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Before the
Subcommittee on Energy and Water Development, and Related Agencies
Committee on Appropriations
U.S. House of Representatives

March 14, 2013

The United States, like all countries, shares the challenges associated with ensuring its people have access to affordable, abundant, and environmentally friendly sources of energy. President Obama continues to make addressing climate change a priority and the Administration has set a goal of reducing carbon emissions by 80 percent by 2050. Nuclear power can play an important role in achieving this goal. As the President noted in Korea last Spring, "in the United States, we've restarted our nuclear industry as part of a comprehensive strategy to develop every energy source."

Nuclear power has reliably and economically contributed almost 20 percent of electrical generation in the U.S. over the past two decades. It remains the United States' single largest contributor (more than 60 percent) of non-greenhouse-gas-emitting electric power generation. Currently, we have five commercial nuclear reactors under construction, including four AP1000 reactors, which represent a new generation of passively safe nuclear plants.

The Office of Nuclear Energy (NE) has achieved several major milestones since I've last been in front of this Committee. In November of last year, the Department selected a small modular reactor (SMR) vendor and utility partnership to support development of the licensing documentation that would enable SMR deployment by 2022. Just this week, the Department issued a second solicitation that will support industry's development of additional innovative and competitive SMR technology options that improve safety profiles and further reduce regulatory risk for these reactors.

In January of this year, the Department released the Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste. The Strategy builds upon the final report and recommendations made by the Blue Ribbon Commission on America's Nuclear Future and serves as an initial basis for discussions among the Administration, Congress and other stakeholders on a sustainable path forward for disposal of nuclear waste.

To ensure that nuclear energy remains a viable energy option for the nation, NE supports research and development activities which are designed to help resolve the technical, cost, safety, waste management, proliferation resistance, and security challenges of continued use of nuclear energy. NE has been well served by the federally chartered Nuclear Energy Advisory Committee (NEAC), chaired by Richard Meserve and Susan Eisenhower, along with esteemed representatives from universities, industry, foreign nationals, and national laboratories. NEAC reviews the elements of the NE program and provides advice and recommendations on the program's long-range plans, priorities, and strategies to effectively address the scientific and engineering aspects of the R&D efforts.

A prerequisite for nuclear power continuing as a vital part of the nation's clean energy portfolio is public confidence in the safety of nuclear plants and commercial confidence that the plants can be operated safely, reliably and economically. Our R&D efforts are coordinated with reactor vendors, utilities, universities, regulators and the international community to ensure that lessons learned from the events at Fukushima, Japan are appropriately incorporated and that these efforts are integrated and efficient.

SMR Licensing and Technical Support

The development of clean, affordable nuclear power options is a key element of NE's *Nuclear Energy Research and Development Roadmap.* As a part of this strategy, a high priority of the Department has been to accelerate the timelines for the commercialization and deployment of small modular reactor (SMR) technologies through the SMR Licensing Technical Support program. The program will focus on first-of-a-kind engineering support for design certification and licensing activities for SMR designs through cost-shared arrangements with industry partners (industry contributions are a minimum of 50% of the cost) to promote accelerated commercialization of the nascent technology. If industry chooses to widely deploy these technologies in the U.S., they could help meet the nation's economic, energy security and climate change goals.

In November 2012, the Department selected the Generation mPower team, comprised of Babcock & Wilcox, Bechtel, and the Tennessee Valley Authority (TVA) to support the development of licensing documentation that could lead to SMR deployment by 2022. DOE determined that the mPower team would be the most capable applicant to achieve program goals as well as gain insights to help address generic issues that will face the SMR class of reactors.

On March 11, 2013, the Department issued a second solicitation for proposals that include innovations to improve SMR safety, operations and economics through lower core damage frequencies, longer coping periods in the event of an accident, enhanced resistance to hazards presented by natural phenomena, and potentially reduced emergency preparedness zones or workforce requirements. This follow-on solicitation will be funded within the $452 million envelope for the SMR Licensing Technical Support program.

Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste

Finding a long-term, consent-based solution to managing the nation's nuclear waste and used nuclear fuel is a long standing challenge. Such a solution, however, is necessary to assure the future viability of an important carbon-free energy supply and further strengthen America's standing as a global leader on issues of nuclear safety and nonproliferation.

In FY 2010, the Secretary of Energy established the Blue Ribbon Commission on America's Nuclear Future (the Commission) composed of experts from government, academia and industry. The charter charged the Commission to conduct a "comprehensive review of policies for managing the back end of the nuclear fuel cycle, including all alternatives for the storage, processing, and disposal of civilian and defense used nuclear fuel, high-level waste, and materials derived from nuclear activities… [and to] provide advice, evaluate alternatives, and make recommendations for a new plan to address these issues." The Commission issued its final report on January 26, 2012.

In January 2013, the Department released its *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, which endorses key principles of the Commission's

report. With the appropriate authorizations from Congress, the Administration's Strategy lays out plans to implement a long-term program that begins operation of a pilot interim storage facility by 2021, advances toward the siting and licensing of a larger interim storage facility by 2025, and makes demonstrable progress on the siting and characterization of geologic repository sites. The Strategy fully endorses the need for a consent-based process for siting facilities in which jurisdictions are treated like partners and consent is obtained at multiple levels. The strategy highlights the need for a new waste management and disposal organization to provide the stability, focus, and credibility to build public trust and confidence. The Administration believes that there are several viable organizational models that can possess critical attributes such as autonomy, leadership continuity, and oversight and accountability. The Administration also recognizes that providing adequate and timely funding is critical to the success of the nuclear waste mission. The Strategy proposes a funding program that contains three critical elements: discretionary appropriations within existing spending caps to pay for specific, ongoing activities; reclassification of fee income or spending to make dedicated funds available in sufficient amounts without competing with other government priorities; and access to the existing balance of the Nuclear Waste Fund in the Treasury.

Full implementation of this program will require legislation to enable the timely deployment of the system elements noted above and the Administration is committed to working with Congress on this important issue. In the meantime, the Administration, through NE, is undertaking activities within existing Congressional authorization to plan for the eventual transportation, storage, and disposal of used nuclear fuel.

Reactor Concepts - Research, Development and Demonstration

The Reactor Concepts Research, Development and Demonstration (RD&D) program is designed to develop new and advanced reactor designs and technologies that enable improved competitiveness and safety to help advance nuclear power as a resource capable of meeting the Nation’s energy, environmental and national security needs. The R&D activities in this area include: advanced SMR approaches; other advanced reactor concepts such as sodium-cooled, fluoride salt-cooled, high temperature gas-cooled reactors; and advanced technologies to support life extensions of light water reactors (LWRs).

Small Modular Reactor Advanced Concepts R&D

The SMR Advanced Concepts R&D program is addressing instrumentation and controls, materials, safety and licensing issues that will offer more affordable and flexible nuclear technology options. In FY 13, NE has continued research on high temperature metals for SMR applications, commenced instrumentation and control research for multi-module systems, and initiated safety and licensing support R&D.

Advanced Reactor Concepts (ARC)

This program is designed to develop and refine future reactor concepts that could dramatically improve nuclear power performance including sustainability, economics, safety, and proliferation resistance. In support of our goal of seeking greater input from industry, NE established a Reactor Concepts Technical Review Panel (TRP) to inform the R&D prioritization process for the Advanced Reactor Concepts program. In response to a Request for Information issued in early 2012, NE received eight reactor concept submittals from vendors and just last month, NE issued a FOA to conduct cost-shared priority R&D identified through the TRP process. This year, ARC pursued testing of an ultra-sonic system for

under sodium viewing to support in-service inspection of sodium fast reactors, continued evaluation of liquid-metal engineering test capability, and commenced advanced power conversion system testing. The program has also continued to provide support for international collaborations on advanced reactor operations and safety.

Next Generation Nuclear Plant (NGNP)

The NGNP program is designed to investigate the technical viability of High Temperature Gas Reactor (HTGR) technology to provide more efficient carbon-free electricity and high-temperature process heat for a variety of industrial uses. After the October 2011 Secretarial Determination to not proceed with Phase 2 design activities, the NGNP program shifted to longer term R&D by focusing on materials and fuels testing. Through the NGNP program, we have continued irradiation testing of graphite materials and continued the qualification testing of TRISO fuel fabrication. The program also continued collaboration with the Nuclear Regulatory Commission (NRC) to develop a licensing framework. In January of this year, NE awarded a cost-shared contract to industry to understand industrial end-user requirements, and produce trade studies evaluating the integration of NGNP into various industrial applications.

Light Water Reactor Sustainability

Through NE's Light Water Reactor Sustainability program, which is closely coordinated with NRC and cost-shared with the Electric Power Research Institute, the Department is conducting R&D to explore extending the operating lifetime of current plants beyond 60 years and, where possible, enable further improvements in their safety and productivity. This research forms the technical basis for age-related material degradation management and informs major component refurbishment and replacement strategies related to instrumentation and control systems, improvement of fuels, and better safety margin characterization. The research also addresses post-Fukushima lessons learned focusing on research to enhance the accident tolerance and response of light water reactors. In FY 13, NE plans to publish a database on concrete performance in nuclear power plant environments and further improve component aging computer analysis tools.

DOE has utilized the Advanced Test Reactor (ATR) National Scientific User Facility (NSUF) to partner with the Electric Power Research Institute to investigate irradiation-assisted stress corrosion cracking in nuclear reactor core materials to ensure the sustainability of light water nuclear reactors well into the future. A series of experiments began last month which involve inserting the materials into the ATR core so they can be exposed to typical reactor conditions for a period of time. After irradiation in the ATR, the materials will then be sent to a specially designed testing apparatus at the Materials and Fuels Complex for post-irradiation examination.

Radiological Facilities Management

The Radiological Facilities Management (RFM) program maintains the nuclear facilities and infrastructure needed to support space mission requirements and research reactor programs.

NE works with NASA on the design and development of power systems. In August 2012, the nuclear-powered Curiosity Rover landed on Mars and is operating successfully for the Mars Science Laboratory mission. Curiosity, the largest and most capable rover ever sent to another planet, is powered by a Multi-Mission Radioisotope Thermoelectric Generator that was designed, built, and delivered by NE. NE

also made significant technical progress on the project to develop an Advanced Stirling Radioisotope Generator (ASRG) for future space exploration efforts. The ASRG will be the first radioisotope power system to use a dynamic power conversion system which will increase efficiency by four times, thereby extending availability of the limited supply of plutonium-238. NE is in the process of building hardware for the qualification unit as part of the process to demonstrate readiness for flight. In FY 2013, RFM's Plutonium-238 Supply Project designed, built, and irradiated its first test target in the High Flux Radioisotope Reactor at Oak Ridge National Laboratory. This represents a first significant step for the NE-managed, NASA-funded project to reestablish a reliable supply of plutonium-238 for powering future space exploration missions.

RFM's Research Reactor Infrastructure program provides fresh reactor fuel to, and removes used fuel from, 26 operating university reactors. FY 2013 efforts include delivering 29 fuel elements to the University of Missouri Research Reactor and to the Massachusetts Institute of Technology Nuclear Research Reactor, and completing five used fuel shipments to the Savannah River Site.

Fuel Cycle Technologies

The continued use of nuclear power will require a sustainable fuel cycle. R&D in fuel cycle technologies spans the range from finding more efficient methods of extracting uranium to techniques to improve waste management. NE has achieved several milestones in the area of Fuel Cycle Research and Development including: developing a catalog of fuel cycle options and proliferation and security evaluation criteria for the FY 2013 fuel cycle options screening; completing two independent relevancy reviews of major subprograms: Separations and Waste Forms and Advanced Fuels, with plans to complete the Material Protection, Accountability, and Control Technologies (MPACT) review this September; developing a roadmap for evaluating, developing, and deploying light water reactor fuels with enhanced accident tolerance; and completing initial testing of candidate adsorbent materials at marine facilities for extracting uranium from seawater.

Systems Integration and Analysis

Systems analysis and integration provides the capabilities needed to analyze complex fuel cycle system options, assess overall performance under various scenarios, and improve understanding of the interdependencies between subsystems and associated technologies. Hundreds of potential fuel cycle options exist within three broad fuel cycle strategies (once through, limited recycle, and full recycle). In FY 2013, NE is conducting an evaluation and screening of fuel cycle options to identify a relatively small number of those options that have the potential to offer significant performance benefits compared to the current fuel cycle. Improvements will be measured in terms of economic, environmental, safety, non-proliferation, security and sustainability requirements. These evaluations can be used to inform future research and development decisions.

Fuels with Enhanced Accident Tolerance

In the wake of the accident at Fukushima-Daiichi, NE is pursuing the development of fuel that could better tolerate the extreme conditions of severe accidents. NE's strategy starts with feasibility assessment and down-selection and moves into development and testing. In FY12 and FY13 the program is focused on evaluation studies of fuel and cladding concepts. In 2013 the program competitively selected over 25 concepts for evaluation and assessment. The program will develop high level screening criteria to evaluate which of the selected concepts are best positioned in terms of

technology maturity, economics, regulatory feasibility, and other factors in order to down-select to one or two designs for potential further development and testing, prior to commercial qualification. For NRC licensing of any new accident tolerant cladding or fuel, abnormal reactor transient tests must be performed to confirm fuel performance. Transient testing involves the irradiation of pre-commercial nuclear fuels under a rapid, high-energy pulse, and high power-level conditions. This testing is required to support a prototype lead test assembly for insertion into a commercial reactor. In FY2013, the Department is initiating an Environmental Assessment and finalizing alternatives to resume transient testing.

Seawater Extraction

Continuing and reliable supplies of uranium are critical to any future use of nuclear power. The oceans contain over 4,500 million tonnes of uranium which would provide an essentially unlimited supply. The office of Fuel Cycle Technologies manages an R&D program on fuel resources with a primary focus on making the technology more economically competitive by improving the selectivity, loading capacity, chemical stability, and biological and mechanical durability of the adsorbent materials. Significant technical progress has been made in the past two years. An advanced material prepared by a research team at the Oak Ridge National Laboratory (ORNL) vastly outperforms today's best adsorbents. The ORNL adsorbent material development was recognized in June 2012 by R&D Magazine as one of the year's most significant technological innovations, winning an R&D 100 Award.

International Nuclear Energy Cooperation

The International Nuclear Energy Cooperation program (INEC) provides the Department the ability to meet growing demands for engagement with international partners on civil nuclear policy, R&D, and related activities. INEC engages both bilaterally and multilaterally in support of U.S. policy goals related to nuclear energy globally and allow more effective integration of NE international R&D and policy interests. INEC has coordinated bilateral R&D Action Plans with China, France, and Russia; advanced DOE's bilateral nuclear safety activities with China; implemented bilateral cooperation programs with the Czech Republic, Kazakhstan, Mongolia, Russia, Ukraine and the Republic of Korea; performed analytical studies related to the Comprehensive Nuclear Fuel Services (CFS) approach to limit incentives for individual countries to acquire or develop capabilities involving sensitive nuclear technology; and established Civil Nuclear Energy Working Group with Japan.

Through INEC support, the U.S. continues to chair the International Framework for Nuclear Energy Cooperation (IFNEC) Steering Group. This year, NE is developing workshops with industry to further explore commercially-based comprehensive fuel services and participant countries are identifying infrastructure development needs and issues via this framework. INEC also supports U.S. Government efforts to increase U.S.-civil nuclear exports by coordinating with the Department of Commerce Advocacy Center and other agencies to ensure that our bilateral and multilateral engagements include advocacy for U.S. exports, as appropriate.

Nuclear Energy Enabling Technologies

The Nuclear Energy Enabling Technologies (NEET) program conducts R&D in crosscutting technologies that may lead to revolutionary improvements in safety, performance, reliability, economics, and proliferation risk reduction and promote creative solutions to the broad array of nuclear energy challenges related to reactor and fuel cycle development.

Nuclear Energy Advanced Modeling and Simulation

The Nuclear Energy Advanced Modeling and Simulation (NEAMS) program is advancing the leading edge computational methodologies for the analysis of advanced fuels, reactor systems and components. These new capabilities are expected to speed technology development by reducing the need for some experiments and better informing the design of others. In addition, more accurate calculation of the underlying physics will enable the establishment of realistic and defensible fuel and reactor operating margins, resulting in lower cost systems that maintain or exceed current levels of safety. This year, NEAMS successfully launched a new iteration of the state-of-the-art reactor systems analysis tool named RELAP7 and will demonstrate this capability to simulate boiling water reactor station blackout. NEAMS will complete a simulation to confirm the methodology for predicting complex behavior driven by competing physical phenomena in a fuel assembly, while also demonstrating that large fractions of an entire reactor core can be simulated with appropriate competing physics.

The Energy Innovation Hub for Modeling and Simulation

The Energy Innovation Hub for Modeling and Simulation (Hub) is an investment in leading-edge modeling and simulation to improve the performance of currently operating light water reactors. The Hub is integrating NEAMS-developed codes and other commercially available codes to run on DOE supercomputer platforms and to display the results in a user-friendly visual format. The development of a high resolution and high fidelity three-dimensional virtual pressurized water reactor (PWR) model has proven to be a feasible proposition. This year, the Hub is delivering a capability that will run independently on industry computers. The Virtual Environment for Reactor Applications (VERA) will be used to better understand and improve the performance of existing PWRs. The Hub approach is to develop modeling and simulation tools within the virtual reactor to address specific "challenge problems" that have been defined by industry. The initial deployment of these technologies will be to computer test stands located at industry partner's sites followed quickly by deployment to other industry users outside of the Hub partnership. This is being accomplished just three years from the start of the Hub and illustrates the importance NE places on getting energy technologies out of the laboratory and into the hands of industry users.

National Scientific User Facility

The National Scientific User Facility (NSUF) program represents a "prototype laboratory for the future" since it promotes the use of unique nuclear research facilities for science-based experiments and encourages active university, industry, and laboratory collaboration in relevant nuclear scientific research. The NSUF, through competitive solicitations, provides a mechanism for research organizations to collaborate and conduct experiments and post-experiment analysis at facilities not normally accessible to these organizations. In FY 2013, NE will issue a FOA for irradiation, post irradiation examination (PIE) and small rapid turnaround projects to provide students and faculty the means to cover the cost of facilities and associated staff support to execute the research projects.

Crosscutting R&D Solicitations

This year, NE has restructured our cross cutting R&D solicitations to increase the efficiency and effectiveness of our resources. NE previously issued separate solicitations for R&D opportunities through the Nuclear Energy University Programs (NEUP) and the Nuclear Energy Enabling Technologies

(NEET) Crosscutting Technology Development Program. In FY 2013, NE integrated these peer-reviewed, competitively-selected R&D opportunities into a single FOA that will allow universities and industry to focus and prioritize research proposals as well as facilitate university-industry-national laboratory teaming. As in previous years, the NEUP program supporting work scopes address the full range of NE R&D with specific emphasis on technical areas best suited for university-based R&D including important aspects of fuel cycle and reactor development, as well as mission supporting transformative research

Since FY 2011, NE has also utilized the Integrated Research Projects (IRPs) to provide R&D solutions that are the most directly relevant to the near-term, significant needs of the NE R&D programs. IRPs are significant, three-year awards for projects that address specific research issues and capability gaps identified and defined by the NE R&D programs. These projects are multidisciplinary and require multi-institutional partners and NE encourages these university-led teams to utilize industry, national laboratory, and international partners. This year, NE plans to award, through NEUP, an IRP in advanced reactor materials that will need to receive radiation doses higher than what can be obtained in a reasonable time in the test reactors currently available.

Impacts of Sequestration to Nuclear Energy Programs

The NE safeguards and security (S&S) program to protect the Idaho National Laboratory is, from a budgetary viewpoint, segregated from other NE programs as it is designated as a national security activity and is therefore funded within the Other Defense Activities account. As a result the S&S program is taking the larger percentage reduction assigned to Defense activities. The total reduction will be about $6.7 million below the FY 2012 appropriation and $8.3 million below our FY 2013 budget request.

Under reduced funding levels, there would be insufficient funds to maintain the site's current S&S Program, which the Department understands may result in layoffs or furloughs of more than 80 contractor employees.

Over the last few weeks, the Department has thoroughly reviewed impacts to our mission, the American public, and our employees, but the nature of the cuts – spread evenly across over 225 funding lines in the Department – has severely limited our flexibility to prioritize activities or lessen the impact of cuts. NE will continue to investigate options to manage these impacts.

The Department is making every effort possible to prevent severe impacts to the mission and layoffs for our workforce.

Closing

These efforts support a strong and viable nuclear industry in the United States and preserve the ability of the industry to participate in both domestic and international nuclear projects, and are intended to ensure a clean, safe, secure, and affordable nuclear energy capability to continue and expand within the U.S.