

Minutes
Nuclear Energy Advisory Committee Meeting
October 13, 2017
Westin Hotel, Arlington, Virginia

Committee Members Participating:

Ashok Bhatnagar	Regis Matzie (via telephone)
Matthew Bunn	Richard Meserve, Cochair
Dana Christensen	Joy Rempe, Cochair
Susan Ion (via telephone)	Burton Richter (via telephone)
Thomas Isaacs	Ray Rothrock
Raymond Juzaitis	Alfred Sattelberger
Karen Vierow Kirkland	

Committee Members Absent:

Margaret Chu	Carl Paperiello
Donald Hintz	Mark Rudin
Maria Korsnick	

Other Participants:

Tracey Bishop, Deputy Assistant Secretary for Nuclear Infrastructure Programs, Office of Nuclear Energy, USDOE
Michele Enders, NEAC Support Staff, Allegheny Science and Technology
Wayne Gordon, Office of the General Counsel, USDOE
John Herczeg, Deputy Assistant Secretary for Nuclear Technology Research and Development, Office of Nuclear Energy, USDOE
Suzanne Jaworowski, Senior Advisor, Office of Nuclear Energy, USDOE
Edward McGinnis, Acting Assistant Secretary and Principal Deputy Assistant Secretary, Office of Nuclear Energy, USDOE
Frederick O'Hara, NEAC Recording Secretary, Allegheny Science & Technology
Robert Rova, NEAC Designated Federal Officer, Office of Nuclear Energy, USDOE
Allen Sessoms, School of Continuing Studies, Georgetown University
Jennifer Wachter, NEAC Support Staff, Allegheny Science and Technology
Michael Worley, Associate Deputy Assistant Secretary for Nuclear Technology Demonstration and Deployment, Office of Nuclear Energy, USDOE

About 30 others were in attendance in the course of the meeting.

Morning Session

Before the meeting, **Wayne Gordon** of the USDOE's Office of the General Counsel conducted the Committee's annual ethics briefing.

At 8:48 a.m., Committee Cochair **Richard Meserve** opened the public portion of the meeting. He had the Committee members identify themselves.

Meserve said that there is a new administration and new Secretary of Energy. Edward McGinnis is the Acting Assistant Secretary for Nuclear Energy. The reorganization of NEAC has been discussed with subcommittee chairs, and that topic will be discussed at this meeting. NEAC may take on two or three specific tasks that would require one or more new subcommittees.

Committee Cochair **Joy Rempe** thanked Robert Rova for the support that he supplied to the Committee.

Edward McGinnis was introduced to review the situation of the Office. This period offers the most historic challenge to the energy sector and the opportunity to “change the dial” to support a healthy, viable nuclear-energy sector in the United States. Few people have the “Chicken Little” perspective now. However, the industry is taking a slow nosedive. Several issues need to be addressed: regulatory issues, market issues, public–private partnerships, and nuclear-power policy. The historic crisis is the large number of nuclear-power reactors that are shutting down. The opportunity to deploy advanced reactors by 2020 was lost. The United States now gets 19% of its electricity from nuclear power. A dramatic drop-off to 13% by 2029 is imminent. Three or four years ago, the Energy Information Administration (EIA) did not factor in these shutdowns. Lifetime extensions were expected. There is now only one combined license (COL), and that might not go to fruition. There is only one design undergoing licensing review. The greatest challenge to the nuclear sector is that the next 3 years will set the trend for the following decades. The nuclear capacity is recognized as a national-security issue. The table needs to be set for those coming decades.

In June, President Trump announced (1) a comprehensive review of the nation’s nuclear-energy policy and (2) the steps that will be taken to expand the nuclear-energy sector. A robust plan has been developed to pursue this expansion. This response will not be easy. The value of the energy system’s resiliency needs to be recognized. Innovative designs need to be brought to an established market. More loans have been advanced to the Vogtle Electric Generating Plant. The Office of Nuclear Energy (NE) has worked with other government agencies to promote the deployment of U.S. nuclear technology overseas. And NE needs to be more than a research, development, and demonstration (RD&D) organization. The Office will work shoulder to shoulder with other key players in the nuclear-energy sector.

The Office’s new approach entails developing a mission space, budget, and priorities, starting from a clean slate. There will be three mission priorities: the fleet, the pipeline, and the fuel-cycle infrastructure. A proactive approach will be taken to resource management with two guiding points:

- Investments should be made in early-stage research and development (R&D), such as R&D for the licensing process).
- Government efforts should be minimized, and industry efforts should be maximized.

This Committee has a great opportunity to recognize the importance of a robust public–private partnership for a robust nuclear industry. NEAC needs to think about how to go about that redevelopment of the U.S. nuclear industry. DOE does not have a good track record on completing large projects. NEAC should look at the regulatory environment and think about getting efficiencies and cooperation with other government agencies, such as the Nuclear Regulatory Commission (NRC), the Federal Energy Regulatory Commission (FERC), and other regulatory entities.

Suzanne Jaworowski was introduced. Her responsibility in the new administration is to enlist the support of stakeholders. She introduced her colleagues Jack Jones and Michelle Sneed. In introducing herself, she noted that she was from Indiana, that she had worked on the Trump campaign, that she had previously worked in communications for a fossil-fuel company, that she wanted to work in the Department of Energy, and that God had a plan for our path and here she was. Energy is critical to America’s way of life. The Office of Public Affairs has just held a ceremony marking the 40th anniversary of the establishment of DOE. Public awareness of the energy sector’s current environment needs to be beefed up, including the challenges and opportunities that it faces. The nuclear industry’s story needs to be told. Public relations outreach is crucial for supporting a developing and expanded nuclear industry. Secretary Perry, a dynamic leader, said that “nuclear needs to be made cool again.” Most people think about danger and weapons when thinking about nuclear power. The nuclear sector has a number of needs:

- To make people aware of the other applications of nuclear energy (e.g., food irradiation)
- To make clear the value of the nation’s nuclear-power assets
- To stay ahead of its opposition (coal, natural gas, and wind power)
- To tell the story of subsidies

The week following this meeting is Nuclear Power Week. DOE will hold a “millennial caucus” on nuclear power for young leaders. A Nuclear Infrastructure Council will address workforce issues. A conference on nuclear visionaries will be held on social media. In the future, a White House conference will be held.

Meserve asked for some sense of NE’s priorities and aspirations. McGinnis listed four:

- The highest priority is to get the first advanced small modular reactor (SMR) plant in the market in the mid-2020s.
- Fast reactors and even test facilities to produce fast reactors are urgently needed assets.
- Beyond light water reactors (LWRs), the future should include other types of reactors, and an industry-led cost-sharing program needs to bring these new designs to fruition in the mid-2020s.
- A lack of American-owned uranium-enrichment plants is crippling the industry and needs to be corrected.

He added that the market has to value resilient assets like nuclear power, and a public–private effort to effectively design and deploy a facility on time and on budget is needed. Underlying all this innovation are power-purchase agreements for new nuclear-power plants. DOE’s JUMP Initiative [Join in the discussion, Unveil innovation, Motivate transformation, and Promote technology to market] postulates modular reactor units for which DOE is not only a research participant but also a customer for the electricity.

Bunn asked (1) if NE was looking for a FY19 budget proposal that is very different from the FY18 request and (2) what is going on with the comprehensive review? McGinnis replied that the FY18 budget was not this administration’s budget. The FY19 budget is under embargo, but it should be known that NE is working hard to fully implement the President’s direction. The full suite of issues needs to be funded. Subscribing to a utility’s new generating capacity through a power-purchase agreement can lessen uncertainty and make a great difference to the utility. The comprehensive review is under the leadership of two DOE people. This is not a tabletop exercise; DOE is concurrently addressing issues brought up by this study.

Rothrock pointed out that there is a 42-month review cycle for a new nuclear-power plant and asked what role NE will play in dealing with the NRC. McGinnis answered that it is parallel. No single group can make a bottleneck. Regulatory reform is being conducted in real time. NEAC needs to weigh in on this topic, looking at regulatory bodies that impact nuclear power. NE staff met with NRC staff during the previous week to provide the NRC with all the possible support it needs.

Isaacs asked what the status and intents of the nuclear-waste issue were, pointing out that the shutdown of plants is an opportunity to galvanize interest in nuclear power. The security dimension is important in enrichment efforts; the United States needs to cooperate in other strategic international partnerships. McGinnis responded that the Yucca Mountain disposition of spent nuclear fuel is a top priority that needs to be addressed. DOE is paying billions of dollars in fees because it has not met its obligations. The ball is in Congress’s court for funding the completion of the Yucca Mountain license. Also, there is a robust spent-nuclear-fuel disposition program, but funds are needed to support it. DOE needs to have a place at the table in maintaining the security of nuclear plants. It needs to have the power of the provider of the reactor and fuel, a hundred-year relationship, to have that seat at the table, and to have influence over operations and policies and procedures. If Russia is selling the reactor and providing all the fuel, America has no content in it and has no say in technology transfer agreements or in third-party transfers of materials and reactors. We have gone from 90% of the market to 20% and declining. Every time there is a lost commercial opportunity, it impacts American jobs, the viability of the nuclear sector, and safety and nonproliferation efforts and controls. The United States needs to work in partnership with others. An example of such partnership is NE’s participation in the Energy Management Working Group (EMWG) and its co-leadership with Canada and Japan of EMWG’s Clean Energy Ministerial.

Kirkland noted that several plants that had been slated for shutdown obtained reprieves because the states in which they were located eased the economic pressures. McGinnis responded that DOE

recognizes states' rights but also the need to work with and support states' efforts to ensure energy and job security in their states. DOE continues to work with Ohio to support its nuclear industries. Jaworowski added that the states need to be made aware of tools and assets that are available to them from DOE. Kirkland added that students need to hear from the Secretary about his support and optimism about nuclear power. Jaworowski responded that NE is working on a road show to do exactly that.

Richter said that the NuScale 40-month design review puzzled him. There are no new fuel or engineering issues. He asked why the review process takes so long. This issue should be studied. Wind and other energy sources get huge subsidies but they never get recognized in cost comparisons with nuclear power, so nuclear appears more expensive than other sources of energy. McGinnis said that those questions are being addressed by the regulatory effort and future subcommittees. The cost of electricity is exactly why the Secretary is studying cost, resiliency, and reliability in the energy marketplace. There are dysfunctions, such as negative costs, because of subsidies. NE's accepting responsibility for the whole spectrum opens opportunities for NEAC to address these market concerns.

Rempe asked if there will be documentation of all these new facilities. McGinnis answered, yes; it will be a strategic plan. It needs to be kept simple, focusing on the fleet, the pipeline, and fuel-cycle infrastructure.

Meserve pointed out that an aspect of resiliency is federal subsidies. One can eliminate all subsidies or introduce subsidies for nuclear. He asked how NE will go. McGinnis replied that the states are also providing subsidies (energy credits), so removing all subsidies is not simple. The markets need to be restructured. Congress is looking at other ways to organize the markets (production tax credits etc.).

A break was declared at 10:24 a.m.

The meeting was called back into session at 10:35 a.m.

Michael Worley was introduced to speak about the Office's support to the existing nuclear fleet.

The existing fleet of nuclear power reactors requires support because, in 2010, the nation had 104 nuclear reactors producing 19.6 percent of the nation's electricity. In 2017, it has 99 units producing 19.6% of the nation's electricity. Closures of nuclear power plants that have already been announced will reduce the number of plants to 95, producing 18.2% of the nation's electricity. And if all at-risk reactors were shut down by 2030, there would be 74 units producing 13.7% of the nation's electricity. There is an appropriate government-industry relationship to avoid this happening. Improving the regulatory environment in the marketplace would result in 103 units operating in 2030 to produce 18.8% of the nation's electricity. The employment of advanced reactors would increase the number of units to 117 that would produce 19.6% of the nation's electricity.

NE has a program on LWR sustainability. It is developing technologies and other solutions to enable long-term economical operation of existing nuclear power plants, to improve reliability, and to sustain safety. The goal of this program is to develop a fundamental, scientific basis to allow continued long-term safe operation of existing LWRs, to enhance their long-term economic viability, and to promote U.S. electrical-grid resiliency. The program focuses on materials' aging and degradation, advanced instrumentation and controls, risk-informed safety-margin characterization, reactor-safety technologies, and systems analysis and emerging issues.

The federal government holds a large theoretical, computational, and experimental expertise in nuclear R&D, largely at the national laboratories, that would benefit industry in developing the next generation of power reactors. Cost-sharing is being employed as a way for industry to tap into this expertise and experience.

The nuclear materials' aging and degradation focus is designed to understand and predict long-term environmental degradation behavior of materials and nuclear power plants, including the detecting and characterizing of such degradation. The advanced instrumentation, information, and control-systems technologies focus is designed to address long-term aging and obsolescence of existing instrumentation-and-control technologies. The risk-informed safety-margin characterization effort is designed to develop significantly improved safety-analysis tools and to apply these tools to analyze the safety margin of aging plants so that they can be more efficient. The systems analysis and emerging issues focus is designed to address high-impact emerging issues, such as flexible operations, chemistry control, and water-usage

issues. The reactor-safety-technology focus is designed to develop technologies to enhance the accident tolerance of current and future reactors. The hybrid systems focus is designed to help nuclear be profitable in a competitive energy market. Competitively awarded cost-share projects with industry are designed to solve the highest-priority cost and technical problems threatening existing plants.

A funding opportunity announcement (FOA) will be issued in FY18 to fund university-led research to support the existing fleet. The FOA will have three foci: (1) applying the concept of big-data analytics to existing nuclear power plants, (2) evaluating current LWRs for design enhancements, and (3) evaluating innovative methods for increasing the passive-safety response for existing plants.

An FOA will be issued in FY18 to fund nuclear-technology developers to move from early concepts to more mature designs, to improve low- to mid-level technology readiness levels, or to perform first-of-a-kind engineering development.

There are three tiers of funding pathways: continued support to bring the reactor design to the NRC, cooperative agreements and loans, and grants or vouchers. In the past, NE has worked collaboratively with the existing fleet through the Electric Power Research Institute (EPRI). That collaboration will continue within the three-tier approach.

Juzaitis asked if there were a cybersecurity portion in any of these programs. Worley replied, no; but there is a small cybersecurity effort in DOE. DOE is looking at how best to do that in the future. It is being included in the effort to sustain the existing fleet. DOE participates in a government-wide cybersecurity effort.

Christensen asked what the government's role was in the existing fleet and whether it includes the transition to advanced technologies, such as digital control systems. He stated that, if the nuclear sector moves to a streamlined regulatory effort, the government should bear the cost of that as part of sustaining the existing fleet. Worley replied, absolutely. It is expected that FOAs will provide the mechanisms to underwrite those efforts (probably on a 50–50 basis). This process should take the industry to the next level. The contracting entities could vary from one FOA to another as long as they referred to the existing fleet.

Isaacs said that another aspect that should be explored is extending the technology to the next generation of people. DOE needs to pay attention to priming the pipeline's pumps. McGinnis said that that is a great idea. A \$67 million FOA has already funded students in 37 states. NE needs to focus on and build that idea of a workplace pipeline in all programs. Ion said that this has been difficult to do in national laboratories and industry; it needs to incorporate the universities, as well. Ion added that this was a very important point because, in an era when utilities are stressed, the opportunities for people to spend some time at a utility's customer at the utility's expense disappear and the transition from the university experience or the national-laboratory experience into industry experience gets much more difficult to do.

Bhatnagar stated that the licensing process can be streamlined, but that will not make any difference economically. Probabilistic risk assessment (PRA) has become an animal unto itself and is propagating new regulations. McGinnis said that a broad spectrum of issues (including regulation) must be factored into NE's mission and programs. The Office needs to be recalibrated to the future, not to the past. All programs need to be evaluated to see where changes need to be made. Bhatnagar suggested looking at the past 40 years to see what was asked of the industry in terms of reliability and resiliency and find out what worked and what did not. Worley said that NE will study those issues internally before it issues the FOAs.

Isaacs stated that he believes that DOE has not taken enough credit for what it has done to further advanced reactors, such as NuScale. The advanced-reactor pipeline includes NuScale and some of the other LWRs and non-LWRs.

John Herczeg was asked to speak about the Versatile Advanced Test Reactor (VATR).

A multi-laboratory kickoff meeting was held in April to roll out the VATR R&D Organization, which has an Engineering and Scientific Adviser; a Strategic Advisory Committee; a Communications and Quality Assurance component; an Academic Committee; and leads for Core Concept and Safety Analysis, Fuel Concept Analysis, Experiment Capability Development, Reactor/Secondary, and Instrumentation and Controls and Protection.

The Organization is operating on a \$4 million budget and has requested \$10 million; the Senate markup gives it \$3.5 million, and the House markup is at zero dollars.

The Organization tried to draft some requirements and assumptions about the VATR. It found out that industry is interested in a high flux of 4×10^{15} n/cm²-s with a prototypical spectrum; as large a load factor as possible; a pathway toward driver-fuel disposal; flexibility for novel experimental techniques; a capability of concurrently running loops representative of typical fast reactors; a user-defined range of effective testing heights [TerraPower wants a slot of 10 m, which would exceed the limit set by the NRC for a test-reactor license]; an ability to perform a large number of experiments simultaneously; and a metallic driver fuel. The LWR community is interested in a high flux, also, not just the fast-reactor community. This facility will look at the core design of a reactor. A large space is needed to do that. Advanced instrumentation should also be looked at to analyze all the data that will be produced.

A 3-year R&D plan has been developed that includes four components: the R&D plan definition (prior to the core review), investigation, R&D, and concept completion.

A team has been assembled and will operate in full engagement with the NRC.

Rempe suggested that the review be a *staff* review.

Michael Worley was asked to speak about NE's support for United States-based SMR technologies.

DOE recognizes the value of SMRs as a new power source for the U.S. electrical grid to enhance its reliability and resilience. The agency initiated its SMR Licensing Technical Support Program in FY12 with the goal of accelerating the availability of safe, affordable SMRs into the market by sharing financial and technical risk with the first movers in the industry. It also established cost-shared cooperative agreements for the most-mature designs.

B&W's NPower was the first awardee selected in FY13; the agreement was suspended in FY15 after helping to establish a regulatory blueprint for subsequent SMRs.

NuScale was an innovative option selected in FY13; the final funding year for the program was FY17 when the program achieved its objectives. The program advanced NuScale development and certification. NuScale submitted a design certification application to the NRC in January 2017, and the NRC issued a 46-month review schedule. Phase 1 of the review is currently ahead of schedule, and the application is dealing with significantly fewer requests for additional information than anticipated from benchmarks. No significant safety concerns have been identified during the NRC review to date.

During the next 30 years, many units of the existing U.S. LWR fleet will be retired. Light-water SMRs are the most mature, with the ability to immediately contribute to the U.S. energy portfolio. Non-light-water SMR designs are also viable but are likely to have a longer licensing horizon. Significant work remains to finalize designs and site licensing projects, as well as to develop a supply-chain infrastructure. It is in the Government's interest to support these efforts because new U.S. nuclear builds regain leadership in global influence, SMRs are expected to be a key element of the nation's future electricity generation portfolio, and commercial deployments of new reactor technologies have always been preceded by significant public-private partnerships.

There will be no SMR-specific program funding in FY18; however, the FY18 request "invests in early-stage research and development on next-generation reactor technologies, including \$20 million supporting advanced small modular reactors." The FY18 House mark recommends that DOE dedicate \$60 million to "support technical, first-of-a-kind engineering and design and regulatory development of next-generation light-water and non-light-water reactor technologies, including SMRs." NE is developing an industry-focused FOA to provide for the development of two of the most mature SMR designs. The support for U.S. industry initiatives takes the same three-tier form described earlier in this meeting.

McGinnis noted that microreactors are another field that may be of interest to industry. Some designs could be robust *and* transportable. We are making them aware of potential access to NE's research facilities. One has a schedule for deployment in 2022.

Juzaitis pointed out that reactor technology has been very slow to evolve from one generation to another. "Safer" reactors challenge the safety of current, operating reactors; therefore the industry impedes evolutionary designs. The country is better off with thousands of SMRs rather than a few 1000-

MW plants. The pipeline sees that. McGinnis stated that the Secretary sees the need for innovation, and the industry needs to punch through to the next generation in the fleet.

Rempe noted that technology working groups had been asked to develop roadmaps and asked whether these roadmaps are still being encouraged and whether they will be used in developing the FOAs. Herczeg replied that roadmaps are the first thing asked for in new programs. The results have not been satisfactory, and good roadmaps are being sought. Some document with details, a roadmap or program plan or something, is needed. Such a document will be required from each program. Another issue is what should be asked for if there is going to be an early deployment of the

Bhatnagar said that the lessons learned from earlier projects should be studied so things that did not go well could be addressed right up front. Also the test reactor should be thought of as a manufacturing project (like SMRs) rather than as a construction project (like large plants). SMRs will need test reactors up front. The main question is what date would one request for an early deployment? McGinnis replied that an industry pull is desired; something in the 2020s would be good. There are three ways to react to it: (1) seek that conclusion within DOE/NE, (2) do it in consultation with the NRC, or (3) have the NRC set the date with the vendor. The NRC's role needs to be respected. At the same time, NE needs to push the envelope. The Chairwoman of the NRC is devoted to efficiency while maintaining the top level of safety. NE is here to help them. An expert perspective is needed to determine what level of streamlining is needed.

Christensen said that it is not clear what the government's role is in developing and deploying SMRs; that role should be clarified. Richter said that, if one looks at who our rivals are, they are governments (such as Russia, China, India, and Korea). A huge amount of work to be done would flood a U.S. effort. The NRC has no money to look at how to streamline its regulatory process. The United States cannot compete with foreign costs of fuel. The nation is going out of the nuclear business. The widely diverging spectrum of reactor designs cannot be supported. McGinnis replied that DOE has demonstrated an intent to select among the array of designs. NE is a partner in the Nuclear Power 2010 Program (NP 2010); it is a partner with NuScale; and it is partnering in microreactors. Richter pointed out that it is discussing sodium-cooled reactors, lead-cooled reactors, fast gas reactors, and many more designs. He could not see the federal government supporting all of those designs. It must focus on technology to sell to the world as well as to the domestic marketplace. McGinnis said that that is one of NE's most vexing problems, and it needs NEAC to guide that decision.

A break for lunch was declared at 12:02 p.m.

Afternoon Session

The meeting was called back into session by Cochair Rempe at 1:15 p.m.

Tracey Bishop was asked to update the Committee on NE mission support.

Mission support includes the planning, acquisition, operation, maintenance, and disposition of NE-owned facilities and capabilities at the Idaho National Laboratory (INL), including providing the site's necessary safeguards and security functions. Infrastructure enables NE and DOE missions to perform impactful nuclear research in a safe, secure manner to support the existing fleet, advanced-reactor pipeline, and nuclear-fuel-cycle infrastructure. All of these are integrated with the research programs to ensure proper alignment and prioritization of investments. Mission support also leverages infrastructure programs to optimize availability and to provide flexibility for programmatic work.

From the FY18 request to the FY18 Senate mark, there was about a 40% increase in the funding for the Idaho Facilities Management and for the Idaho Sitewide Safeguards and Security line items.

The site is approximately 890 mi², 98% of which is undeveloped. It has almost 600 buildings, of which 330 are overseen by NE. It has three operating research reactors and one mothballed reactor undergoing resumption. It has a full complement of utilities and services, including electrical service, water, paved roads, and railroad tracks.

In FY05 to FY09, the site was taken from a caretaker role to operations. Gaps in basic site functions were closed, deferred-maintenance backlogs were worked off, and the infrastructure was aligned with

missions. Near-term gaps were closed to enable research missions. Funding profiles were stabilized to ensure infrastructure sustainment. And operational processes were improved to maximize research. Currently, unique research infrastructure and capabilities are being refurbished to world-class status, and business models are being optimized to improve access to infrastructure.

The Idaho Facilities Management (IFM) Program provides direct funding to operate and maintain site-wide nuclear infrastructure in Idaho, including maintaining safe and compliant nuclear-research facilities, addressing aging infrastructure needs, and addressing infrastructure gaps identified and required to fulfill research mission needs and basic site operations.

INL's irradiation capabilities include the Advanced Test Reactor (ATR); the ATR Critical Facility; the Neutron Radiography Reactor; and the Transient Reactor Test Facility, which is scheduled to resume operations in 2018. The other major area of operations is in post-irradiation examination. There, the capabilities include the Hot Fuels Examination Facility, the Fuel Manufacturing Facility, the Fuel Conditioning Facility, and the Irradiated Materials Characterization Laboratory.

The Idaho Sitewide Safeguards and Security Program protects nuclear materials, classified matter, government property, and other vital assets at INL from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may cause unacceptable, adverse impacts on our national security, program continuity, or health and safety of employees, of the public, or of the environment. Cost-effective, performance-based, risk-informed execution of physical and cybersecurity activities enable the use of special nuclear material and classified/unclassified information for research and development needs.

In summary, INL's infrastructure enables NE and DOE missions to perform impactful nuclear research in a safe, secure manner. Significant progress has been made to align infrastructure with programs to ensure accurate prioritize station of investments. Security infrastructure is needed to ensure continued access to special nuclear materials and information for research missions.

Bunn noted that this is a huge portion of NE's budget and asked whether the infrastructure should be consolidated. Specifically, he wanted to know why the security cost was so large. Bishop replied that NE has studied and identified excess facilities, has eliminated several of those, and has consolidated efforts. Security is carefully overseen and performed. The Office is always looking for opportunities for cost efficiencies. The facility is now in a stable place, and it is hoped that it stays there.

Rothrock wanted to know what the "access" was that is cited in the slides. Bishop said that it has been for industrial-partner access and university researchers; some costs are recovered. Worley noted that some processes have been changed to allow industry to propose access for industrial-research projects. Rothrock commented that the use over time would be powerful information. McGinnis added that the Office also strives to allow maximum access to U.S. Government agencies. Rempe pointed out that there has been a backlog in R&D projects, resulting in some researchers turning to foreign laboratories. Bishop stated that the Office has been increasing reliability and efficiency, cutting back on that backlog. Also, additional facilities and capabilities are being added in response to industrial needs.

Alfred Sattelberger was asked to present the Nuclear Technologies R&D Subcommittee report.

The Fuel-Cell Technologies Subcommittee held a one-day meeting on May 10, 2017; a report was sent out to Committee members prior to this meeting. Highlights of the report include organizational overview of NE-4 (the Office of the Deputy Assistant Secretary for Science and Technology Innovation); the advanced-reactor or programmatic overview (with presentations on advanced materials, fast-reactor R&D and future directions, gas-cooled reactor R&D and future directions, molten-salt reactor R&D and future directions, and energy conservation R&D and future directions); a report from the Office of Science "Basic Research Needs Workshop," which was held in August of 2017; a presentation on the R&D path forward for the proposed test reactor, and a roundtable discussion on spent fuel and waste disposition.

The Subcommittee's review focused on the functional management structure for NE-4. A Steering Committee made up of personnel from INL and Oak Ridge National Laboratory (ORNL) is now in place. A Versatile Reactor-Based Fast-Neutron Source Research and Development Organization has been

established, and representatives from INL, Argonne National Laboratory, ORNL, and others will be brought into this organization in the future.

The Subcommittee had two key observations about the organization of NE-4:

- Merging Advanced Reactors with Fuel-Cycle Technologies is an excellent organizational option for enabling the conceptualization and planning of full “nuclear-energy systems.”
- Interfaces between NE-4 and NE-5 (the Office of the Deputy Assistant Secretary for Fuel-Cycle Technologies) will require managed coordination and careful budget planning to achieve desired outcomes. Also, activities pursued by NE-4 should be informed by industry plans for deployment. Advanced modeling and simulation capabilities will be needed; predictive (research) models will need to be scaled up to system models; this will be complicated and may not be able to be split up among four organizations (national laboratories).

The key recommendation of the Subcommittee is that the standing up of a test reactor organization is timely and in sync with a recent NEAC recommendation. It is recommended that the proposed organization be phased in gradually. This large management organization is more appropriate for a major program/project than for the conceptual-design effort currently planned for FY17 in FY18.

The Advanced Reactors Technology (ART) Program’s mission statement calls for identifying and resolving the technical challenges needed to be overcome in order to enable transition of advanced non-LWR technologies and systems and in order to support detailed design, regulatory review, and deployment by the early 2030s.

The objectives of the Program are to conduct focused R&D to reduce technical barriers to deployment of advanced nuclear-energy systems; to develop technologies that can enable new concepts and designs to achieve enhanced affordability, safety, sustainability, and flexibility of use; to collaborate with industry to identify and conduct essential research to reduce technical risk associated with advanced-reactor technology; to sustain technical expertise and capabilities within national laboratories and universities to perform needed research; and to engage with standards-developing organizations to address gaps in codes and standards to support advanced-reactor designs.

The Program’s focus areas are fast-reactor technologies, gas-reactor technologies, advanced-reactor demonstration and industry awards, and technology-area leads for energy conversion and special applications.

The Subcommittee encourages the ART Program to use technology roadmaps in its prioritization strategy and in developing a credible schedule for deployment. Other countries want test reactors, so the United States should be able to find partners.

At the Subcommittee meeting, Linda Horton of DOE’s Office of Science presented a report from the Basic Energy Sciences Advisory Committee that recommended that DOE enable the design of revolutionary molten-salt coolants and liquid fuels, master the hierarchy of materials design and synthesis for complex reactor environments, tailor interfaces to control the impact of nuclear environments, reveal multi-scale evolution of spatial and temporal processes for coupled extreme environments, and identify and control unexpected behaviors from rare events and cascading processes.

At the Subcommittee meeting, a roundtable discussion concluded that it appears that the Department is pivoting back to restart Nuclear Waste Policy Act activities associated with the Yucca Mountain license application. The Subcommittee recommends that available NE resources should be marshaled and focused on assisting the Yucca Mountain licensing effort.

McGinnis noted that a request is already on the Hill to fund that Yucca Mountain licensing effort.

Bunn noted that the mission is to support regulatory review. Limiting it to the 2030 timeframe leaves out a lot of technologies. McGinnis said that the Office is in the process of recalibration. It is trying to accelerate the development of advanced reactors with significant federal resources, bringing 2030 objectives into the 2020s. Technologies need to be brought to market as soon as possible. The pipeline needs to be opened up again. There is a need to prioritize and to focus on four or five items.

Bunn suggested that, if the Chinese are moving aggressively, the United States should partner with some country to get to some point that is profoundly different from the one that the current trend will lead us to. McGinnis stated that some countries are interested in investing in a U.S. test facility.

Richter asked if DOE would bet on a sodium reactor if it decided to pursue a fast reactor. The world knows a lot about sodium-cooled reactors. He was unsure about the state of the other reactor types and asked if anyone had looked at the cost of a sodium-cooled reactor. Herczeg replied that Russia has operated its BN-600 sodium-cooled fast-breeder reactor at the Beloyarsk Nuclear Power Station since 1980. Its BN-800 has been commissioned and reached full power in 2016. The scaled-up BN-1200 is under development. Japan's Monju Nuclear Power Plant failed. A pebble-bed gas-cooled reactor has a lot of promise. Companies in Japan and The Netherlands are developing small molten-salt reactors. Which of these ends up as the most economical is the big question.

Rempe opened the floor to public comments on the report. There were none. Sattelberger moved to accept the report. Rothrock seconded the motion. The vote was unanimous to accept the report.

Allen Sessoms was asked to report on the International Subcommittee.

The charge to NEAC was twofold: (1) to examine and provide recommendations on how NE could further support U.S. Government international commercial-nuclear-energy policies and priorities and (2) to identify international nuclear facilities that the U.S. nuclear industry could leverage to support the further development of the Gateway for Accelerated Innovation in Nuclear (GAIN) Initiative and complement existing U.S. facilities.

In regard to the first charge, in the early days of civilian nuclear power, the United States was the unquestionable leader both in technology and reactor deployment. After the 1972 oil embargo and the Three Mile Island reactor accident, the situation changed in the United States with respect to new nuclear project starts. Today, nuclear energy supplies 19% of U.S. electricity, but that will decrease as operating units shut down. Foreign nuclear-technology suppliers have emerged and have taken over civilian nuclear leadership. Approximately 60 new nuclear units are under construction today, the vast majority in Asia; Chinese, Russian, Indian, and South Korean suppliers are leading the way. U.S. influence on nuclear matters, both civilian and military, is waning by the day because of the U.S. Government's overall approach to nuclear energy during recent years. This has to be considered an impediment to developing a robust nuclear industry in the United States.

Nuclear energy is of vital strategic importance because of the special relationship developed between suppliers and customers, which may endure for 100 years. This strategic importance has been recognized by U.S. competitors, most notably China and Russia. International competition is generally from state-backed companies, putting U.S. suppliers at a disadvantage in making it difficult for them to compete. The Department of Commerce estimates the civilian nuclear market will be \$500 to \$750 billion over the next 10 years; each billion dollars of export sales supports 5,000 to 10,000 domestic jobs. Currently, the U.S. nuclear fleet is declining, and the nation's R&D budgets are shrinking, sending the wrong signals to potential international customers.

The Subcommittee's general findings for the first charge are:

- The U.S. Government does not approach civilian nuclear energy as a strategic policy issue as do other countries.
- U.S. leadership on security, nonproliferation, and reactor safety is lessening.
- It is often difficult for U.S. companies to obtain adequate financing for large international projects.
- U.S. nuclear export regulations are generally complex, restrictive, and time-consuming.
- U.S. implementation of the convention on supplementary compensation places a potential significant burden on domestic suppliers.
- A White House-level coordinator for international nuclear-energy policy is needed to help bring the strengths of the U.S. Government to bear in support of foreign sales.

The Subcommittee's recommendations for the first charge are:

- Make civilian nuclear energy a foreign-policy strategic imperative, with strong coordination across government agencies.
- Support the continued safe and reliable operation of existing U.S. nuclear power plants and encourage the construction of new plants.

- Simplify and streamline the U.S. nuclear export regulations and processes.
- Expand and strengthen available export financing so that U.S. companies can compete with foreign state-backed companies.
- Help countries entering the civilian nuclear market to set up appropriate international liability regimes.
- Draw upon and integrate the strengths and capabilities of U.S. national laboratories, research universities, and training capabilities with those countries.
- Increase funding and the use of new approaches to public–private arrangements for R&D to help regain U.S. global nuclear leadership.

In regard to the second task, the GAIN Initiative is based on three ideas: (1) Global demand for nuclear energy is increasing, and U.S. leadership is eroding. (2) A sense of urgency is needed with respect to deployment of innovative nuclear-energy technologies. (3) Effective private–public partnerships are required. The gain initiative will provide nuclear innovators and investors a simple point of easy access to a broad range of capabilities across the DOE laboratory complex. GAIN helps fund access to DOE’s national laboratories and Nuclear Science User Facilities (NSUF) partners to conduct rapid-turnaround experiments for advanced nuclear projects selected through open, competitive proposals. NSUF currently has both domestic (13) and international (3 plus 3 more in the works) members/collaborators.

The Subcommittee’s findings for the second charge are:

- A large number of international nuclear facilities are available to complement existing U.S. facilities and thereby leverage the GAIN Initiative.
- Some of these potential international facilities are located in countries where a changing political environment may make collaboration difficult, and such entities should not be considered reliable partners.
- It is difficult to transport irradiated materials internationally, particularly special nuclear material.
- The Nuclear Energy Infrastructure Database (NEID) already exists and would be a natural starting point for U.S. companies to look for the best partners.
- Processes and protocols exist for international collaboration, although different specific vehicles are typically used for each project.

The Subcommittee’s recommendations for the second charge are:

- An analysis needs to be conducted comparing domestic nuclear infrastructure capabilities and international facilities.
- A standardized and simplified process should be established for collaboration between U.S. companies and potential international nuclear facilities.
- The funding and scope of GAIN should be increased.
- The impediments to transporting irradiated materials internationally for R&D should be examined and resolved.
- The Generation-IV International Forum should be taken advantage of by member countries to self-identify facilities that would welcome international collaboration.
- The NEID should be updated regularly, and a process to track who is using the database should be established to improve its usefulness.

The Subcommittee also observed that the Secretary of Energy should take to the National Security Council the premise that nuclear energy is a national-security concern. There are more specific findings and more detailed recommendations in the Subcommittee report. Background information is also provided to understand what DOE is already doing in areas related to these charges.

Rothrock asked what responses were received from international industries. Sessoms replied that there was a significant response from Westinghouse on the Chinese experience. Feedback was also received from national laboratories about their international experiences.

Christensen asked whether the Subcommittee had talked about tensions that could come to bear between international suppliers and domestic users. Sessoms answered that many countries put up barriers

to transborder exchanges. Filling out forms is a big problem that would be aided if counselors were provided to help identify the necessary forms and to advise on how to fill them out.

McGinnis stated that many of these recommendations were made a while ago but are still relevant today. The United States has a large number of companies in its nuclear industry, and NE has offered to help them to become aware of foreign requests for products and to expedite such trade. The Office is ramping up these capabilities and will push U.S. companies to compete in this market and win.

Bunn had an additional thought: The United States is seen as a leader in nuclear security and safety. However, it no longer has personnel in several of the offices dealing with these issues. A new administration could work with countries around the world on these issues, reestablishing U.S. leadership.

Rempe opened the floor to public comment. There was none. Bunn moved to accept the report, and Christensen seconded the motion. The motion was unanimously approved.

Meserve said that the question had come up about whether the Committee's current subcommittee structure could be optimized and made more effective. There are other models of organization than the current subcommittee model.

McGinnis cautioned that no changes were being made today. What was wanted was a discussion of the issue. The Office that NEAC is advising is changing with the recalibration to focus on the fleet, the pipeline, and the fuel-cycle infrastructure. The Secretary of Energy Advisory Board (SEAB) has a task-driven structure that was established for a specific sunset time, forcing SEAB to be contemporary with the issues. The Office would like to see NEAC be issue-driven, but some topics need a longer-term perspective. Task forces or task groups can be stood up to address specific issues.

Meserve pointed to three tasks that have come up at this meeting:

- Regulatory issues, such as export controls, the NRC, etc.
- The comprehensive review of the funding of projects
- Technologies being at different stages of readiness, producing problems in comparison, funding, and down-selecting

Sattelberger commented that a hybrid model is also possible. A standing subcommittee can be tasked on current issues and asked for specific advice at a particular time. Rempe noted that the Reactor Technology Subcommittee has operated as a hybrid for some time now.

Bhatnagar suggested that focused task forces could address the three priorities more functionally.

McGinnis pointed out that the current structure was put in place a year ago. DOE is going to reorganize itself in the near future, and NE will be included in the reorganization and will transition to a new, clear, and intuitive organization.

Bunn observed that all missions involve technologies and politics. The Office is structured as an R&D office. He asked McGinnis if he saw an Office of Nuclear Policy being formed to deal with the international aspects of nuclear power. McGinnis replied that the Secretary does not see the Office as simply nuclear-energy R&D. The Office has a broad scope of mission. It needs to deal with technologies, market issues, and regulation. It needs to know what field it is playing on and what its priorities are. The pipeline is not only U.S. deployment but also exports, so NE should address the global market.

Rothrock said that a lot of shots on goal need to be taken. A very effective selection process is being carried out. It is not up to DOE to pick winners and losers. There are 30 companies involved. There is a lot of money involved. McGinnis replied that it is not a negative if there are many flowers blooming. However, NE has limited resources and needs carefully to see how to partner up and do early R&D to overcome barriers and meet regulatory requirements so industry can own the product and get it into deployment.

Richter said that nuclear energy has to worry about what is going on now and what will go on in the future. DOE needs more advice on international matters in the long term. There is nothing wrong with setting up subcommittees to deal with issues you are not dealing with right now but are needed for the long run. The Committee may need to set up task forces for short-term concerns and standing subcommittees for long-term issues.

Matzie asked: (1) What additional creative support could DOE consider for SMRs? (2) What public-private arrangements could be considered to regain international leadership in nuclear power (as

recommended by the International Subcommittee)? McGinnis replied that he liked to say “private–public” to emphasize that this effort needs to be driven by the nuclear industry. He would see some public–private financial arrangement.

Rempe polled the Committee members for final thoughts.

Ion said that it is important for the private and public sectors to work cooperatively to forge a vibrant U.S. nuclear industry. A number of groups of leaders will be needed to serve that purpose.

Matzie stated that the way forward is bright. NEAC has to consider its broad capabilities to see how it can best guarantee reaching that bright future.

Isaacs said that, 30 years ago, a fateful meeting on funding a program for nuclear waste considered three sites and ended up funding Yucca Mountain; canceling the second site; and setting up a committee to study monitored, retrievable sites. Now, 30 years later, the nation still does not have a repository.

Bhatnagar said that, if one wants to stop the nosedive, one needs to take quick action: to draw up a list of regulatory reforms; to get the Summer Nuclear Generating Station back on track; to set up NuScale for an accelerated schedule; and to find a solution to the nuclear-waste problem.

Kirkland said that the new structure for NEAC subcommittees makes sense.

Rothrock said that the mission redefinition is appreciated. The private industry is not patient. The Center for Advanced Energy Studies (CAES) is “open for business.” NE needs to get on with it, set some dates, make those deadlines, and get some early wins.

Christensen recommended getting quality people in the Office to deal with policy. And the Office also needs to communicate an expanded program plan to the right people the right way. It has to be done now. One needs to put resilience into the government’s role in nuclear power. A domestic product needs to be developed that can then be sold overseas. A quick win would be putting an SMR in hurricane-ravaged Puerto Rico next week.

Bunn said that he would be amazed if FERC would approve anything in 15 days. What is needed is a more real analysis of resilience. New ways are needed to evaluating the value of nuclear plants. The three-part structure is attractive, but it is not feasible to reestablish the enrichment industry. There are a lot of international sources of low-enriched uranium, tritium, etc. A plausible, sustainable, supportable, maintainable pathway forward for advanced reactors is needed. A number of reports have been issued on the topic, citing billions of dollars spent by DOE on R&D in support of reactor development. On the other hand, there are a lot of companies out there that think they can do it with no government support. He doubted that. The proper government role needs to be identified along with a path that would make it happen.

Juzaitis complimented the personal energy, commitment to public relations, and concise statements of the new leadership team of NE. He said that dumping RD&D is not feasible. RD&D needs to be linked up to the mission. The weapons programs saw that in the impending nuclear test ban; the nuclear industry should recognize that in the shutdown of nuclear power plants. One needs to work backwards from a deadline to identify where science can make a difference. The deployment time scale is urgent. It is a national-security issue; it is more than just nonproliferation, but guaranteeing the domestic supply of electricity. The faults show up in strange places, such as in shortages of safety engineers.

Sattelberger said that he thought that something needed to be built. A test reactor was seen to be a good bet. That enthusiasm has spilled over to industry and universities. It needs to be done now, on budget, and on schedule.

Meserve said that it was good to hear what the objectives and priorities of DOE and NE were. What is lacking is a single place where all the reasons we need nuclear energy can be listed together: economics; domination of the electric market by single source like natural gas; the need to be in the game to lead other countries on safety and security; the nuclear Navy as another aspect of security; reliability; resilience (a unique capability of nuclear power in responding to a black start); a clean, carbon-free source of power; energy security for countries with no indigenous fuels and long supply lines; and environmental benefits. This whole story needs to be pulled together.

Rempe pointed out that the NRC has used DOE's modeling and simulation, and DOE has used NRC tools. The two agencies should work together. To stand up a nuclear power plant, a site and someone to build the plant are needed, not just technology.

McGinnis expressed appreciation to the Committee members for their comments, observing that NEAC provides a rich pool of talent and experience. There are many ways to approach this issue. We cannot take our time but need to start doing more than just commercial deployment: research and development, regulatory reform, etc. Some early wins are needed. The pipeline needs to be opened, a vibrant fleet needs to be assembled, and a fuel cycle needs to be developed. A bold path is needed for the Secretary to follow. Making people unhappy should not deter the effort to try once again to stimulate the nuclear industry with significant resources.

He agreed that a mosaic of nuclear power had not been put together. If there were no or little nuclear power, it would be a disaster for the country. NE needs to speak up, telling stakeholders to get going. Something should be written up about the entire enterprise. R&D is the wheelhouse. The Secretary expects NE to be experts in the full breadth of nuclear energy, but particularly on R&D. This is the only office dealing with nuclear energy in the entire federal government. The other fuels have reserves, but nuclear has the best resilience. Possible early wins might be to get loan guarantees to Vogtle, get government resiliency rule-making out, and/or get a big increase in the FY19 budget.

Rempe announced that no one had signed up to make a public comment. However, she called the Committee's attention to the fact that the Committee's recording secretary, Frederick O'Hara, had served on the staff of the Committee since its very beginning, that he was retiring, and that this was his last meeting. She asked if he would address the Committee. He noted that he was the only person in the world who had attended *every* meeting of NEAC, dating back to 1998. Working with NEAC and seven other federal advisory committees had provided an amazing education and allowed him to continue learning throughout his career. There were times when he would be taking notes on lectures by Nobel Prize winners, heads of national laboratories, or government leaders, and he would stop to think, "I used to pay tuition to do this." He thanked the Committee members and the staff of NE for that learning experience. [Round of applause.]

There being no further business, the meeting was adjourned at 4:02 p.m.

Respectfully submitted,
Frederick M. O'Hara, Jr.
Recording Secretary
October 27, 2017