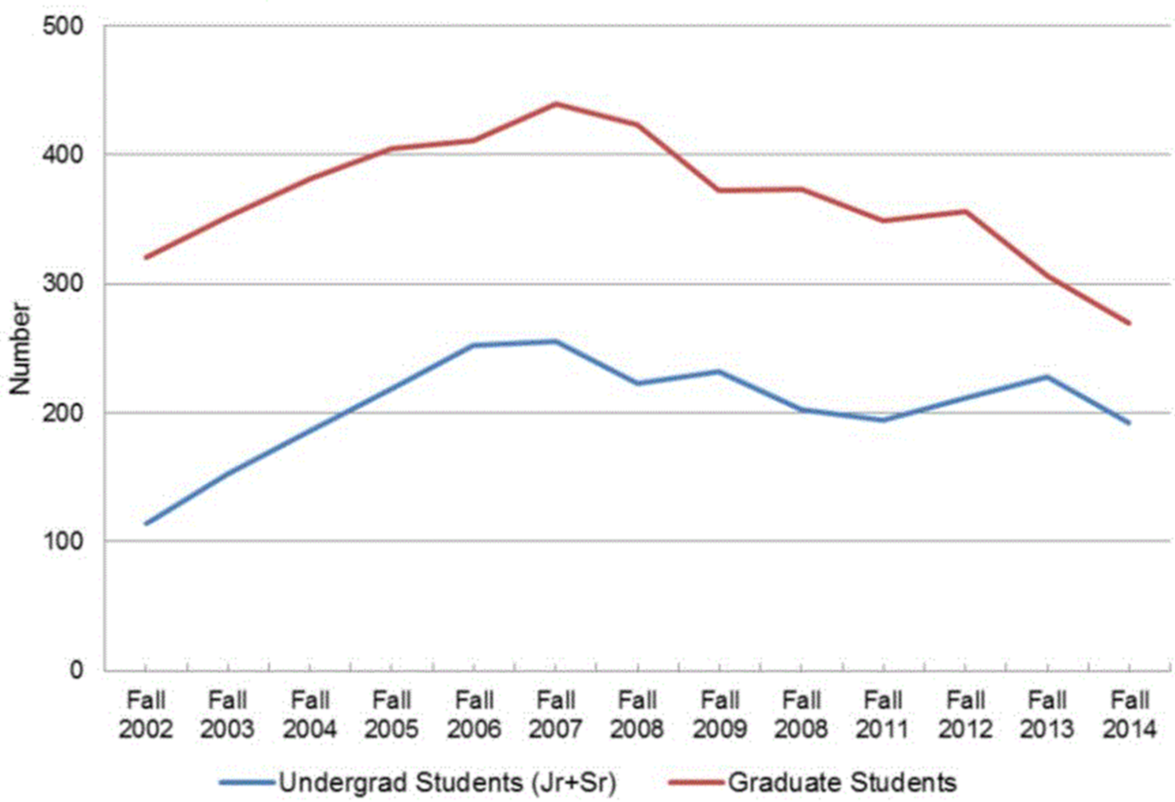
2 years could stimulate an increase in health physics enrollments and further increase the number of bachelor's degree graduates and, to a lesser extent, the number of master's degree graduates. Based on historical experience, however, it appears quite unlikely that any increase in the number enrolled would be sufficient in size to cause an oversupply of new health physics graduates available in the labor market over the next 3 years.

Health Physics Enrollment Trends

In 2014, the enrollment of junior and senior health physics undergraduates was approximately 190, which is a 16-percent decrease from 2013 and a 9-percent decrease from 2012. The 2014 number is considerably lower than it was in 2009. The undergraduate enrollment decrease in 2014 indicates that the number of B.S. degrees is likely to continue at the same level through 2015 and then will continue to fall in 2016.

Graduate enrollment in 2014 was 270 students. This is nearly 12-percent lower than in 2013 and 24-percent lower than in 2012. The 2014 graduate enrollment is the lowest reported since the early 1970s. The enrollment trends indicate that the number of M.S. degrees is likely to be in the 65 to 75 range in 2015 and 2016, while the number of Ph.D. degrees is likely to be in the 5 to 10 range in 2015 and 2016. As with undergraduate health physics degrees, it is suspected that the decrease in enrollments could be attributed to closure of health physics programs.

Figure 2. Health Physics Enrollments Trends
Fall 2002 - Fall 2014



VII. Specialized Technical Areas

Over the last few years, the NRC, DOE and NEI have concluded that radiochemistry, seismology, and health physics are specialized technical areas that will require training beyond that which is necessary for the general nuclear workforce. DOE and the NRC have coordinated efforts to address these areas. As additional areas are identified, the agencies will coordinate to determine ways to address the needs of the nuclear industry.

Radiochemistry

There is a need to ensure a sufficient workforce in specialized technical areas, such as radiochemistry. DOE has mission-specific/mission-critical workforce needs in the area of radiochemistry. Given that the current radiochemistry workforce is approaching the age for retirement and that a limited number of universities in the United States provide radiochemistry curriculum because of a lack of professors and infrastructure, the U.S. is faced with a growing demand for the education and training of scientists in radiochemistry. The DOE national laboratories are all losing capability because of retirement of a substantial number of their "core" groups of radiochemists and nuclear chemists. Complementary to but completely separate from IUP, the requested FY 2016 DOE traineeship in radiochemistry will seek to provide graduate-level radiochemistry training to a small cadre of selected students with the goal of establishing an enduring curriculum at the selected academic institution and associated partners. Radiochemistry is an area currently supported by the NRC and DOE IUP programs.

Seismology

The nuclear energy industry maintains seismic analyses for each nuclear facility. The analyses are conducted during the initial design, siting and licensing of the faculty and updated, as required, when changes are made to the facility.

Seismic analyses are typically conducted by experts who are employed at a handful of engineering consulting firms. Utilities do not employ these experts as full-time staff because the work is very specialized and the workload is not consistent enough to keep these people engaged full-time for their entire careers. These experts usually also work on non-energy and non-nuclear projects to ensure they maintain a consistent workload.

Many of the nation's seismic experts are approaching retirement and will not be available much longer to educate and mentor the next generation of seismic professionals. The industry needs structural engineers and seismologists with advanced degrees to take interest in energy-facility seismic analysis to gain the experience to replace the experts who are about to retire.

The nuclear industry would benefit from assistance in developing additional expertise in this area. The NRC has included seismology as a focus area in its FY 2016 Funding Opportunity Announcement.

Health Physics

Health physics is a discipline that intersects biology, engineering, physics, and mathematics and is practiced by health physicists (HPs) in the nuclear industry. The profession exists to ensure safe usage of radiation and radioactive materials in many different settings.

As discussed earlier, there are low numbers of HPs with B.S., M.S., or Ph.D. degrees graduating in the United States. It is highly likely that the number of job openings for new graduate HPs will continue to exceed the number of new graduates available.

HPs work at the NRC and other Federal Government agencies to perform licensing and registration functions; develop regulation guidance and policy; perform inspections and audits; write and review emergency plans; respond to radiological emergencies; assess accidents resulting from the misuse of radiation; evaluate new drugs and devices that use radiation; and develop and execute environmental monitoring and survey programs.

HPs are also employed by private entities, including power reactors, hospitals, universities, analytical laboratories, food and medical equipment sterilizers, environmental cleanup firms, and a variety of industrial firms.

Health physics is an area currently supported by the NRC and DOE–NE IUP programs.

VIII. Recommendations

There is one recommendation being proposed. Through program oversight, the recommendation is to allow the agency greater flexibility in the allocation of IUP funds between the two general purposes of these funds.

Consistent with prior years, the NRC's FY 2016 appropriations legislation provides:

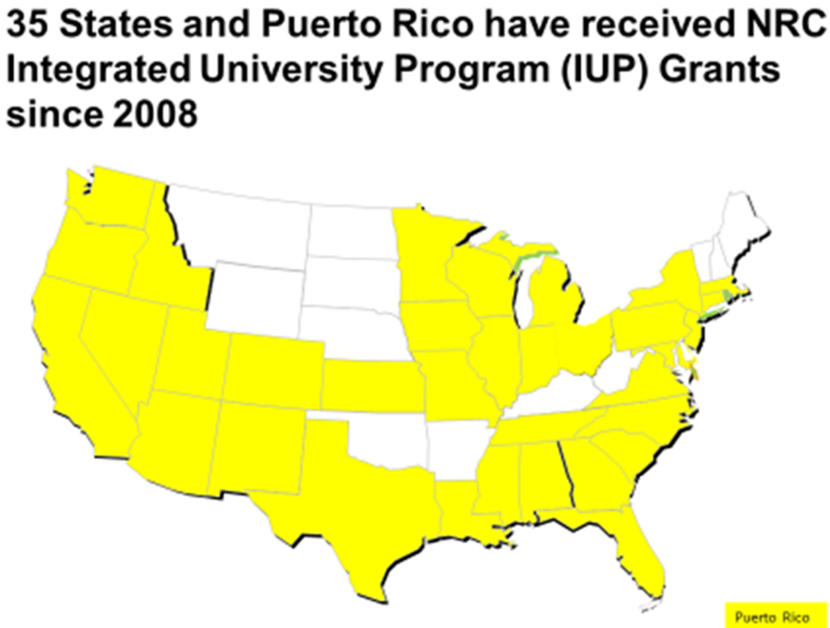
> *Provided further*, That of the amounts appropriated under this heading, $10,000,000 shall be for university research and development in areas relevant to their respective organization's mission, and $5,000,000 shall be for a Nuclear Science and Engineering Grant Program that will support multiyear projects that do not align with programmatic missions but are critical to maintaining the disciplines of nuclear science and engineering.

The Joint Explanatory Statement associated with the NRC's FY 2016 appropriations legislation specifies that "Not less than $5,000,000 of this amount is to be used for grants to support research projects that do not align with programmatic missions but are critical to maintaining the discipline of nuclear science and engineering."[4] The IUP could benefit from the flexibility to adjust the allocation of the $15 million between the two programs if the agency receives an insufficient number of quality proposals under one of the two programs and an excess number of quality proposals under the other.

[4] 161 CONG. REC. H9693, H10124 (daily ed. Dec. 17, 2015).

IX. Conclusion

To date, 326 individual IUP grants have been awarded in 35 states and Puerto Rico. Cumulatively, this translates to over 2,300 students supported by scholarship or fellowship grants, and more than 100 faculty members supported to advance their research and teaching capabilities at educational institutions around the Nation.



The IUP has allowed for excellent working relationships with educational institutions and for new nuclear programs to begin. In addition, it has helped to ensure that the United States maintains a highly trained and educated workforce in nuclear science, technology, and engineering fields from which it may draw upon for future workforce development needs. The NRC also has authority to “appoint directly, with no further competition, public notice, or consideration of any other potential candidate an individual who” has received a scholarship or fellowship and those individuals who completed the academic program for which the scholarship or fellowship was awarded.[5] The NRC has used this authority through its grant programs, providing a number of direct appointments over the past few years under its entry-level NSPDP.

The NRC funding has been heavily leveraged with non–Federal Government funding in public–private partnerships, including utilities, vendors, States, and universities, thus providing a multiplier effect of the NRC's $15 million. The United States’ ability to graduate students with nuclear degrees is directly correlated to the number of education programs available to educate these students. Without Federal funding, history has shown that the non-Federal funding will diminish along with student enrollments in areas related to science, technology, engineering, and math. This was evidenced multiple times. When funding began to decline in the 1990s, nuclear engineering programs and research reactors both began to close. The number of

[5] 42 U.S.C. § 2015b.

university programs that train nuclear students declined from 87 in 1990 to 37 in 2001. The number of university research reactors declined from 64 in the 1960s, to 27 in 2002. Government's support for these programs is necessary to keep these programs viable.

Educating the next generation of engineers and scientists is essential to meet the Nation's present and future national security needs and for building new, and maintaining existing, nuclear power plants that provide a safe, nonpolluting domestic energy source.

Specialized areas such as radiochemistry, seismology, and health physics may require training beyond that which is necessary for the general nuclear workforce. The nuclear energy industry is only a small segment of the potential employer pool for these specialties, but these specialties are necessary and vital to maintain nuclear facilities.