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ENABLING ADVANCED REACTORS AND A LEGISLATIVE HEARING ON S. 2795, THE NUCLEAR ENERGY INNOVATION AND MODERNIZATION ACT

HEARING

BEFORE THE

SUBCOMMITTEE ON CLEAN AIR AND NUCLEAR SAFETY

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

SECOND SESSION

APRIL 21, 2016

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ENABLING ADVANCED REACTORS AND A LEGISLATIVE HEARING ON S. 2795, THE NUCLEAR ENERGY INNOVATION AND MODERNIZATION ACT

THURSDAY, APRIL 21, 2016

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON CLEAN AIR AND NUCLEAR SAFETY,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:45 a.m. in room 406, Dirksen Senate Building, Hon. Shelley Moore Capito (chairwoman of the subcommittee) presiding.

Present: Senators Capito, Crapo, Wicker, Fischer, Inhofe, Carper, Whitehouse, Markey, and Booker.

OPENING STATEMENT OF HON. SHELLEY MOORE CAPITO, U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

Senator CAPITO. I would like to welcome all of our witnesses today, but a particular welcome to an alumnus of this committee, Mr. Merrifield, who told me he began here in 1986. I appreciate your returning.

Each witness has been asked to give a 5-minute oral statement and then take questions.

We are here to examine an exciting topic: advanced nuclear reactors. I would like to thank Senator Carper because I know he has a great interest in this. While nuclear issues may be somewhat new to me, I am learning that these technologies have the potential to make great strides in advancing nuclear technology.

This is a topic many of us are very interested in because nuclear energy is an essential component of our all-of-the-above energy strategy. Our current nuclear plants provide clean, safe, reliable, and affordable energy to power our economy while providing thousands of jobs and millions of dollars in benefits to local communities.

They have made vital contributions to our energy security for years, but we need to look forward to what comes next. Advanced reactors have the potential to be cleaner, safer, and more secure.

One purpose for this hearing is to better understand these technologies and the barriers to their development as commercial energy sources. The other purpose of this hearing is to examine S. 2795, the Nuclear Energy Innovation and Modernization Act, introduced last week by my colleagues, Senators Inhofe, Booker, Whitehouse, and Crapo. S. 2975 directs the NRC to develop a regu-

latory framework under which license applications for a variety of technologies can be reviewed, in keeping with the NRC's safety and security mission.

The NRC's existing regulations were designed around one technology and are not well suited to the innovations that are underway. This is clearly an issue our committee needs to address, and I am glad my colleagues have come forward with a solution.

Efficient and timely decisionmaking at the NRC is crucial for our existing plants and for emerging technologies. The bill modernizes the NRC's budget and fee structure to ensure funds are available to complete reviews that the existing industry needs to remain economically competitive and that will also allow emerging technologies to grow.

The NRC's safety and security mission is a vital one but must be accomplished efficiently and with fiscal discipline. According to the NRC's Principles of Good Regulation, the American taxpayer, the rate paying consumer, and licensees are all entitled to the best possible management and administration of regulatory activities.

This bill aligns with that principle, and I thank my colleagues for their hard work and bipartisanship to advance innovative new energy technologies. These are technologies where our Nation should lead the way, not just for our energy security but also in the interest of national security. Only by leading can we hope to advance our nonproliferation goals.

With that, I am eager to hear Senator Carper's remarks and those of our witnesses.

Senator Carper.

OPENING STATEMENT OF HON. THOMAS R. CARPER, U.S. SENATOR FROM THE STATE OF DELAWARE

Senator CARPER. Thank you, Madam Chairman.

Thanks for letting me be your wing man. It is good to be here with all our colleagues, particularly with Senator Inhofe and Senator Crapo who have a huge interest and a lot of expertise in these issues.

I want to welcome each of you. It is nice to see one of you again for many years now, have a chance to welcome back others and to meet some of you for the first time.

When our country began exploring nuclear power, I think it was more than 60 years ago. I do not know how many had much of an idea how important this technology could be to the future of our Nation's energy supply. Serious incidents in places like Chernobyl, Three Mile Island and Fukushima caused a number of people, both at home and around the world, to question the viability of nuclear power, but I think support for this clean, reliable technology has begun to grow again in recent years.

Given that development, Congress has an important role to play in ensuring that our Nation invests wisely in nuclear while at the same time maintaining our focus on safety. Many Americans may be unaware that nuclear technology was actually invented in the United States. In fact, for a number of years, our Nation led the world in nuclear manufacturing, construction and production.

The jobs and the economic benefit of this growth stayed here at home for the most part. Unfortunately, this is no longer the case.

Many nuclear components are now only available from our international economic competitors, including the French, South Koreans, Japanese and now the Chinese.

While the United States continues to have more nuclear power plants than any other country, other nations, China in particular, are gaining quickly. At the same time, our country's nuclear reactors are getting older, and many will need to be replaced in the years to come.

Some people believe that our Nation's nuclear success story may be winding down. But I believe that like a distance runner, nuclear power in America is just getting its second wind. Albert Einstein used to say with adversity lies opportunity. He was right then, and he is right today.

While this industry has faced a good deal of adversity in recent years, there appears to be a fair amount of opportunity ahead of it now. If we are smart, we will seize the day and begin to replace our aging nuclear reactors with new ones in the years ahead that are safer, produce less spent fuel and are less expensive to build and operate.

If we are smart about it, I foresee an opportunity to develop and build the next generation of nuclear reactors on American soil. I foresee a chance to have some of our closed manufacturing plants reopen, construction crews will be called back to work, and colleges will face a new demand from industry for skilled nuclear technicians.

In short, I foresee an opportunity for the United States to once again lead the world in nuclear technology. Today's hearing is about how we seize this opportunity. Decisions we make today will impact what types of nuclear reactors will be operating in this country 10, 20 even 50 years from now.

Fortunately, there has been good progress of late, and we are beginning to deploy new nuclear technology. Several years ago, the NRC approved construction to build four new reactors in Georgia and South Carolina that will incorporate some of the most up-to-date safety technology.

Construction of these new reactors is creating thousands of new jobs for the economies in those States. It is becoming increasingly likely that small modular reactors will become a reality in this Nation with the first reactors expected to become operational within the next decade. This is an encouraging start, but I know we can and need to do better.

I have also heard from U.S. businesses who believe that we can do better. Over 50 companies are investing in next generation nuclear technologies. Today, we are going to hear directly from a company that is making some of those investments.

As these companies make advances in technology, we need to make sure that our regulatory framework can keep pace. The NRC is considered the world's gold standard of nuclear regulatory agencies. However, as science and technology evolve, so must the NRC.

In closing, let me say I believe that Government in this country has a number of roles to play. I am sure you agree. Among them, few are as important as helping to create a nurturing environment for job creation and job preservation. That includes making sure that we have affordable, dependable energy, that we produce it

safely in this country, and in ways that diminish the threat of climate change rather than increasing it.

Advances in nuclear energy can help us attain that more nurturing environment and provide a more promising future for our Nation, for its people and for our planet. I hope we will learn today about the roles the NRC and other agencies need to play if that promising future is to be realized.

Thank you, Madam Chair.

Senator CAPITO. Thank you.

With that, I think the Chairman has requested time.

Senator INHOFE. Just unanimous consent that my statement be placed in the record.

Senator CAPITO. Without objection, so ordered.

[The prepared statement of Senator Inhofe follows:]

STATEMENT OF HON. JAMES M. INHOFE,
U.S. SENATOR FROM THE STATE OF OKLAHOMA

I have been a strong supporter of nuclear energy since I became Chair of this subcommittee almost 20 years ago. It is a vital source of clean, safe, and affordable energy which helps power this machine called America.

Our existing nuclear plants have run safely for decades and will operate for years to come. However, I believe we also need to look to the future.

Innovation has come to the nuclear industry. There are many new companies, nuclear "startups," in fact, that are pursuing concepts that advance safety, security, and efficiency.

I strongly support this progress and am eager to see these innovators succeed.

That is why I joined my colleagues—Senators Booker, Whitehouse, and Crapo—to introduce the Nuclear Energy Innovation and Modernization Act.

Advanced reactor innovators must have an efficient regulatory process at the Nuclear Regulatory Commission in order to bring these new technologies into operation.

The NRC's existing processes were designed around one particular technology: light water reactors. These processes are poorly suited for the wide range of advanced technologies currently being pursued.

Our bill directs NRC to develop "technology inclusive" regulatory processes in an effort to enable the growth of the new, exciting industry.

Our section to modernize NRC fees reflects oversight work done by the EPW Committee over the last few years.

One need that is shared between advanced reactor innovators and existing reactor operators is the need for timely decisionmaking from the NRC.

Our bill directs the NRC to budget for industry requested work and to preserve those funds solely for those purposes to improve the NRC's timeliness.

Altogether, these provisions represent a solid, bipartisan effort to modernize the cost and regulatory frameworks and enable the development of new generations of reactors with bold new technologies.

Other countries like China and Russia are proceeding to develop advanced technologies regardless of what we do here in the U.S. We cannot forgo advancements in reactor technology or we forgo our economic competitiveness and worldwide influence on nuclear non-proliferation.

We need to enable advanced reactor innovators by providing a regulatory framework that is predictable and cost effective while maintaining the NRC's safety and security mission. This bill does that.

In a time when people question whether Congress still knows how to be bipartisan, this bill is proof that we can find common ground and craft important solutions to benefit the Nation.

This legislation was the product of teamwork with my friends, Senators Booker, Whitehouse, and Crapo. I'm proud to be part of that team.

Senator CAPITO. Again, I would like to thank the witnesses and welcome you to give a 5-minute statement. Your full testimony has been submitted for the record. Then we will go through a round of questioning.

Senator Booker, I understand you would like to make a comment about the bill in advance of the testimony.

OPENING STATEMENT OF HON. CORY A. BOOKER, U.S. SENATOR FROM THE STATE OF NEW JERSEY

Senator BOOKER. I am very grateful, Madam Chairman, for this opportunity, and thank you for giving me a chance to say a few words.

I am a Senator today with no name today, or a Senator whose name shall not be mentioned.

Again, thank you, Chairman Capito. I want to thank Senators Inhofe, Whitehouse and Crapo for their partnership on this really important bill.

American leadership on nuclear energy is absolutely critical. The historic Paris Climate Agreement set ambitious goals to target and limit global warming to 1.5 centigrade above pre-industrial levels. However, scientists agree that even if all countries meet their commitments under this pact, we are not on track to meet these ambitious targets, not even close. Meeting the rising global demand for energy while simultaneously slashing carbon emissions presents a very difficult challenge for this generation.

Think about this. By 2050, meeting the Paris targets would require us to cut emissions by up to 70 percent while producing 70 percent more electricity. That is an incredibly difficult thing to do, to produce 70 percent more electricity than we do today while at the same time emitting 70 percent less carbon.

I am a big believer in energy efficiency and renewable energy. I fought with other Senators to expand the tax credits last year for renewable, but in order to avert the worst effects of climate change, we do not see any way around the idea that we must substantially increase our nuclear energy capacity in the coming decades. We have no choice but to increase nuclear capacity.

Nuclear energy, which provides a critical baseload power, currently comprises more than 60 percent of our Nation's carbon free electricity generation. Right now in the United States we have five new reactors under construction, the first new commercial units in 30 years, but several existing reactors have already been shut down prematurely, and many more are at risk.

We need to make sure that we see dozens of more private sector companies beginning to move into this area and help to produce an environment where they are making their billion dollars of investment.

We desperately need sound, long term Government policies that will support our existing fleet and also support a sustained commitment by the private sector to advance nuclear reactors that can be commercialized in the future.

This bill, S. 2795, takes several positive, bipartisan steps in that direction. First, the bill would direct NRC to develop new staged licensing processes for advanced nuclear reactors. Second, the bill would, over longer terms, put in place new technology, inclusive regulatory framework and would make licensing of advanced nuclear more efficient, flexible and predictable while maintaining the NRC's safety and security missions.

Third, the bill would authorize a new cost sharing grant program at the Department of Energy that would help the first advanced reactor projects that move forward to pay for some of the licensing costs at NRC.

This bill would place a cap on the annual fees that existing nuclear reactors pay to the NRC. While this cap may never be hit, putting it in place will provide certainty and protection for the existing fleet.

This is a critical challenge we have in our Nation right now, making sure we are meeting our energy needs, dealing with the realities of climate change and empowering business and innovation.

I am very happy to have worked in a bipartisan fashion on what is a solid bill that will help us to take a step forward.

Thank you, Chairman, for providing me this opportunity to make an introduction to the bill. I look forward to hearing from all of our witnesses.

Senator CAPITO. Thank you.

Senator INHOFE. Just a 10-second response. Let me assure you that while we enjoy this bill, we are co-sponsoring the bill, it has nothing to do with global warming. The disaster you will see tomorrow of what they call Earth Day in New York is an embarrassment. The President is not even going there for it.

My motivation on this is when I say all of the above to save this country, all energy, it includes nuclear. Thank you.

Senator CAPITO. Thank you.

Another bill sponsor, Senator Crapo, would like to make an introduction to the bill and make some comments.

OPENING STATEMENT OF HON. MIKE CRAPO, U.S. SENATOR FROM THE STATE OF IDAHO

Senator CRAPO. Thank you, Madam Chairman. I appreciate the opportunity to be here today.

Senators Inhofe, Whitehouse, Booker and I have introduced legislation to ensure the NRC will be ready to license advanced reactor designs as companies are ready to commercialize them.

We have undertaken a deep dive into the inner workings of the Commission. Through hearings and discussions with officials and stakeholders, we have developed a plan that will help modernize the Commission and enable it to stay abreast of reactor design advancements in the nuclear industry.

Our bill, the Nuclear Energy Innovation and Modernization Act, NEIMA, increases transparency and accountability in the NRC's budget and fee structure through modernizing reforms based on years of EPW oversight efforts.

The measure also directs the agency to develop a technology inclusive regulatory framework enabling the Commission to review a diverse set of advanced reactor technologies. NEIMA's improvements bring a great deal of transparency and accountability to the NRC.

We want the Commission to make changes that allow stakeholders of various backgrounds and motivations to look at the Commission's actions and understand what it is doing.

In particular, the agency must be more transparent in its budgeting and fee process. This is especially true regarding the Com-

mission overhead costs. When the NRC talks about overhead costs, it refers to activities that may be categorized as corporate support, office support and mission indirect.

At this point, our bill only captures one portion of these overhead costs, the corporate support costs, because that is the only portion of the overhead costs that we can get the NRC to clearly label and define. The NRC must endeavor to make its budgeting information more transparent and accessible.

Some amount of overhead is necessary for all organizations. Nonetheless, the NRC needs to be able to clearly account for its overhead costs and for the way it uses fees from licenses to support these costs. Clear and transparent budget processes are required for effective oversight. This is something I look forward to working with my fellow EPA colleagues on, both in this bill and in beyond.

Finally, it is imperative that we licensing process for advanced reactors is transparent and takes into account past lessons learned. NEIMA enables the NRC to create a technology inclusive regulatory framework. By creating a technology inclusive framework, we are enabling the NRC to review and license any advanced reactor design that it considers to be safe and secure.

We are not forcing the NRC to pick winners and losers among reactor designs by forcing it to allocate resources on one type of reactor or design. As a whole, NEIMA provides important transparency and accountability improvements across the NRC and improves the communication between various stakeholder groups and the agency.

Enabling better transparency, accountability and communication are critical to ensuring the NRC remains the world's preeminent safety and security regulator. Such improvements also provide more stability and predictability in the industry and among stakeholder groups.

Increasing the NRC's ability to be transparent and accountable will increase its ability to perform its safety mission and share information with all stakeholder groups.

Thank you very much, Madam Chairman.

Senator CAPITO. We would like to go to the witnesses, but I understand the original sponsor, Senator Whitehouse, has some comments.

OPENING STATEMENT OF HON. SHELDON WHITEHOUSE, U.S. SENATOR FROM THE STATE OF RHODE ISLAND

Senator WHITEHOUSE. Thank you, Madam Chairman.

Let me first thank Chairman Inhofe, Senators Crapo and Booker for the work we have done together to try to streamline this process.

The sense that I have and that brought me to this conversation is that the approval process at NRC is an obstacle course that is designed for a particular type of technology but is not well suited to technologies that are not that technology.

Indeed, the irrelevancy, as I think someone mentioned to me, is two plus two equals cheese. It just does not fit or make sense at all.

We do have new technologies that are emerging. They have enormous promise for a carbon constrained world. We, in America, have

done a lot of the leadership design for them, but if we cannot get them through a process to where they are actually creating electrons, then we have not done ourselves any good. I look forward to pursuing this.

I would add two brief points. One is that it should remain, I think, a very high priority goal of this committee and this process to continue to point toward ways to reuse spent nuclear fuel.

Some of these technologies hold out at least the promise of taking the enormous stockpile of what is now dangerous nuclear waste, for which we have no means of disposal and which will be very expensive to deal with, and repurpose that into, as one person told me, potentially trillions of dollars of virtually free power. That, I think, needs to be a significant subordinate goal as we go forward in this process.

The last thing I will say is that I think it is a tragedy that we are losing some of our nuclear facilities to an economic problem, that there is no payment for their carbon free power. If a nuclear plant is not safe, then I am the first person to want to shut it down yesterday.

However, if the only reason it is being shut down is because it cannot compete economically with a natural gas plant, and the only reason it cannot compete economically with a natural gas plant is because it gets no benefit for being carbon free when across the country through our corporate world, throughout our Government, we recognize there is actual value to being carbon free, then we are artificially damaging an industry that should be doing better.

We need to figure out a way to make sure there is, in fact, a payment to this industry for the carbon free value of the electrons they produce.

With that, I will close my comments.

I again thank my colleagues on this bill for their leadership. I am delighted to be working with them.

Senator CAPITO. Thank you.

We will proceed to the witnesses. I am going to begin on my left with Dr. Christina A. Back, Division Director of General Atomics Inertial Fusion and Advanced Fission.

Welcome.

STATEMENT OF CHRISTINA A. BACK, DIVISION DIRECTOR, INERTIAL FUSION AND ADVANCED FISSION, GENERAL ATOMICS

Ms. BACK. I would like to thank Chairman Capito and Ranking Member Carper for holding this hearing and Chairman Inhofe, Senators Crapo, Whitehouse and Booker for their legislation. Also, thanks to my home State Senator, Ranking Member Boxer.

My name is Christina Back, and I am the Vice President of Nuclear Technologies and Materials at General Atomics. General Atomics is a privately held company with over 60 years of experience in nuclear energy, one where we continuously push the technological envelope.

I was asked to describe what nuclear reactors are and what we believe may be appropriate issues for you to consider when developing public policy for encouraging the development of new reactors. We believe advanced reactors are vital to making nuclear

power economically competitive and vital to reversing the current decline of the nuclear industry.

In order to be helpful to the committee's efforts, I would like to start by noting that the term advanced reactors is somewhat loosely used. Some people consider them to be non-light water reactors, while others mean new light water reactors.

We believe an advanced reactor concept is one whose design is guided by the four core principles that help ensure economic success. These principles are to produce significantly cheap electricity, to be safer, to produce significantly less waste, and reduce proliferation risk. We believe every worthy reactor concept must address these four core principles jointly if it is to be an advanced reactor. It is not sufficient to excel in just one with disregard to the others.

I would like to discuss GA's reactor concept. This is one of many of the advanced reactor concepts referred to before. GA has a concept which is an energy multiplier module or EM2. As a way of illustrating what advanced can mean, I would like to discuss this reactor.

GA chose to employ innovative design and engineered materials to meet the four core principles. What makes it compelling to think about nuclear reactors and advanced reactors now is that in the last 30 years scientists have made unprecedented advances in understanding materials.

We at GA know how to manipulate these materials and are trying to revitalize the nuclear industry with them. Now let us consider each of the principles I mentioned.

First is cost. The drive to make a cheaper reactor led us to design a much smaller reactor that would produce up to 60 percent more power than today's reactor from the same amount of heat.

Second is safety. For a radical improvement in safety, EM2 uses engineered, ceramic materials to hold the fuel that work in intense radiation and withstands more than two times higher temperatures than current reactor materials today. They would not be subject to failure like those in Fukushima.

Third is waste. EM2 will reduce the amount of waste by at least 80 percent. The reactor can also use spent light water reactor waste as fuel, thus turning this waste into energy.

Fourth is nonproliferation. EM2 keeps the fuel in the reactor for 30 years without the need for refueling or repositioning the fuel rods. This means we access the core once, much less than the 20 times the current reactors need for existing refueling. We calculate that EM2 will produce power at approximately 40 percent lower costs than today's reactors and be passively safe.

As for any new reactor design, this one will require extensive interactions with the NRC, and we think involving the NRC early in this process is important to inform the design for a safer reactor. Radically new concepts require up front investment involving risk. Some of these investments may not pay off, and even those that are successful could take up to 10 years to produce revenue.

While GA has already invested $40 million in EM2, it is hard to divert scarce dollars from R&D to NRC considerations at this early point in time. If this committee's objective is to stimulate the development of new advanced reactors, hopefully as we have defined and

outlined here, we suggest that it would be relatively inexpensive to involve the NRC early in the consultations with potentially very high impact.

We suggest the committee consider authorizing the appropriation of $5 million at first to provide NRC services to developers of advanced reactors and perhaps with a relatively low cost share of, say, 3 percent. The NRC is important and necessary for ensuring nuclear power is safe. Therefore, it plays a critical role in nuclear power innovation.

In closing, I would like to say right now is a very exciting time in nuclear energy. I love that I get to put science in practice and engage the next generation of scientists and engineers and help meet the Nation's energy needs by creating a new, innovative way to produce clean and safe power.

Thank you for the efforts of this committee. Thank you for the opportunity to speak to you. I would be pleased to answer questions.

[The prepared statement of Ms. Back follows:]

GENERAL ATOMICS

Testimony of Christina Back, Ph.D.
V.P., Nuclear Technologies and Materials, General Atomics
Before the U.S. Senate Committee on Environment and Public Works, Subcommittee on Clean Air and Nuclear Safety "Enabling Advanced Reactors and a Legislative Hearing on S.2795, The Nuclear Energy Innovation and Modernization Act"
April 21, 2016

Chairman Capito, Chairman Inhofe, and Ranking Members Carper and Boxer, thank you for the invitation to appear before you today. My name is Christina Back and I am the Vice President of Nuclear Technologies and Materials at General Atomics. General Atomics is a privately held company providing high-technology systems with over 60 years of experience in nuclear energy starting with the TRIGA research reactor. I was asked to describe what "advanced reactors" are, and what we believe may be appropriate issues for you to consider when developing public policy for encouraging the development of new reactor concepts.

We believe that it is important for our country to increase its use of nuclear energy because it is critical to maintain a diversity of energy sources and nuclear provides emission-free, baseload electricity. If we could make nuclear energy cost-competitive it would provide thousands of years of safe, clean electricity for our country. In addition, remaining the technology leader in nuclear energy is critically important to minimize foreign dependence and strengthen national security.

Unfortunately, because nuclear energy using existing technology is currently too expensive to be competitive, the U.S. nuclear industry is in decline. To reverse this trend, we believe our country must do what it does best: bring the ingenuity of its people to bear on creating new ways to produce nuclear energy safely, cleanly and at much lower cost. We are very pleased that there seems to be increased interest in this effort as shown by Members of this Committee, attention from the Administration, and efforts from industry.

In order to be helpful to the Committee's effort, I would like to start by noting that thus far, the term "advanced reactors" has been used rather loosely, and can mean different things to different people. Some people consider it to refer to any non-light water reactor, such as a gas-cooled, sodium-cooled, or molten salt-cooled reactor. Others use it to refer to a new light water reactor, such as a Small Modular Reactor (SMR).

To establish the context, let's remember that, fundamentally, nuclear energy involves splitting an atom and using the heat energy released, to turn a generator to produce electricity. At the end of the day, electricity is a commodity, and many consumers do not care whether it is made from nuclear fuels or from burning coal or gas, or from renewables; what matters is its cost.

To provide that commodity in today's world, an "advanced reactor" must improve over existing reactors in the following 4-core attributes. It must:

- produce cost-competitive clean electricity,
- be safer,
- produce significantly less waste, and
- reduce proliferation risk.

These four attributes are consistent with the definition of the seven improvements identified for an advanced reactor in the Nuclear Energy Innovation Modernization Act. Essentially, three of the defined improvements: reliability, thermal efficiency and ability to integrate electric and non-electric applications, are connected with the first attribute, cost-competitive electricity. Fuel utilization is intertwined with the third attribute, less waste. We believe every worthy advanced reactor concept must address these 4-core attributes jointly. It is not sufficient to excel at one with disregard to the others.

Now, I would like to discuss General Atomics' reactor concept, the Energy Multiplier Module or EM^2, as a way to illustrate what "advanced" can really mean. EM^2 was designed, from the beginning, to meet the 4-core attributes I just mentioned.

In the design of EM^2, GA gave serious consideration to risk versus payoff, and we chose to employ innovative design and innovative engineered materials to reach our goals. What makes it compelling to rethink advanced reactors now is that in the last 30 years, scientists have made unprecedented advances in understanding materials. It is now actually possible to engineer and manipulate materials for specific applications. Use of customized materials and technologies is what we chose to do for EM^2. This is what sets GA apart.

Now I will go through each of the attributes. First is cost. The drive to minimize costs led to the design of a much smaller reactor that could produce much higher power output per reactor volume than today's reactors. It also led to a push to higher efficiency, i.e., 50% more electric power from the same amount of heat. We do this by producing the electricity from higher temperature heat.

Second is safety. For a radical improvement in safety, EM^2 uses engineered ceramic materials that are capable of working in higher radiation and higher temperature environments. The fuel is contained in materials that can survive accident temperatures over 2 times higher and would not be subject to failure like those in Fukushima. While challenges remain, our results so far have been promising. If they hold up, we will revolutionize this industry.

Third is waste. Minimizing waste products is linked to better fuel utilization. For EM^2, this is accomplished by the innovation of long-burn core physics and by higher conversion efficiency. Consequently, EM^2 will use only 20%of the fuel and produce only 20% of the waste of a current reactor for the same amount of power.

Finally, fourth is non-proliferation. The innovative design of EM^2 keeps the fuel in the reactor for 30 years, without the need to refuel or reposition fuel rods. Less handling of the fuel, and tight security allowed by offsite core fabrication significantly reduces proliferation concerns and lowers operating costs.

As a guiding principle, we believe that to bring advanced nuclear power into the market, the cost of nuclear must be significantly reduced below the existing levels projected for new light water reactors. This reactor, if it performs as designed, would produce power at perhaps 40% lower cost than today's existing nuclear reactors, and with a capital investment per EM^2 unit in the $1.5 billion range. It would be produced in a factory, reducing proliferation concerns and potentially reducing licensing costs, and shipped to the site and installed within 4 years, again keeping costs down.

As for any new reactor design, this one will require extensive interactions with the NRC. In particular, this radically new material requires intensive development and testing. We think involving the NRC early in this work is imperative. Ideally, interactions would occur early enough to inform the design from the beginning and produce a safer reactor design. Then, when we applied for licensing based on what the market called for, a few years from now, this early effort would pay off many times over.

GENERAL ATOMICS

Radically new concepts that employ new technology require upfront investments involving some risk. Some of these investments may not pay off, and even those that are successful could require at least 10 years to produce any revenue. While General Atomics has already invested $40 million in the EM^2 concept, these commercial realities make it very difficult to justify early costs to engage the NRC.

If this Committee's objective is to stimulate the development of new advanced reactor concepts, we would suggest that it is in this early phase of development that it would be relatively inexpensive to involve the NRC for early consultations with potentially very high impact. Every advanced reactor concept that involves significant long lead development would benefit enormously from being able to work with the NRC at an early stage.

We suggest the Committee consider authorizing the appropriation of $5 million at first, growing to possibly $15 million over 5 years, to provide NRC services to developers of advanced reactor concepts. To trigger funding, a relatively low cost share of perhaps 3%, could be required. In addition, the NRC could engage outside advice from the DOE, universities, and other experts, to ensure the individual reactor concepts were viable.

We very much appreciate your interest in this subject, and this opportunity to appear before you. The NRC is an important and necessary agent in ensuring nuclear power is safe. Therefore, it plays a critical role in nuclear power innovation. I would be pleased to respond to any questions you may have. Thank you.

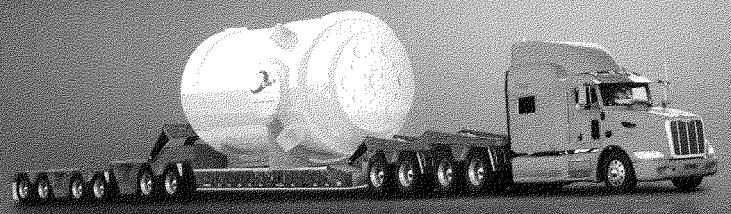
CHRISTINA BACK, PH.D. TESTIMONY

APPENDIX 1

Energy Multiplier Module (EM^2): A Performance-Based Reactor Concept

By
Dr. Christina Back
Vice President
Nuclear Technologies and Materials

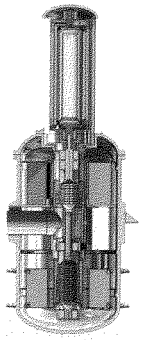
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Appendix 1

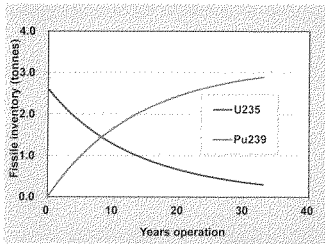


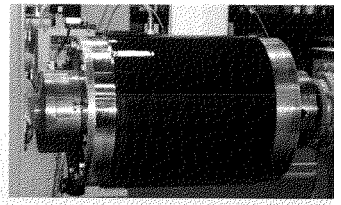
GENERAL ATOMICS

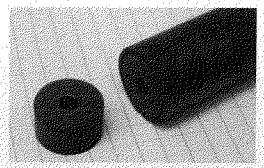
New Technologies Are Key

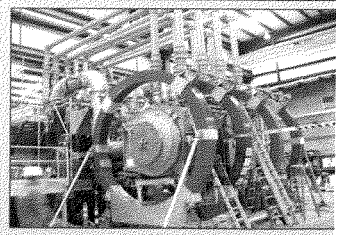
- Convert-and-burn core physics
- Silicon carbide composite structures
- Advanced fuels
- High temperature systems
- Asynchronous, high-speed compact generators
- Proliferation resistant used fuel recycling







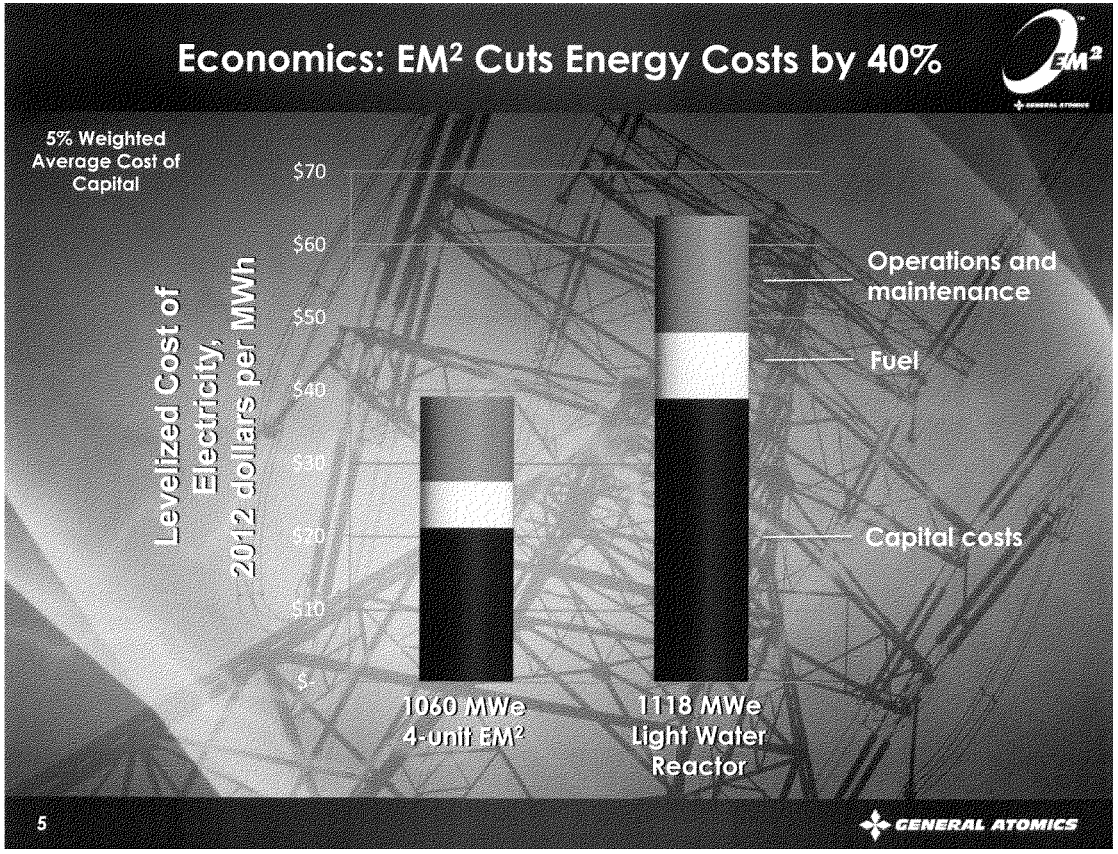




GENERAL ATOMICS

Economics: Higher Efficiency and Higher Power Density
Gas Reactor
286 MWe @ 48% eff.
6.6W/cc power density
Efficient, large and high power
6.6W/cc
30.5 m
8.2 m
Fast Gas Reactor
265 MWe @ 53% eff.
58W/cc power density
Compact size, highly efficient and high power
58W/cc
GENERAL ATOMICS
3

Economics: Performance-Based Comparison
EM²
265
45
Power (MWe)
NuScale
65 ft.
28%
33%
38%
43%
48%
Efficiency
EM²
35 ft.
GENERAL ATOMICS
4


Economics: EM² Cuts Energy Costs by 40%
5% Weighted Average Cost of Capital
Levelized Cost of Electricity, 2012 dollars per MWh
$70
$60
$50
$40
$30
$20
$10
$-
Operations and maintenance
Fuel
Capital costs
1060 MWe 4-unit EM²
1118 MWe Light Water Reactor
5
GENERAL ATOMICS

Safety: Requires High Temperature Materials and New Fuels to Achieve Passive Safety



Silicon Carbide (SiC) loses strength (2000°C)

2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200

UN (2700°C)

UC (2400°C)

Primary ceramic fuels

Primary fuels and their approximate melting points:

UMo (1200°C)

UZr (1130°C)

Primary metal alloy fuels

EM^2 Gas (850°C)

Metals lose strength (700°C)

Lead-bismuth (500-600°C)

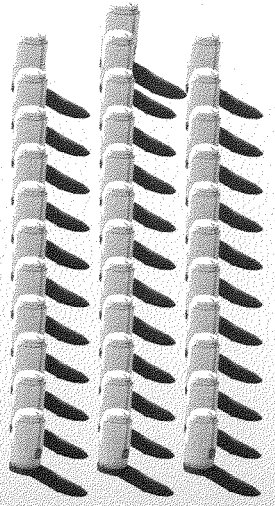
Molten salt (600°C)

Sodium (550°C)

Light Water (LWR) (300°C)

Waste Reduction: Benefits from High Temperature and Radiation Resistant Materials

One LWR produces ~600 tonnes of nuclear waste over 30 years



$$\frac{1}{1.6} \times \frac{1}{3} \simeq \frac{1}{5}$$

- $\frac{1}{1.6}$: 60% more efficient than LWR
- $\frac{1}{3}$: Higher burnup
- $\frac{1}{5}$: The fuel of LWR

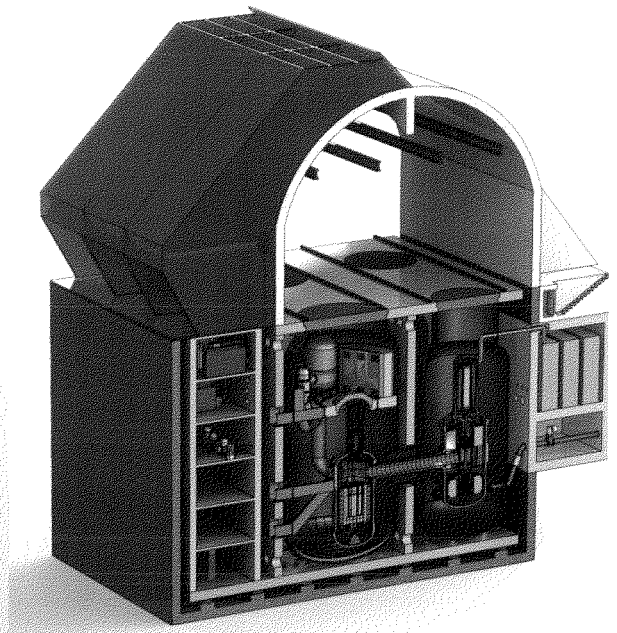
4-unit EM² produces 80% less waste over the same period



For EM² closed cycle, waste is further reduced to 97%

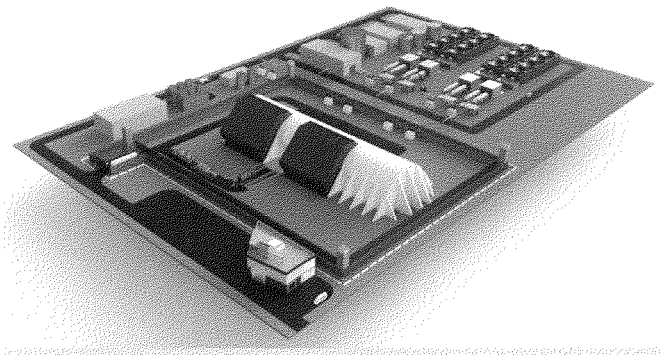
Enhanced Proliferation Resistance: Underground Siting

- **Reduces vulnerability to some surface-based threats**
- **Fuel not accessible**
  - Sealed core
  - Core cannot be reconfigured
  - Fuel handling equipment not on site
- **Fuel highly self-protecting**



Energy Multiplier Module (EM^2) is a Compact Fast Gas Reactor Optimized for the 21st Century Grid

Below-ground construction negates many physical threats and improves security



1060 MWe EM^2 plants fits on 9 hectares

- 30-year fuel life – high burnup
- Multi-fuel capable
- Reduced waste stream
- Cost competitive
- Flexible siting, no need for water cooling
- Rapid load following
- Higher efficiency – 53% net

CHRISTINA BACK, PH.D. TESTIMONY

APPENDIX 2

GENERAL ATOMICS

Christina A. Back, Ph.D.
Vice President,
Nuclear Technologies and Materials



Dr. Christina Back has 27 years of experience leading research in private industry and US Department of Energy (DOE) laboratories, including the DOE weapons complex. She is internationally recognized in both fission and fusion energy research and regularly serves on committees for the National Academy of Sciences, National Nuclear Security Administration, and the DOE. She has over one hundred peer-reviewed publications and is a Fellow of the American Physical Society.

At General Atomics, Dr. Back is responsible for nuclear fission programs, which draw on a diverse portfolio of innovative technologies. Current activities focus on the development of advanced nuclear reactors for electric power, production of isotopes for medical uses, and fabrication of Accident Tolerant Fuel rods for safer nuclear reactors, among other projects.

Dr. Back is a scientist who earned her B.S. in physics from Yale University, and her Ph.D. in plasma physics from the University of Florida. She spent two years as an experimentalist at the Ecole Polytechnique in France. Prior to joining General Atomics, she performed research using high powered lasers at Lawrence Livermore National Laboratory in the Inertial Confinement Fusion and High Energy Density Science programs for 13 years. She has devoted more than two decades to energy research and holds an active DOE-Q and US Department of Defense clearance.

For her contributions, Dr. Back has received numerous awards, including the DOE Technical Excellence Award and Defense Nuclear Sciences Award. In 2013, she was named Woman of the Year in Business by the San Diego East County Chamber of Commerce.

Senator CAPITO. Thank you.

Our next witness is Dr. Ashley E. Finan, Policy Director, Clean Air Task Force, Advanced Energy Systems.

Welcome.

STATEMENT OF ASHLEY E. FINAN, POLICY DIRECTOR, NUCLEAR INNOVATION ALLIANCE

Ms. FINAN. Chairman Capito, Ranking Member Carper, and distinguished members of this subcommittee, thank you for holding this hearing and for giving me the opportunity to testify.

My name is Ashley Finan, and I am Policy Director for the Nuclear Innovation Alliance, NIA, a non-profit organization dedicated to leading advanced nuclear energy innovation.

The NIA was established by a cross cutting group who believe that advanced nuclear energy is needed to ensure a better future. This group includes innovators, academics, environmental organizations, industry groups and other experts and stakeholders.

The world will double or triple its energy demand in 30 years, driven by a growing middle class in the developing world and the need to bring electricity to 1.4 billion people who lack it today. At the same time, many analyses point to the pressing need to reduce global carbon emissions by 80 percent or more by 2050 if we are to avoid the worst impacts of climate change. A more rapid expansion of nuclear power is an essential part of the solution.

In the United States and elsewhere, dozens of innovative startup companies and other stakeholders are pioneering designs that promise to lower risk and cost and reduce deployment barriers, but the transition from design to commercialization and deployment, both in the U.S. and globally, has been slow.

Current NRC regulation confronts the licensing of advanced technologies with two major challenges. First, NRC design certification or approval calls for enormous front loaded investment during a protracted development and licensing phase without a staged structure to provide applicants with clear, early feedback on an agreed schedule.

Second, current regulation primarily evolved to oversee light water reactor technologies. It must be adapted to the features and performance characteristics of advanced reactors, which rely on substantially different fuels, cooling systems, and safety strategies, and require novel operating strategies.

Over the past 2 years, the NIA has been developing strategies to facilitate the efficient, cost effective, and predictable licensing of advanced nuclear power plants in the United States. These strategies are based on consultations with nuclear innovators, safety experts, regulators and investors, key stakeholders of the nuclear industry.

We compiled the results of our work into a report called Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing, which was issued on April 12. The report has been provided to the committee and is available to the public on the NIA Web site. It discusses in much greater detail the points that I am touching on today.

To address the LWR-centric nature of the current regulations, a more technology inclusive approach is needed. A risk informed, per-

formance based licensing approach will allow the NRC to review a diverse set of advanced reactor technologies.

This would incorporate both modern methods of risk assessment and traditional deterministic approaches to provide an exhaustive safety review. S. 2795 provides for the NRC to do work in this area without impacting the costs incurred to the existing plants.

To illustrate the investment challenge, I would like to direct your attention to Figure 1. This shows schematically the risk/investment profile of nuclear energy projects relative to the licensing process today and the large monetary and temporal hurdle of obtaining design approval.

Figure 2 illustrates a staged approach that provides interim feedback and opportunities for risk reduction. It better aligns with private sector development of innovative technology using a licensing project plan, topical reports, and other mechanisms. It can provide clear and early feedback to investors and developers through a statement of licensing feasibility process. This approach maintains the rigor and high standards of the NRC and facilitates the development of advanced nuclear technology that produces less waste or even consumes it.

S. 2795 authorizes the NRC to do the crucial work to develop and implement this staged licensing process with dedicated funding. This is important for two reasons. It helps the NRC to develop the rigorous, technology inclusive regulatory infrastructure to support the review of advanced nuclear energy technologies.

Significantly, it does this without diluting funds used to regulate operating plants. It also allows for immediate adjustments that will provide a more efficient, predictable, and effective process.

Thank you for this opportunity to testify. S. 2795 is needed to enable progress and advance nuclear energy.

I would be pleased to respond to any questions you might have today or in the future.

[The prepared statement of Ms. Finan follows:]

Written Testimony of
Dr. Ashley E. Finan
Policy Director
Nuclear Innovation Alliance

Before the Subcommittee on Clean Air and Nuclear Safety
Committee on Environment & Public Works
U.S. Senate

Enabling Advanced Reactors

April 21, 2016

Summary of Testimony

Chairman Capito, Ranking Member Carper, and distinguished members of this subcommittee, thank you for holding this hearing and for giving me the opportunity to testify. My name is Ashley Finan, and I am Policy Director for the Nuclear Innovation Alliance (NIA), a non-profit organization dedicated to leading advanced nuclear energy innovation.

The NIA was established by a cross-cutting group of innovators, academics, environmental organizations, industry groups, and other experts and stakeholders who believe that advanced nuclear energy is needed to ensure a better future. The world will double or triple its energy demand in 30 years, driven by an emerging middle class in the developing world and the need to bring electricity to 1.4 billion people who lack it today. At the same time, many analyses point to the pressing need to reduce global carbon emissions by 80 percent or more by 2050 if we are to avoid the worst impacts of climate change.

A more rapid expansion of nuclear power is an essential part of the solution. In the United States and elsewhere, dozens of innovative start-up companies and other stakeholders are pioneering designs that promise to lower risk and cost, and reduce deployment barriers. But the transition from design to commercialization and deployment—both in the US and globally—has been slow.

Current NRC regulation confronts the licensing of advanced technologies with two major challenges. First, NRC design certification or approval calls for enormous front-loaded investment during a protracted development and licensing phase—without a staged structure to provide applicants with clear, early feedback on an agreed schedule. Second, current regulation primarily evolved to oversee light water reactor (LWR) technologies. It must be adapted to the features and performance characteristics of advanced reactors, which rely on substantially different fuels, cooling systems, and safety strategies, and require novel operating strategies.

Over the past two years, the NIA has been developing strategies to facilitate the efficient, cost-effective, and predictable licensing of advanced nuclear power plants in the United States. These strategies are based on consultations with nuclear innovators, safety experts, former NRC staff and commissioners, members of the financial community, and other nuclear industry stakeholders. We compiled the results of our work into a report called "Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing," which was issued on April 12th. The report has been provided to the Committee, and is available to the public on the NIA website. It discusses in much greater detail the points that I am touching on today.

To address the LWR-centric nature of the current regulations, a more technology-inclusive approach is needed. A risk-informed, performance-based licensing approach will allow the NRC to review a diverse set of advanced reactor technologies. This would incorporate both modern methods of risk assessment and traditional deterministic approaches to provide an exhaustive safety review. S.2795 provides for the NRC to do work in this area without impacting the costs incurred to the existing plants.

To illustrate the investment challenge, I'd like to turn to Figure 1. This shows schematically the risk/investment profile of nuclear energy projects relative to the licensing process today, and the large monetary and temporal hurdle of obtaining design approval.

Figure 1: Current Project Risk/Investment Profile Relative to Licensing

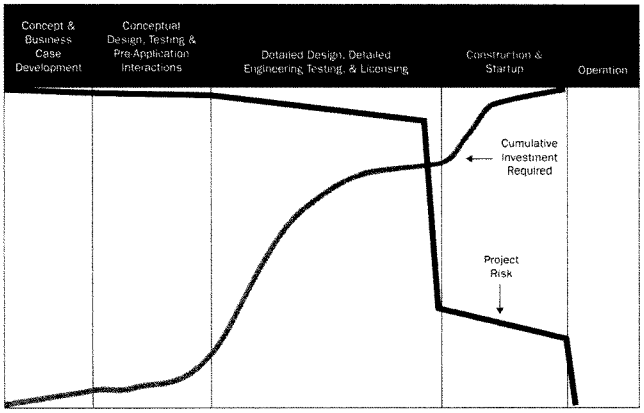
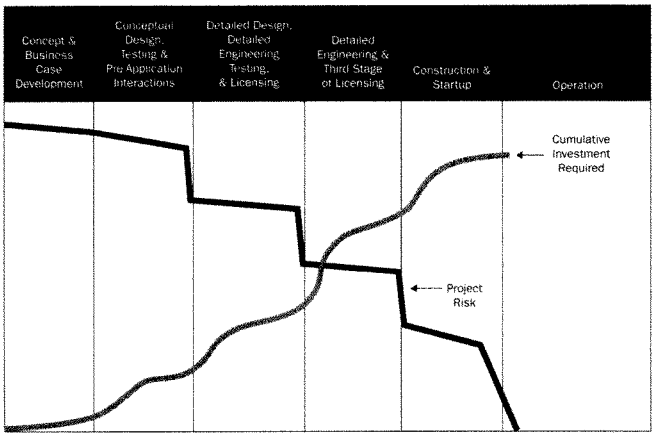


Figure 2 illustrates a staged approach – one that would update the current process to be more aligned with private sector development of innovative technology using a licensing project plan, topical reports, and other mechanisms; and one that would provide clear and early feedback to investors and developers through a statement of licensing feasibility process. This approach maintains the rigor and high standards of the NRC, and facilitates

the development of safer nuclear technology that produces less waste, or even consumes it.

Figure 2: Desirable Project Risk/Investment Profile Relative to Licensing



S.2795 authorizes the NRC to do the crucial work to develop and implement this staged licensing process with dedicated funding. This is an important bill that will enable the NRC to develop the rigorous, technology-inclusive regulatory infrastructure to support the review of advanced nuclear energy technologies without diluting funds used to regulate operating plants. It also allows for immediate adjustments that will provide a more efficient, predictable, and effective process. S.2795 is needed to enable progress in advanced nuclear energy.

Thank you for this opportunity to testify. I would be pleased to respond to any questions you might have, today or in the future.

Full Written Testimony

Chairman Capito, Ranking Member Carper, and distinguished members of this subcommittee, thank you for holding this hearing and for giving me the opportunity to testify. My name is Ashley Finan, and I am Policy Director for the Nuclear Innovation Alliance (NIA), a non-profit organization dedicated to leading advanced nuclear energy innovation.

The NIA was established by a cross-cutting group of innovators, academics, environmental organizations, industry groups, and other experts and stakeholders who believe that advanced nuclear energy is needed to ensure a better future.[1] The world will double or triple its energy demand in 30 years, driven by an emerging middle class in the developing world and the need to bring electricity to 1.4 billion people who lack it today. At the same time, many analyses point to the pressing need to reduce global carbon emissions by 80 percent or more by 2050 if we are to avoid the worst impacts of climate change.

A more rapid expansion of nuclear power, though an essential part of the solution, faces stiff challenges. Accidents raise public fears about safety; large cost overruns and protracted schedules deter investors and owners; and concern over spent nuclear fuel disposal and weapons proliferation continues to block expansion in some parts of the world.

Innovation will be necessary if these challenges are to be addressed. In the US and elsewhere, dozens of innovative start-up companies and other stakeholders are pioneering new designs that promise to lower risk and cost, and reduce deployment barriers. But, despite the American talent for developing advanced nuclear reactor technologies, the transition from design to commercialization and deployment—both in the US and globally—has been slow. Two of the most critical barriers are the lack of a clear and efficient pathway for a first demonstration project, and continuing doubt that the Nuclear Regulatory Commission (NRC) will be able to issue a license for a non-light water reactor in a time frame compatible with private-sector needs. *These obstacles **must** be addressed before we can realize the benefits of the next generation of nuclear technology.*

Many other hurdles exist, including technology challenges, supply chain limitations, a difficult market environment, inaction on nuclear waste management, and restrictions on international cooperation. In addition, clean air policy must be updated to recognize the benefits of nuclear power. Progress on all of these fronts is urgently required.

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[1] A list of NIA Policy Committee and Advisory Committee members is included after this written statement.

The analysis here focuses on a key initial obstacle—a nuclear regulatory process badly in need of an update. It is important to keep in mind that addressing this challenge is a necessary first step; other steps will be required.

Current NRC regulation confronts the licensing of advanced technologies with two major challenges. First, NRC design certification or approval calls for enormous front-loaded investment during a protracted development and licensing phase—without a staged structure to provide applicants with clear, early feedback on an agreed schedule. Second, current regulation primarily evolved to oversee light water reactor (LWR) technologies. It must be adapted to the features and performance characteristics of advanced reactors, which rely on substantially different fuels, cooling systems, and safety strategies, and require novel operating strategies.

Over the past two years, the NIA has been developing strategies to facilitate the efficient, cost-effective, and predictable licensing of advanced nuclear power plants in the United States. These strategies are based on consultations with nuclear innovators, safety experts, former NRC staff and Commissioners, members of the financial community, and other nuclear industry stakeholders. The NIA also examined nuclear reactor licensing systems in the United Kingdom and Canada, and scrutinized analogous regulatory systems administered in the United States by the Federal Aviation Administration and the Food and Drug Administration. We compiled the results of our work into a report called "Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing," which was issued on April 12th. The report has been provided to the Committee, and is available to the public on the NIA website. It discusses in much greater detail the points that I am touching on today.

Based on this research and analysis, the NIA offers the following recommendations:

A. Regulatory Recommendations

(1) To structure a staged review of advanced reactors and support long-range resource planning by the agency and the applicant, the NRC and industry should develop and employ guidelines for a licensing project plan (LPP). The LPP would be a living document that serves as a roadmap for the entire process, defining—in as much detail as possible—project schedules, testing requirements, deliverables, and NRC review budgets. The most effective approach will be for the applicant and the NRC to design a licensing project plan that establishes milestones corresponding to meaningful stage-gates along a given project's development pathway and that take full advantage of the NRC's readiness to review specific aspects of the design. To provide the foundation for open communication and effective project management, we recommend that, as soon as a potential applicant initiates interaction with the NRC, the agency produce an initial LPP establishing guidelines that define the working relationship among the parties. This should help to ensure rapid resolution of conflicts and efficient progress. The NRC and potential applicants should discuss the appropriate contents of an LPP during this initial engagement period, and the LPP should be built up with additional detail as the project progresses and it is

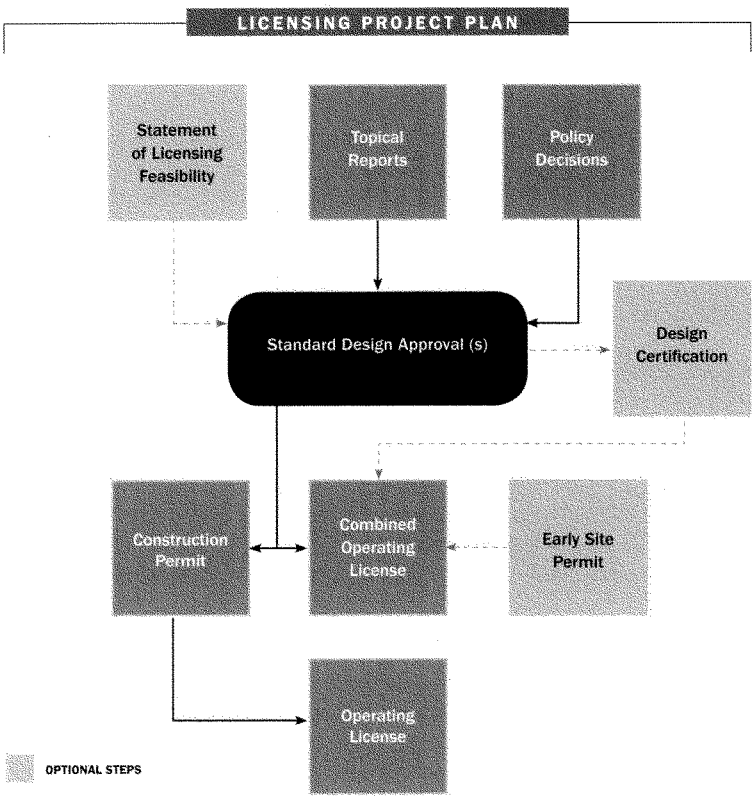
possible to foresee upcoming interactions. Much of the responsibility for designing an effective LPP lies with the applicant; the applicant will need to understand a project's design, development, deployment, and investment milestones in order to propose corresponding licensing milestones. At the same time, NRC expectations for the level of design detail must correspond to the particular milestone, and be clearly communicated to potential developers.

(2) The NRC should promote and applicants should use topical reports and the standard design approval as tools to introduce stages into the advanced reactor licensing process, while emphasizing the need to achieve a level of finality that supports staged decision making. These tools can be employed under current regulations, if the proper staff guidance and policies are put in place, and if dedicated funding can be authorized and appropriated; the proposed licensing project plan could structure their use.

(3) The NRC should develop and employ an optional statement of licensing feasibility process with time frames and budgets to be agreed upon in the licensing project plan. This would permit it to more easily assess whether an applicant's design intent was conceptually aligned and consistent with established regulatory requirements. Doing so would offer important benefits: (i) it would standardize a review phase that, because of its limited cost and duration, could be used by stakeholders to compare available design options; (ii) it would provide early feedback to the applicant, allowing timely alterations in approach to better meet regulatory obligations; and (iii) it would provide useful structure to pre-application engagement.

Figure 3 depicts the elements that could be used to support the staged licensing of an advanced reactor, structured by an LPP.

Figure 3: Elements of a Staged Licensing Process



(4) The Commission and license applicants should cooperate to adapt the agency's light water reactor (LWR)-centric requirements so that they are better suited to advanced reactors seeking licenses in the near term, while, wherever appropriate, increasing the use of risk-informed and performance based techniques. For new technologies, alternative approaches to the exemption process should be considered. Advanced reactor designers from both traditional industrial organizations and small start-ups are concerned with the cost and schedule uncertainty associated with the exemption process (as well as potential negative perception that applicants are trying to avoid stringent safety regulation). A means should be available earlier in the process for the NRC and the applicant to reach agreement on alternative compliance strategies for specific requirements that are only partially applicable or are not applicable at all. The LPP would be a natural place to do this, once the NRC and stakeholders have identified promising approaches. This will increase efficiency and effectiveness in the design and regulation of advanced

technologies without sacrificing safety or security.

(5) The NRC and DOE should continue to move forward with the DOE/NRC Advanced Reactor Licensing Initiative.[2] This will help to establish and clarify acceptable approaches for creating the underlying design criteria associated with these concepts, thereby removing a portion of the regulatory uncertainty associated with advanced non-LWRs.

(6) Given the substantial investments that have already been made by industry and DOE in pre-application reports and proposals for advanced reactors (including the Next Generation Nuclear Plant), and by NRC staff in evaluating them, the NIA recommends that (i) the NRC complete its evaluation and the Commission issue its decisions or opinions at this stage of the application, and (ii) generic issues raised by DOE and NRC be resolved through the issuance of guidance for advanced reactor applicants.

(7) At the same time that the NRC pursues the above initiatives, the NRC should designate a special technical team to develop and implement a technology inclusive licensing and regulatory framework for advanced reactors based on risk-informed and performance-based principles. The technical team should propose a roadmap for putting the new framework into practice by 2025 (supported by a rulemaking completed in 2023), and then be given the administrative flexibility and resources to succeed. Because this framework will not be ready immediately, it should remain optional (similar to the Part 52 licensing processes as an alternative to the Part 50 process)—at least until it is fully demonstrated. That way, its development will not delay current projects. The authorization and appropriation of dedicated funding will be necessary to enable this work.

(8) To provide a clear and achievable regulatory pathway for developing and deploying advanced demonstration reactors, the NRC should:
   (i) In collaboration with stakeholders, clarify terminology and resolve discrepancies and gaps in statutes, regulations, and practice;
   (ii) Using terminology revised pursuant to (i) above, clarify responsibility for reviewing potential applications;
   (iii) Develop guidelines for advanced reactor demonstrations to support the review process; and
   (iv) Provide or develop guidelines for prototype plant regulation (as defined in 10 CFR 50.2 and 10 CFR 52.1) and conversion to commercial operation.

(9) The NRC should continue development and execution of advanced reactor technology knowledge management and training opportunities for NRC staff. Mid- and upper-level managers should be included in these programs. Funding will be needed to support this.

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[2] This was recently described in the following report: US Department of Energy, Office of Nuclear Energy, *Guidance for Developing Principal Design Criteria for Advanced (Non-Light Water) Reactors*, December, 2014. http://pbadupws.nrc.gov/docs/ML1435/ML14353A246.pdf.

B. Policy

(1) Congress should revise the NRC's budget structure so that, instead of a 90% fee-based, 10% public funding model, licensees and applicants reimburse the NRC for activities related to their regulation, with Congress funding other agency-related activities—including the development of new regulations for advanced technologies, R&D, international programs, and other initiatives not related to a specific licensee. The nuclear fleet operating today was licensed by an NRC that had been fully funded by Congress, before the advent of current fee-recovery rules. Unlike that earlier generation of reactors, licensing of the AP1000s now under construction has been supported by substantial cost-shared funding from DOE. To prepare for the licensing of advanced reactors, the NRC faces a greater challenge that will require consistent public funding.

(2) Congress should authorize and appropriate funds for the NRC to prepare for advanced reactor licensing, including but not limited to:

- Development and implementation of strategies to stage and expedite the advanced reactor licensing process;
- Development and implementation of a risk-informed, performance-based licensing framework for advanced non-light water reactors;
- Efforts to prepare the process of licensing advanced demonstration reactors; and
- Staff training or the hiring of experts.

(3) To expand available financial resources for advanced reactor companies, Congress should continue to fund DOE to competitively award grants for early efforts to license advanced reactor companies, including but not limited to:

- Pre-application engagement with the NRC;
- Developing a licensing project plan; and
- Applying for a statement of licensing feasibility or similar early-stage design review.

The DOE Gateway for Accelerated Innovation in Nuclear (GAIN) initiative's small business voucher program is one possible mechanism for this.

C. Industry Action

Industry has an important role to play as a constructive participant in all of the above recommendations, but also has primary responsibility for several actions:

(1) Industry stakeholders should cooperate to deliver a coordinated message to the NRC regarding technology-inclusive advanced reactor priorities.

(2) Prospective applicants should proactively address the NRC's need for information about future projects by informing the agency as early as possible of their intent to

request NRC review. By capturing this information in regulatory issue summaries, the NRC will have a stronger basis to support research, as well as budgetary estimates and requests.

(3) Industry should take a more active role in communicating with the NRC, DOE, and other stakeholders on the challenges and opportunities associated with various advanced reactor designs, including R&D priorities.

(4) Working with appropriate research and standards organizations, industry should pursue the development of codes, standards, and conventions for advanced nuclear power.

S.2795 authorizes the NRC to do the crucial work to develop and implement a staged licensing process with dedicated funding. This is an important bill that will enable the NRC to develop the rigorous, technology-inclusive regulatory infrastructure to support the review of advanced nuclear energy technologies without diluting funds used to regulate operating plants. It also allows for immediate adjustments that will provide a more efficient, predictable, and effective process.

Thank you for this opportunity to testify. I would be pleased to respond to any questions you might have, today or in the future.

NIA Committee Membership

Nuclear Innovation Alliance Policy Committee

Armond Cohen, *Clean Air Task Force*
Desmond Chan, *Bechtel National*
Ashley Finan, *Clean Air Task Force*
Richard Lester, *Massachusetts Institute of Technology*
Christofer Mowry, *ARC Nuclear*
Ray Rothrock, *RedSeal Networks*
Elina Teplinsky, *Pillsbury Law*

Nuclear Innovation Alliance Advisory Committee

Amir Afzali, *Southern Nuclear Company*
Todd Allen, *Third Way*
Suzanne Baker, *Third Way*
Willis Bixby, *Gen4 Energy*
David Blee, *U.S. Nuclear Infrastructure Council*
Sam Brinton, *Bipartisan Policy Center*
Gilbert Brown, *UMass Lowell*
Jacopo Buongiorno, *Massachusetts Institute of Technology*
Caroline Cochran, *Oklo, Inc.*
Christopher Colbert, *NuScale Power*
Leslie Dewan, *Transatomic Power*

Jacob DeWitte, *Oklo, Inc.*
Ashley Finan, *Clean Air Task Force*
Michael Ford, *Carnegie Mellon University*
Charles Forsberg, *Massachusetts Institute of Technology*
Tim Frazier, *Energy Innovation Reform Project*
Josh Freed, *Third Way*
Kirsty Gogan, *Energy for Humanity*
Jeff Harper, *X-Energy*
Jane Hotchkiss, *Energy for the Common Good*
Eric Ingersoll, *Energy Options Network*
Simon Irish, *Terrestrial Energy*
Jacob Jurewicz, *Exelon*
Andrew Kadak, *Kadak Associates*
Jim Kinsey, *Idaho National Laboratory*
Marilyn Kray, *Exelon*
Jessica Lovering, *The Breakthrough Institute*
Sam Mar, *Laura and John Arnold Foundation*
David B. Matthews, *NEC, Inc.*
Rachel Pritzker, *Pritzker Innovation Fund*
Everett Redmond, *Nuclear Energy Institute*
Paul Roege, *Creative Erg*
Robert Schleicher, *General Atomics*
Sam Shaner, *Massachusetts Institute of Technology*
David Slavick
Kirk Sorensen, *Flibe Energy*
Elina Teplinsky, *Pillsbury Winthrop Shaw Pittman*
Sam Thernstrom, *Energy Innovation Reform Project*
Ed Wallace, *GNBC Associates*
Kevan Weaver, *TerraPower*
Aditi Verma, *Massachusetts Institute of Technology*

Biography

Dr. Ashley Finan serves as Policy Director for the NIA. Ashley earned her Ph.D. in Nuclear Science and Engineering at the Massachusetts Institute of Technology. Her doctoral work focused on energy innovation investment and policy optimization, both in nuclear and renewable energy technologies. She has played a key role in studies of the use of advanced nuclear energy to reduce greenhouse gas emissions in several applications, including hydrogen production, coal to liquids processes, and oil production methods. Ashley has worked as a strategy and engineering consultant, primarily on nuclear energy applications. She also contributed to an analysis of the techno-economic potential of energy efficiency improvements in the residential and commercial sectors and several related topics. Ashley holds an SB degree in Physics as well as SB and SM degrees in Nuclear Science and Engineering from MIT.

Senate Committee on Environment and Public Works
Subcommittee on Clear Air and Nuclear Safety
Hearing entitled, "Enabling Advanced Reactors and a Legislative Hearing on S.2795, the Nuclear Energy Innovation and Modernization Act"
April 21, 2016

Questions for the Record for Dr. Ashley Finan
Second Round of Questions, May 19. 2016

Questions from Senator Whitehouse:

1. *Dr. Finan, the U.S. Nuclear Innovation Alliance recently released a white paper titled, "Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing." The report finds that the most critical barriers for deployment of advanced reactors is, "the lack of a clear and efficient pathway for a first demonstration project and continuing doubt that the NRC will be able to issue a license for a non-light water reactor in a time frame compatible with private-sector needs."*

a. *Can you explain how this bill would address these problems?*

S. 2795 ensures that the NRC will make plans to develop appropriate guidelines to support demonstration projects through the research and test reactor process. This will provide one clear and efficient pathway for a first demonstration project. S. 2795 also ensures that the NRC will develop plans and strategies for implementing a staged licensing process that will provide greater and earlier confidence in the licensing process, and for implementing more technology inclusive techniques that will enable more straightforward and predictable evaluation of non-light water technologies. Whether the improvements will result in a licensing timeframe compatible with private sector needs will depend partly on whether the NRC is given the resources necessary to implement the planned changes, and whether the NRC is aggressive enough in seeking to make its process more efficient.

b. *Can you discuss the merits of a licensing framework that is technology inclusive as outlined in the bill?*

A licensing framework that is technology specific necessarily gives a competitive advantage to the technology around which it is constructed. The barrier to entry for a technology that does not fit within the existing framework is almost insurmountably high. This limits the ability of the U.S. to develop and adopt innovative technologies that improve on past generations, and to export those technologies and develop the manufacturing and commercial jobs that accompany them. A technology inclusive licensing framework like the one outlined in S. 2795 will open up myriad opportunities for innovation, development, and commercialization of new nuclear energy technologies that will be more competitive and will offer other improvements over existing technology. The U.S.

could play a leadership role in this industry, and with that could benefit from the jobs and clean energy it will create. A technology-inclusive licensing framework is a key ingredient to achieving that.

c. *Is the advanced reactor licensing framework proposed in the bill any less safe than what is currently in place at NRC?*

The advanced reactor licensing framework proposed in S. 2795 is no less safe than what is currently in place at the NRC. It in no way changes the top level safety requirements of the NRC, and in no way degrades the standards of the NRC. It will enable the introduction of major advancements and improvements in nuclear energy technology that are expected to outperform today's technology.

For advanced reactors that adopt innovative ways to address operation and safety,[1] a strong case can be made for using a risk-informed approach to identify the most safety-significant systems, structures, components, initiating events, and accident scenarios. Experience suggests that this approach will yield a more realistic picture than deterministic approaches (e.g., engineering judgment) can, standing alone. Probabilistic Risk Assessment (PRA, a tool used in risk-informed regulation) will focus resources and attention on the systems that are the most crucial for safety, and enable more elegant design and engineering solutions than those mandated by deterministic methods—which are based on past experience and thus are less adept at incorporating new ideas. The most thorough safety analysis will come from the combined use of a design-specific PRA, traditional engineering analysis, and performance-based monitoring.

d. *Does the proposed advanced reactor licensing framework streamline or expedite the licensing process at NRC?*

The proposed framework will make the process much more predictable and efficient for advanced reactors, because they won't need to seek adaptations and exemptions to the many light-water-reactor centric regulations that do not apply. In this sense, it will also streamline the process, since the new framework should be fully applicable to advanced reactors. The framework does not actively seek to expedite the process, but through improved communications and efficiency, it should be possible for an applicant to move much more quickly than they could under the existing light-water reactor focused framework.

e. *The advanced reactor licensing framework in the NRC bill would be paid by the taxpayer. Is it common for NRC to have taxpayers pay for programs like this?*

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[1] Such as operating at atmospheric pressure so that rapid loss of cooling does not occur, using a coolant or moderator with high heat capacity so that external power is not needed to maintain cooling during an accident, siting underground for improved security, eliminating offsite releases during an accident, etc.

The NRC collects user fees to cover the direct costs of work it does for most applicants and licensees, but it is also typical for the NRC to undertake some activities with taxpayer funding when those activities serve a public interest or are related to long-term development and don't benefit an individual licensee or applicant. For example, some taxpayer funds are used to cover NRC activities in the areas of R&D, homeland security, staff training, regulatory framework changes, oversight of research reactors, and international programs. Since the development of an advanced reactor regulatory framework creates the technology inclusive structure and performance requirements essential to efficient and effective licensing of advanced, non-light water reactors, and does not directly benefit any individual commercial interest, it is appropriate to dedicate some taxpayer funding to this effort. In addition, this work is critical to the health of the nation's nuclear energy industry and will enable innovation, clean energy, and economic growth. Taxpayer funds are regularly used for similar reasons to support regulation in other industries like health and aviation.

2. *Dr. Finan, we have heard from the advanced nuclear community that up-front costs associated with reactor development and pre-application and application review activities at NRC can hinder reactor concepts moving forward with licensing. This bill would create a new DOE cost-share program that would help applicants pay for some of the pre-application and application review activities.*

a. *Can you explain how this type of program can help a start-up or smaller advanced reactor company move forward with getting their designs licensed?*

A DOE cost-share program to help defray the costs of licensing is a strategy that has proved highly effective in the past, both in the Nuclear Power 2010 program, which assisted with the licensing of Generation III+ technologies and in the current SMR program, which is assisting with the licensing of the NuScale power plant. A similar program for advanced reactors will undoubtedly be helpful, and is probably essential. Start-ups and small reactor development companies begin with low funding levels and big questions from investors about whether their technology can be licensed. Some assistance early-on to answer those questions with funding leveraged by public matching will enable the companies to reduce their uncertainty, to raise more funds for development, and to move forward, while focusing on key questions that may be identified during the pre-application process.

b. *Can you explain the role of NRC and DOE in the development and licensing of advanced reactors and whether this type of program is the right way to help incentivize advanced reactors to move through licensing?*

In the development and licensing of advanced reactors, the NRC and DOE have distinct roles. The NRC is responsible for preparing requirements and regulations, for informing applicants about the process and their requirements, and for reviewing ad evaluating applications and pre-application materials. The NRC may

seek some expertise from DOE to assist in the review of advanced reactors, but this is done in a very structured and segmented way. The DOE also has a more promotional role, and can assist with research and development activities, with funding for private projects, and with preparing application materials. A DOE cost-share program is a logical way to help incentivize advanced reactors to move through licensing, and has proved to work well in the past. It does have some disadvantages, in that grants must be awarded through a process of selection, and in that DOE's direct involvement in the application preparation process may raise concerns about speed, efficiency, and protection of proprietary information. On balance, these concerns are outweighed by the benefits of the program for most developers. Other strategies, like reduced NRC fees for all advanced reactor applications would have lower transaction costs and would be more equal-opportunity, but they come with challenges of their own. The DOE cost-share program is a good solution, given the mechanisms that are available.

Senator CAPITO. Thank you.

Our next witness is Maria Korsnick, Chief Operating Officer of the Nuclear Energy Institute.

Welcome.

STATEMENT OF MARIA KORSNICK, CHIEF OPERATING OFFICER, NUCLEAR ENERGY INSTITUTE

Ms. KORSNICK. Thank you very much, Chairman Capito.

On behalf of the commercial nuclear energy industry, I want to thank the committee for considering S. 2795. Introduction of this bill is particularly well timed.

Nuclear energy makes a significant contribution to our clean air quality, the reliability of our electricity supply and our national security. Yet, regulatory inefficiency and costs are constraining our use of this valuable national resource. If not addressed in the very near term, those issues will impede deployment of even more innovative reactor technologies here and around the world.

Despite NRC's effort to reduce its budget and right size the agency, fees continue to be excessive, and the limitations of the mandated 90 percent fee rule create fundamental structural problems. The NRC's budget continues to hover at approximately $1 billion a year, despite significant declines in its workload as plants have shut down. In particular, according to Ernst & Young, the NRC spends 37 percent of its budget on support costs. That is more than 10 percent higher than some of its peer agencies.

Because the NRC must collect 90 percent of its budget from licensees, and the NRC's budget has not correspondingly declined, remaining licensees are responsible for paying these higher annual fees. With several recent premature shutdowns and additional reactors decommissioning in the coming years, the current fee structure virtually guarantees that remaining licensees will continue to bear even higher annual fees.

The cost of licensing actions also continues to increase well beyond the cost of living. For example, since 2000, the NRC review fees at license renewals have been an eight-fold increase in review costs.

Objectively, one would expect a decrease based on efficiencies gained in the review process. This is particularly notable as we look ahead and want second license renewal for some of our plants. These illustrate that a fundamental change to the NRC fee recovery structure is needed. S. 2795 repeals the 90 percent fee recovery requirement and replaces it with a much more rational approach.

It requires the NRC to expressly identify annual expenditures anticipated for licensing and other activities requested by applicants. The legislation would also help drive greater efficiency in the NRC's operations.

In turn, it would drive down annual fees by limiting corporate support percentages, although we do recommend that the cap be lower than the 28 percent level proposed by this legislation. Complementing the limit on corporate support, the bill would cap annual fees for operating power reactors at the fiscal year 2015 level. We also recommend that it apply to all licensees so non-reactor licensees as well.

S. 2795 also affirms Congress' view that this country can, and in fact should, be a leader in advanced reactor technology. The bill effectively directs the NRC to think differently about reactor licensing.

It requires that the NRC's regulatory regime accommodate large light water reactors as it does today, small light water modular reactors and advanced non-light water reactors, in short, an all of the above approach.

The bill's call for a technology inclusive licensing framework, use of a risk informed performance based licensing technique and a staged licensing process will, in fact, be a good and helpful step forward. Developers will be able to demonstrate progress to investors in this first of a kind project, thus obtaining necessary capital resources as they achieve milestones.

Too often we hear from our members that regulatory uncertainty is the greatest impediment to new plant deployment in the United States. S. 2795 tackles top line issues now standing in the way of innovation.

In sum, we must be thoughtful and deliberate in the way we plan for advanced reactor technologies, but we must also begin today if we are to meet the potentially enormous demand by 2030 for U.S. technology not only here but in the international market.

Senators Inhofe, Crapo, Whitehouse and Booker, on behalf of the industry, I want to thank you very much for taking a strong leadership role. NEI supports S. 2795, and we look forward to continuing to work with you and your staffs as it progresses through Congress. I hope it is enacted expeditiously.

Thank you very much.

[The prepared statement of Ms. Korsnick follows:]

Testimony for the Record
Maria G. Korsnick
Chief Operating Officer
Nuclear Energy Institute
Before the
Senate Environment and Public Works Committee
April 21, 2016

The Nuclear Energy Institute (NEI) appreciates the opportunity to provide testimony on S. 2795, the Nuclear Energy Innovation and Modernization Act, introduced on April 13, 2016.

I am Maria Korsnick, Chief Operating Officer of the Nuclear Energy Institute. NEI is responsible for establishing unified industry policy on regulatory, financial, technical, and legislative issues affecting the commercial nuclear energy industry. NEI has more than 350 members, including all U.S. companies licensed to operate commercial nuclear power plants, nuclear plant designers, major architect/engineering firms, fuel cycle facilities, materials licensees, labor organizations, universities, and other organizations involved in the nuclear energy sector. Before joining NEI in 2015, I held a number of senior positions in industry. I have been an NRC-licensed senior reactor operator, a site vice president responsible for all aspects of reactor operations, and a chief nuclear officer responsible for a fleet of reactors.

Nuclear energy is the largest and most efficient source of carbon-free electricity in the United States. Currently, 99 reactors in 30 states produce nearly 20 percent of our nation's electricity and approximately 63 percent of our carbon-free electricity. Nuclear energy facilities demonstrate unmatched reliability by operating with an average capacity factor of 91.9 percent—higher than all other electricity sources. Nuclear energy facilities are essential to the country's economy and the communities in which they operate. The typical plant generates $470 million each year in the sale of goods and services in the local community, and employs between 500 and 700 workers. Importantly, an additional five reactors are under construction in the United States. While under construction, a new nuclear plant project creates up to 3,500 jobs at peak periods.

Despite the environmental and economic benefits nuclear plants provide, time consuming and outdated U.S. Nuclear Regulatory Commission (NRC) regulatory processes and excessive fees challenge continued operation of the current nuclear fleet and impede our ability to build new, technologically advanced reactors.

On behalf of NEI and its members, I wish to express our deep appreciation to the bill's sponsors for working together to create legislation to tackle these issues. We support this bill and Congress' efforts to help maintain existing nuclear power plants, and to set the stage for developing and deploying innovative nuclear reactor technologies. My testimony will explain how the bill advances these objectives by (1) reforming the NRC fee recovery structure, and (2) directing the NRC to modernize its regulatory regime to facilitate licensing of new nuclear technologies. In addition to offering the industry's views on why this legislation is important and timely, I will offer additional ways the bill can further enhance safety by honing the focus and efficiency of the NRC's regulatory processes.

Reform of the NRC's fee recovery structure is necessary and overdue.

The Omnibus Budget Reconciliation Act of 1990, as amended (OBRA-90), requires the NRC to recover approximately 90 percent of its budget through fees charged to licensees and applicants.[1] Congress provides the remaining 10 percent of the agency's budget authority through appropriations, which covers the costs for some of the NRC's activities that are not attributable to existing NRC licensees (*e.g.*, international assistance activities and Agreement State oversight). This arrangement requires the industry to pay for "fees-for-services" at a current rate of $268 per hour, as well as annual fees, which are fees apportioned among licensee classes to cover the remainder of the agency's budget.

For the past several years, the NRC's annual budget has hovered in the one billion dollar range. The industry has expressed increasing concern about the magnitude of NRC fees and the failure of the agency to reduce its budget given its decreasing workload. For example, one licensee reports that it paid NRC $7.9 million in fees in 2015, which constituted almost 10 percent of its annual non-outage operations and maintenance budget. Because the NRC's budget has not correspondingly declined as the number of operating reactors and materials licensees has declined, remaining licensees are responsible for paying higher annual fees to fund the NRC's corporate support, generic rulemaking activities, and even certain international activities. The magnitude of these fees is exacerbated by the fact that the NRC's budgeting and fee invoicing are not transparent, predictable, or timely. These concerns have been the focus of extensive industry comments on the NRC's proposed fee rules, and have been highlighted in various forums to authorizers and appropriators in Congress.

Notably, in June 2014 the NRC recognized the need to right-size the agency and refocus its work on higher priority matters. Project Aim, instituted to accomplish those goals, has made some progress. There have been reductions in staff, a program was implemented to prioritize work on generic issues and rulemakings, and there have been reductions in the budget. Although we commend the agency for its initial efforts in this regard, progress is not being made quickly enough, and the limited reductions in the budget evidence continued inefficiencies in agency management and operations.

We appreciate Congress' efforts to encourage the NRC to implement Project Aim more aggressively. Despite those efforts, there are systemic problems with the agency's fee recovery structure that require legislation to ensure durable reform. We call your attention to the following problems with the status quo:

- The NRC's overhead costs remain excessive and higher than peer agencies. In April 2015, Ernst and Young provided the NRC with an Overhead Assessment Report. Ernst and Young found that the NRC spends 37 percent of its budget on mission support costs.[2] The NRC's

[1] This fee-recovery requirement excludes amounts appropriated for waste incidental to reprocessing, generic homeland security activities, and inspector general services for the Defense Nuclear Facilities Safety Board, as well as any amounts appropriated from the Nuclear Waste Fund.

[2] As listed in the report, mission support includes corporate support (acquisitions, administrative services, financial management, human resources, information management, information technology, international activities, outreach,

peer agencies spend only 20, 25, and 32 percent of their total budgets on mission support. Ernst and Young also found that "[w]ith the exceptions of FY 2015 and FY 2016, NRC's mission support costs as a percentage of total outlays have increased year-over-year for the last decade." To help roll back this decade-long increase in overhead costs, appropriators in Congress limited the portion of the NRC's FY 2016 budget allocated to corporate support (which constitutes the bulk of NRC's mission support costs) to roughly one-third (34 percent) of the agency's total budget. The NRC recently indicated in its FY 2017 budget justification that it would remain below this cap in FY 2016, spending about 32 percent of its budget on corporate support. Notwithstanding this recent effort to limit the longstanding increases in corporate support costs, the NRC's FY 2017 budget would *increase* corporate support spending both in real dollars (an additional $3.3 million) and as percent of the agency's total budget (bringing it to 33 percent). This proposed increase is especially troubling because the NRC's FY 2017 request removed more than $23 million from the corporate support category. In other words, the NRC simply "realigned" (*i.e.*, re-categorized) certain activities that previously would have been listed as corporate support.

- A reduction in the number of licensees increases the fee burden on the remaining licensees. The number of operating reactors and materials licensees has declined in recent years. Because the NRC must collect 90 percent of its budget from licensees and the NRC's budget has not correspondingly declined, remaining licensees are responsible for paying higher annual fees. With several recent premature power reactor shutdowns—and additional reactors planning or considering decommissioning in the coming years—the current fee structure virtually guarantees that remaining licensees will continue to bear even higher annual fees. Materials licensees face an even more significant problem because Agreement States and their licensees do not pay NRC fees. With more than 86 percent of all material licensees now under Agreement State jurisdiction, the remaining 14 percent of NRC material licensees are left to fund an extremely disproportionate share of the NRC's generic materials program. For example, when the number of uranium recovery facilities dropped from twelve to nine for FY 2016, the NRC proposed an 11 percent increase in the annual fee for the remaining licensees. This situation will worsen when seven current licensees become part of the developing Wyoming Agreement State program.

- The costs of licensing actions have unnecessarily increased over time. The costs of licensing actions continue to increase well beyond cost-of-living increases. For example, since 2000 the NRC review fees for operating reactor license renewals have increased annually at a rate of almost 17 percent despite the agency's extensive experience with the review process. This represents an *eight-fold increase* in review costs for license renewals rather than the decrease that would be expected based on efficiencies that should have been developed for reviewing later applications. Similarly disturbing increases have occurred with new reactor licensing as early site permit review fees have increased at an annual rate of 15 percent since 2007. Worse, these increases often are accompanied by extended delays in the completion of the licensing actions and add to the NRC's licensing backlog.

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policy support, training, and travel) and office support (acquisitions, administrative services, financial management, human resources management, information management, information technology, support staff, training, and travel).

- The industry pays for unjustified generic activities. Despite Congress' direction in the FY 2016 Consolidated Appropriations Act to include in the NRC's budget submittal all planned rulemakings, it is unclear how many existing rulemakings remain on the NRC's docket and how much the NRC plans to spend on each of its rulemakings. Although the NRC's report to the House and Senate Appropriations Committees on January 15, 2016, listed 43 proposed rules pending before the Commission, the NRC's 2015-2016 Rulemaking Activity Plan included prioritization results for 93 rulemakings. Of these 93 rulemakings, the NRC ranked only nine with a LOW priority, meaning 84 rulemakings were ranked with a MEDIUM or HIGH priority. A February 22, 2016 Commission letter to the House and Senate Appropriations Committees attempted to clarify this discrepancy by providing another list with 89 rulemakings: 55 proposed rules in development or published for public comments or final rules under Commission consideration; 12 rulemakings identified for possible termination; and 22 petitions for rulemaking pending before the agency. Putting aside the lack of transparency associated with how the agency counts "active" rulemakings, the fact remains that the NRC should not be pursuing 50+ rulemakings after more than 60 years of intensive regulation of an industry that operates at the highest levels of safety and reliability. This level of activity suggests that the NRC is pursuing rulemakings that are unlikely to be necessary to accomplish its public health, safety, and security mission.

- The NRC budget and fee processes are not transparent. The industry also pays for other unjustified generic activities (*e.g.*, international activities) not covered by the 10 percent fee-relief offset. Because the breakdown of fee recoverable items and fee relief is not discernable from agency documents, it is effectively impossible for the industry to determine the extent to which it pays for activities that are not attributable to and do not benefit a class of NRC licensees. For example, a comparison between the NRC's congressional budget justification and the FY 2016 proposed fee rule indicates that the NRC will spend $23.2 million for international activities but will only credit licensees with $12.6 million in so-called fee relief. The NRC provided no explanation for why licensees should be assessed fees to pay for the remaining $10.6 million. Unquestionably, NRC engagement in the international arena advances U.S. foreign policy objectives, but it also is the case that those efforts provide no direct benefit to the regulated community.

The bottom line is that fundamental change to the NRC's fee recovery structure is needed, and the NRC is not on course to accomplish that change in the absence of congressional direction. The Nuclear Energy Innovation and Modernization Act would effect that change. It would repeal the relevant provisions of OBRA-90 and replace them with a rational fee recovery process that will also ensure the agency continues to be sufficiently funded to effectively carry out its mission to protect public health, safety, and security.

The fee recovery process envisioned by S. 2795 would create greater accountability and transparency by requiring the NRC to expressly identify annual expenditures anticipated for licensing and other activities requested by applicants (*i.e.*, fees-for-services). The bill further directs that funds allocated to those activities can be used only for those purposes, thus avoiding diversion of agency resources to other accounts, including corporate support. The legislation also would help drive greater efficiency in agency operation and, in turn, drive down annual fees by establishing that corporate support costs can be no more than 30 percent of the agency's

budget authority beginning in FY 2019 and FY 2020. The percentage cap on corporate support is to be reduced by 1 percent every two years until reaching 28 percent in FY 2023. Complementing the upper limit on corporate support, the bill would cap annual fees for operating power reactors at the FY 2015 level (adjusted to reflect changes in the Consumer Price Index). Finally, the bill would appropriately prevent the NRC from recovering fees for activities that are not attributable to an existing NRC licensee or class of licensees, and provide for federal funding via appropriations for the development of regulatory infrastructure for advanced reactor licensing.

While these fee reforms go a long way to addressing the problems the industry has identified, we suggest that the Committee also include several additional provisions in this legislation:

1. To ensure that a reduction in the number of licensees does not increase the fee burden on the remaining licensees, the cap on annual fees should be applicable to decommissioning reactors, fuel cycle facilities, and other materials licensees. Excessive annual fees have been imposed on these categories of licensees in recent years. For example, in addition to the materials licensee fees referenced earlier in my testimony, the annual fee for high-enriched uranium facilities has increased by 55 percent from FY 2005 ($5.45 million) to FY 2015 ($8.47 million).

2. To ensure the NRC's overhead costs are consistent with its peer agencies, the Committee should consider whether the 28 percent cap on corporate support is sufficient. A lower cap would limit expenditures on corporate support and encourage the NRC to sharpen its safety focus and become more efficient. The Ernst and Young report found that some of the NRC's peer agencies operate with levels of corporate support as low as 20 and 25 percent. The bill also should prohibit the NRC from simply redefining corporate support activities to circumvent the cap and avoid making the improvements that Congress demands.

3. To minimize the industry's obligation to pay for unjustified generic activities, the NRC should be required to expressly identify in its budget request anticipated expenditures necessary for each rulemaking and for other generic activities. Offering a clear picture of what the NRC intends to spend on each rulemaking and international activity would significantly improve accountability and transparency.

Congressional action is necessary to accelerate licensing and deployment of advanced nuclear reactor technologies.

NEI supports an "all-of-the-above" nuclear future that includes additional large light water reactors (LWRs), small modular light water reactors (SMRs), and advanced non-light water reactors. Advanced LWR designs are already commercially available with four units under construction; SMRs are expected to be available by the mid-2020s; and advanced non-LWRs are being developed to complement the suite of nuclear generating options available in the future. NEI's all-of-the-above vision recognizes that the U.S. nuclear industry can best maintain a leadership role in nuclear technology development and contribute to worldwide safety enhancements by designing and building new nuclear plants.

Advanced non-LWR designs must be commercially available by the early 2030s to meet global energy needs. This is a daunting task but one that is necessary to accomplish if the U.S. is to meet its clean air commitments and maintain the reliable electricity service Americans now enjoy. Even at less than 1 percent annual growth in electricity demand, the U.S. Energy Information Administration forecasts a need for 287 gigawatts of *new* electric capacity by 2040 in the U.S.—*in addition to the electric capacity that will need to be replaced because of retirements.*

Focusing only on the need for additional electricity in the U.S. in the upcoming decades would mistakenly overlook the likelihood of a significant increase in electricity demand worldwide. Many countries are looking to a rapid expansion of nuclear generation to address their growing electricity needs making it imperative that the U.S. industry's technology be available for international deployment. Advanced nuclear reactor designs have many potential technological advantages making them particularly appropriate for placement in developing economies (*e.g.*, passive cooling even in the absence of an external energy supply; operation at or near atmospheric pressure, which reduces the likelihood of a rapid loss of coolant; and consumption of nuclear waste as fuel, reducing or eliminating disposal issues). However, without strong federal leadership and direction, the U.S. industry runs the risk of falling behind, as other countries have substantial, state-funded advanced reactor technology programs.

The Nuclear Energy Innovation and Modernization Act will bring us a step closer to realizing the enormous potential of advanced reactor technologies. The bill represents Congress' affirmation of the need to accelerate the development, licensing, and deployment of these innovations by establishing a path the NRC is to follow to develop an efficient and timely licensing framework. We commend the bill's sponsors for their leadership on this issue.

We particularly appreciate Congress' recognition of the challenges facing advanced reactor development. This legislation serves as a necessary "wake-up call" to the NRC. Given the lead times necessary to obtain approval for a new reactor design, license a nuclear power plant, and fabricate and build new generating capacity, planning for advanced reactors must begin today. We highlight several of the ways in which the bill can advance Congress' and the industry's vision.

- By requiring the NRC to develop and implement enhanced strategies for establishing stages in the licensing process, there will be a clear means by which developers of advanced technologies can demonstrate to investors and other project participants progress toward eventual licensing of their first-of-a-kind projects. A staged licensing approach relieves developers from the need to seek a multibillion-dollar capital investment in the very early stages of design development because financing can be coordinated with achievement of each stage. Further, because perceptions regarding regulatory risk increasingly have become an impediment to new reactor development, being able to successfully complete specific licensing milestones should reduce concerns about regulatory uncertainty. Similarly, Congress' mandate that the NRC develop and implement strategies to prepare a regulatory framework for licensing a research and test reactor will help advanced reactor developers achieve greater regulatory certainty. Successful demonstration via testing provides credible proof that a technology or design is sound, can be used for the intended application, and can be economically competitive.

- The bill would require the NRC to modernize aspects of its regulatory approach to licensing advanced reactors. It directs the agency to develop and implement strategies to increase the use of risk-informed, performance-based licensing evaluation techniques and guidance within the NRC's existing regulatory framework.

- Because advanced reactor technologies will need to be available for licensing in the 2030-2035 timeframe, the bill requires that the NRC complete a rulemaking to establish a technology-inclusive licensing framework by the end of 2023. While this should lead to an efficient regulatory paradigm that will encourage private-sector investment in advanced reactor development, the seven-year deadline to complete this rulemaking is too long. The bill appropriately allows applicants the option of choosing the regulatory approach most appropriate to their particular designs.

- The bill would establish and authorize appropriations for a U.S. Department of Energy (DOE) Advanced Nuclear Energy Cost-Share Grant Program to make grants to applicants to fund a portion of the NRC fees for pre-application and application reviews. This provision is critically important because it provides a mechanism for DOE to provide its imprimatur and support for technologies with which the Department and its national laboratories have decades of experience.

Additional action is necessary to improve the focus and timeliness of NRC regulatory processes.

The bill removes a long-standing inefficiency in the NRC's hearing process by eliminating the need for an uncontested, mandatory hearing on construction permit and combined license applications. The mandatory hearing is an artifact of early licensing proceedings and no longer serves a useful purpose. Today, in addition to having the opportunity to request a hearing, members of the public can access extensive information about a license application on the NRC's website, attend the numerous public meetings the NRC holds in their community, and submit comments to the NRC through its environmental review process. There is no need for a mandatory hearing at which issues are uncontested and the public does not participate.

Although the bill appropriately removes the requirement for the mandatory hearing, it should go further and eliminate or streamline other outdated and unnecessary procedures:

1. The legislation should allow for international investment in nuclear plants by eliminating the Atomic Energy Act prohibition on foreign ownership, control, or domination (FOCD) of nuclear power plants. As NEI has repeatedly argued in recent years, FOCD restrictions relating to U.S. nuclear reactors are outdated, unnecessary, overly broad, and ignore the realities of today's global nuclear energy market. This prohibition is a relic of the 1950s when effective means to address concerns about nuclear technology transfers and the proliferation of special nuclear material were lacking. The FOCD provision unduly restricts foreign investment in otherwise worthy projects and ultimately adds no value to nuclear safety or protecting national security.

2. The bill should ensure that hearings on inspections, tests, analyses, and acceptance criteria (ITAAC) do not delay the startup of new plants. While the Commission has recently approved hearing procedures that attempt to minimize the potential for delay, Congress should set aggressive hearing deadlines, mandate the use of streamlined informal hearing procedures, and ensure that a future Commission does not narrowly construe its authority to authorize interim operations while conducting an ITAAC hearing.

Conclusion

In closing, on behalf of NEI and its members, I wish to thank the bill's sponsors for introducing this important legislation. Passage of S. 2795 will provide environmental and economic benefits to all Americans by helping to retain the generation source responsible for 63 percent of the nation's carbon-free electricity and setting the stage for development and deployment of innovative nuclear reactor technologies. We look forward to working with members of Congress to obtain its enactment into law.

Answers to Questions for the Record Received May 19, 2016
Maria G. Korsnick
Chief Operating Officer
Nuclear Energy Institute
Before the Senate Committee on Environment and Public Works
Subcommittee on Clean Air and Nuclear Safety
Hearing Entitled, "Enabling Advanced Reactors and a Legislative Hearing on S. 2795, the Nuclear Energy Innovation and Modernization Act" (Apr. 21, 2016)

Questions from Senator Inhofe:

1. ***Please describe in as much detail as possible why you believe the cap on annual fees for operating reactors which is embodied in S. 2795 is appropriate, reasonable, and warranted. In particular, please describe whether you believe such a cap would inappropriately constrain the NRC's resources in ways that might compromise the agency's safety and security mission.***

Answer:

The cap on annual fees for operating reactors in S. 2795 helps to remedy fairness issues associated with the current framework established by the Omnibus Budget Reconciliation Act of 1990, as amended (OBRA-90). OBRA-90 requires the NRC to recover annually approximately 90 percent of its budget through fees. Because the NRC's budget has not correspondingly declined as the number of operating reactors has declined, remaining licensees are responsible for paying higher annual fees. The annual fee for operating power reactors (including the spent fuel storage/reactor decommissioning fee) has increased 59 percent from FY 2005 ($3.16 million) to FY 2015 ($5.03 million). This misalignment between the NRC's budget and its workload has resulted in an annual fee structure that essentially penalizes reactor licensees that continue to operate for another licensee's decision to decommission. With several additional reactors planning or considering decommissioning in the coming years, the current fee structure virtually guarantees that remaining licensees will bear even higher annual fees.

A cap on annual fees helps to mitigate the potential for excessive fee increases if the NRC does not adequately adjust its budget to reflect the declining workload associated with fewer operating reactors. However, by setting the cap on annual fees at the FY 2015 level and allowing increases to reflect changes in the Consumer Price Index, S. 2795 would not adversely affect safety. As an initial matter, the FY 2015 annual fees are among the highest in the NRC's history. This unusually high level of annual fees is driven largely by the NRC's extensive post-Fukushima generic activities. As the NRC noted in the FY 2015 fee rule, as the agency "completes the generic regulatory actions that resulted from the Fukushima Near-Term Task Force (NTTF) report, the costs related to those generic actions will decline." 80 Fed. Reg. 37,432, 37,451 (June 30, 2015). Thus, by using the high-water mark for generic activities as the cap, S. 2795 provides the NRC with significant resources to carry out its safety and security mission.

In addition, the annual fee cap does not affect "fee-for-service" activities, which the NRC recovers separately through 10 C.F.R. Part 170 fees. As a result, the NRC will continue to recover fees necessary to support the NRC resident inspector program, force-on-force exercises, security plan reviews, and emerging issues that may require NRC resources to perform additional safety or security inspections at specific facilities. For example, as licensees implement the NRC's new Fukushima-related requirements, Part 170 fees will increasingly cover follow-up activities that result in site-specific activities by the NRC. *See* 80 Fed. Reg. at 37,451.

Although the cap on annual fees in S. 2795 would not constrain the NRC's resources in a way that would compromise the agency's safety and security mission, the legislation nonetheless provides for a waiver of the cap in the case of unforeseen and unlikely circumstances. Upon notifying the appropriate congressional committees of jurisdiction, the waiver provision allows for an annual waiver of the cap if the Commission determines that the cap may compromise the agency's safety and security mission. Again, while there is no reason to believe the Commission would need to invoke this provision, it provides the Commission with broad authority to ensure that the cap on annual fees does not impede its mission.

2. ***Do you believe a limit on the NRC's spending on corporate support might impair that agency's ability to provide for the physical protection of its personnel and facilities? If not, why not?***

Answer:

Bringing the NRC's spending on corporate support in line with other federal agencies will not impair the agency's ability to provide physical and personnel security services for the agency's facilities and employees. In April 2015, Ernst and Young provided the NRC with an Overhead Assessment Report. In this congressionally-mandated report, Ernst and Young found that the NRC spends 37 percent of its budget on mission support costs. The NRC's peer agencies spend only 20, 25, and 32 percent of their total budgets on mission support. Ernst and Young also found that "[w]ith the exceptions of FY 2015 and FY 2016, NRC's mission support costs as a percentage of total outlays have increased year-over-year for the last decade." To help roll back this decade-long increase in overhead costs, appropriators in Congress limited the portion of the NRC's FY 2016 budget allocated to corporate support (which constitutes the bulk of NRC's mission support costs) to roughly one-third (34 percent) of the agency's total budget. The NRC recently indicated in its FY 2017 budget justification that it would remain below this cap in FY 2016, spending about 32 percent of its budget on corporate support.

Notwithstanding this recent effort to limit the NRC's longstanding increases in corporate support costs, the NRC's FY 2017 budget would *increase* corporate support costs to more than $319 million—an increase both in real dollars (an additional $3.3 million) and as a percent of the agency's total budget (bringing it to 33 percent). S. 2795 would place the NRC on a smooth glide path to reduce its corporate support to 28 percent by FY 2023. This would give the NRC 7 years to reach this modest goal by implementing cost reductions such as those already identified by Ernst and Young and the agency's Project Aim efforts.

To justify its increase in corporate support spending for FY 2017, the NRC noted that it "has additional security requirements that contribute to higher costs in areas such as physical and personnel security." But the NRC did not say what percentage of its corporate support spending is needed for these security functions. It did note, however, that corporate support includes many things beyond physical and personnel security. In fact, physical and personnel security constitute only one portion of the "administrative services" portion of the corporate support budget. Given that administrative services constitutes only about a third of the entire corporate support budget, the NRC has many other areas where it can identify efficiencies to bring its corporate support spending in line with other federal agencies.

Finally, it is worth noting that Ernst and Young identified physical security as an area where the NRC should identify cost reductions. Specifically, Ernst and Young recommended that the NRC examine the size and deployment of security staffing at NRC facilities "to identify opportunities to reduce costs without decreasing effectiveness." Notably, the NRC agreed with this recommendation and has started to implement it as part of Project Aim. *See* SECY-15-0109, Assessment of the Recommendations in the April 30, 2015 Ernst and Young Overhead Assessment, Encl. 2, Assessment of Cost Reduction Recommendations (Sept. 16, 2015).

Senator CAPITO. Thank you.

Our next witness is Dr. Edwin Lyman, Senior Scientist, Union of Concerned Scientists Global Security Program.

Welcome.

STATEMENT OF EDWIN LYMAN, SENIOR SCIENTIST, GLOBAL SECURITY PROGRAM, UNION OF CONCERNED SCIENTISTS

Mr. LYMAN. Thank you, Chairman Capito, Ranking Member Carper and distinguished members of the subcommittee.

My name is Edwin Lyman. I am a senior scientist at the Union of Concerned Scientists. On behalf of my organization, I would like to thank you for the opportunity to provide testimony on this very important subject, nuclear energy innovation and the critical role of effective regulation to ensure nuclear safety and security.

UCS is neither pro- nor anti-nuclear power. We are a nuclear safety watchdog, and we work to ensure that U.S. reactors are adequately safe both from accidents and secure from terrorist attacks. Our position on nuclear power is not ideological but pragmatic. We do believe nuclear power could have a role to play in helping to mitigate the threat of climate change, but this really can only happen if nuclear power is sufficiently safe and secure.

That means if nuclear power is to grow, then there must be a corresponding increase in safety and security. Otherwise the risk to public health and the environment will increase. Nuclear power could take itself out of the running if there is another event like the March 2011 Fukushima Daiichi disaster.

Just over 5 years ago, Japan was a world leader in nuclear energy with over 50 operating nuclear power plants, but its nuclear establishment was too complacent about the dangers their reactors faced. Today, only two of those reactors are running, and a battle is raging in the courts over the restart of two others. The United States needs to do everything it can to avoid repeating Japan's mistakes.

Therefore, Congress must ensure that the Nuclear Regulatory Commission continues to serve as a thorough and rigorously independent regulator for overseeing both the operation of existing plants and the licensing of new ones.

We believe the most efficient and cost effective way to enhance reactor safety and security in the near term is making evolutionary improvements in current designs and strengthening regulatory oversight, but we do acknowledge new and novel reactor technologies have the potential to achieve these goals in the longer term.

However, experience has shown that there are no quick or easy fixes to make nuclear power safer. Although each new reactor type has advocates who make claims about the benefits of their preferred designs for improving safety, proliferation resistance or economic competitiveness, such assertions rarely stand up to scrutiny. Reality is a lot messier.

Given the proliferation of new reactor designs and the massive investment needed to commercialize just one of them, private and public investment in nuclear development should be focused on those concepts that have the greatest chance of meeting goals for enhanced safety, security, proliferation resistance, and economic vi-

ability. Cutting through the hype and identifying the best prospects is a major challenge.

For this reason, a thorough and independent technical peer review process needs to be part of any Government program that provides support to new nuclear projects, whether at the national labs or in the private sector.

Now I would like to focus my remarks on the matter at hand, S. 2795. Fundamentally, UCS believes that the NRC's regulations and procedures governing both operating plants and new plants are not strong enough today to achieve the level of safety and security needed in the post-Fukushima era.

Correspondingly, we do not agree with the notion that the NRC's licensing processes for advanced reactors are too stringent and need to be weakened to facilitate deployment. Some argue that the NRC's regulations impede U.S. competitiveness, allowing other countries like China to get ahead of us. We think the opposite is true; the reputation of the NRC for being a gold standard, as Senator Carper pointed out, is a good brand.

The NRC's reputation for rigorous safety reviews only enhances that brand. We do not think we should be engaged with China and other countries in a regulatory race to the bottom just to secure customers.

We believe that the focus of the bill on NRC licensing is misplaced and will do little to facilitate the deployment of advanced reactors in the United States. The NRC licensing process may be a convenient target, but we think the NRC is being scapegoated for the far more formidable institutional barriers.

These barriers include a lack of support for Government-funded energy R&D, the enormously high cost and long time needed for commercializing any advanced reactor, the lack of utility interest in making those investments, and the failure of nuclear power entrepreneurs to put any significant money into the projects they espouse.

We do not think the NRC's licensing process is a significant factor in inhibiting advanced reactor deployment. As a result, we do not think that the prescriptions in S. 2795 are the problem. The problem is the cost and difficulty of obtaining the analyses and experimental data sufficient to satisfy the regulatory requirements ensuring the reactors can be licensed and safely operated. This is the fundamental issue we think Congress needs to address.

In summary, we think the legislation is premature. We would offer that the National Academy of Sciences first review the systemic obstacles to licensing and deployment of advanced reactors, including all the issues we mentioned and whether the specific prescriptions in changing NRC regulations would be efficient and effective in achieving these goals.

In conclusion, the future of nuclear power depends crucially on the NRC's credibility as an effective regulator, so we think Congress should reject any attempt to short circuit NRC safety reviews and help ensure that oversight and licensing will result in clear improvements in safe and secure operations.

Thank you for your attention.

[The prepared statement of Mr. Lyman follows:]

Testimony of Edwin Lyman, PhD

Senior Scientist, Union of Concerned Scientists

On "Enabling Advanced Reactors and a Legislative Hearing on S.2795,

The Nuclear Energy Innovation and Modernization Act."

Before the

Subcommittee on Clean Air and Nuclear Safety

Committee on Environment and Public Works

U.S. Senate

April 21, 2016

Chairman Capito, Ranking Member Carper, and other distinguished members of the Clean Air and Nuclear Safety Subcommittee of the Committee on the Environment and Public Works:

Good morning. My name is Edwin Lyman. I am a senior scientist in the Global Security Program at the Union of Concerned Scientists. On behalf of the Union of Concerned Scientists, I greatly appreciate the opportunity to provide testimony on the important subject of nuclear energy innovation and the critical role of effective regulation to ensure nuclear safety and security.

The Union of Concerned Scientists (UCS) puts rigorous, independent science to work to solve our planet's most pressing problems. UCS is neither pro- nor anti- nuclear power. We are a nuclear safety watchdog and work to ensure that U.S. nuclear reactors are adequately safe from accidents and secure from terrorist attacks.

Our position on nuclear power is not ideological but pragmatic. UCS believes that nuclear power could have a role to play in helping to mitigate the threat of climate change, and that the United States may need to extend the life of existing reactors and/or build new ones to address this problem. But this should only happen if nuclear power is sufficiently safe and secure. This means that any growth in nuclear power must be accompanied by increases in reactor safety and security; otherwise, the total risk to public health and the environment will increase.

Moreover, nuclear power could take itself out of the running if there is another event like the March 2011 Fukushima Daiichi nuclear plant disaster, whether caused by an accident or by a terrorist attack. Just over five years ago, Japan was a world leader in nuclear energy, with over

50 operating nuclear power reactors and bold plans to build many more. But Japan's nuclear establishment was too complacent about the dangers their reactors faced. Today, only two of those reactors are running and a battle is raging in the courts over the restart of two others. Japan's nuclear energy capacity is not likely to return to its pre-Fukushima level for many decades, if ever. The United States needs to do everything it can to avoid repeating Japan's mistakes. Therefore, Congress must ensure that the Nuclear Regulatory Commission (NRC) serves as a thorough and rigorously independent regulator for overseeing both the operation of existing plants and the licensing of new ones.

While the most efficient and cost-effective way to enhance reactor safety and security in the near-term is making evolutionary improvements in current designs and strengthening regulatory oversight, new and novel reactor technologies have the potential to achieve these goals in the longer term. However, experience has shown that there are no quick or easy fixes to make nuclear power safer. Although each new reactor type has advocates who make claims about the benefits of their preferred designs for improving safety, proliferation resistance or economic competitiveness, such assertions rarely stand up to scrutiny. Those who are engaged in the complex business of nuclear reactor development usually learn this lesson quickly. For example, the "traveling wave" concept that was a major early selling point of Bill Gates' Terrapower reactor—one of a class of reactors that UCS believes shows great promise—turned out not to work, necessitating a significant change in design.

Given the proliferation of new reactor designs and the massive investment needed to commercialize just one of them, private and public investment in nuclear development should be

focused on those concepts that have the greatest chance of meeting goals for enhanced safety, security, proliferation resistance, and economic viability. Cutting through the hype and identifying the best prospects is a major challenge. For this reason, a thorough and independent technical peer review process needs to be part of any government program that provides support to new nuclear projects, whether at the national labs or in the private sector.

Now I would like to focus my remarks on the matter at hand: S.2795, the Nuclear Energy Innovation and Modernization Act. Fundamentally, UCS believes that the NRC's regulations and procedures governing both operating plants and new plants are too weak to achieve the level of safety and security needed to ensure the viability of nuclear energy in the future. UCS does not agree with the notion that the NRC's licensing processes for advanced reactors are too stringent and need to be loosened to facilitate deployment of advanced reactors.

Some argue that the NRC's regulations impede U.S. competitiveness in the new nuclear power arena, allowing other countries like China to get ahead of us. We think the opposite is true: the reputation of the NRC for rigorous safety reviews only enhances the U.S. brand. We don't think that it would be wise for the United States to engage in a regulatory race to the bottom with China, which is mired in a Wild West-era of industrial development and is plagued by environmental catastrophes such as the 2015 warehouse explosions in Tianjin. U.S. companies should also appreciate the safety benefits of NRC scrutiny of nuclear power test and demonstration projects and resist the temptation to avoid it by out-sourcing such work to countries like China.

We believe that the focus of this bill on NRC licensing is misplaced and will do little to facilitate the deployment of advanced reactors in the United States. The NRC licensing process may be a convenient target, but we think the NRC is being scapegoated for the far more formidable institutional barriers that inhibit progress in advanced reactor development. These barriers include a lack of support for government-funded energy R&D in general and nuclear energy in particular; the enormously high cost (tens of billions of dollars) and long time needed (many decades) for bringing an advanced reactor project from design to commercialization; the lack of utility interest in investing in advanced reactor technology, especially in the face of the current electricity market climate; and the failure of nuclear power entrepreneurs to put their money where their mouths are and commit the resources necessary for seeing a project through to the end. We have seen no convincing evidence that the NRC licensing process is a significant factor in inhibiting advanced reactor deployment.

The history of the failed Next Generation Nuclear Plant (NGNP) project, a high-temperature gas-cooled reactor concept, is an illustrative example. The Energy Policy Act of 2005 mandated that the NRC and the DOE develop a licensing strategy for a prototype reactor within three years, address the differences between the gas-cooled reactor design and the NRC's light-water reactor-focused regulations, and set a 2021 target date for commencement of reactor operation. The NRC-DOE report, submitted to Congress in 2008, concluded that a "risk-informed, performance-based technical approach" (along the lines of what S.2795 proposes) would be the best way to establish a licensing basis for the reactor. The NRC began to engage with the DOE in developing such a licensing basis. Yet the project was suspended in 2011, not because of any licensing issues, but because the DOE was unable to find a single industry partner willing to accept at least

50 percent of the risk by participating in a cost-sharing arrangement, as required by the 2005 Energy Policy Act. (In spite of this, the NRC continued to work on issues related to licensing the reactor although it was clear no license application would be forthcoming.)

In its letter to then-DOE Secretary of Energy Steven Chu recommending suspension of the project, the DOE Nuclear Energy Advisory Committee cited the fact that "the current reluctance of vendors, owner-operator, and customers to commit to substantial up-front cost sharing in the NGNP development is unlikely to change in the near term."[1] The advisory committee also pointed out that other conditions worked against the project, including "short-term natural gas prices, a failure to internalize the social cost of carbon emissions, and the perceived high initial capital cost of the first few reactor plants deployed."

Thus, UCS does not believe the NRC's licensing procedures are the problem. The main problem is the cost and difficulty of obtaining the necessary analyses and experimental data to satisfy regulatory requirements and ensure that new reactors can operate safely. This is a fundamental issue we think Congress needs to address through oversight of the budget for nuclear energy R&D.

It is not clear that the fundamental changes to the current regulatory framework mandated by S.2795 would even help to accelerate the approval and deployment of advanced reactors. If the regulations themselves are changed to become less prescriptive, then more work on the part of applicants will be needed to demonstrate compliance, because the applications themselves will

[1] Nuclear Energy Advisory Committee, Department of Energy. *Readiness Review of NGNP to Proceed to Phase II of the Project.* letter to Energy Secretary Steven Chu. June 30, 2011.

need to translate the requirements into terms applicable to their own technology. Even if the rules are "technology-inclusive" (otherwise called "technology-neutral"), the applications of course will be technology-specific, and the NRC staff will require technology-specific expertise in order to review the applications. (This point was made very well in an April 14, 2016 post on the Energy Collective blog by scholars from Carnegie-Mellon University and University of California, San Diego.[2])

S. 2795 also calls for the NRC to establish a plan for a staged licensing structure of commercial advanced nuclear reactors. The bill itself is quite vague on what such a structure would look like, so it is hard to assess the benefits and risks of such an approach. However, we caution that dividing up a license application approval into stages may not lead to the increase in predictability of the process that the bill presumes would result. Leaving safety issues partially unresolved at early stages may only cause more problems at later stages, where resolution can be more troublesome, costly and time-consuming. For instance, approval of construction based on an incomplete design will likely lead to issues during construction that will require retrofitting and cause delays, or even worse, safety concerns during operation. For this reason, the nuclear industry is now striving to have substantially complete facility designs in hand before commencing construction.

We note that past attempts by Congress to legislate regulatory streamlining for new reactors—most notably "one-step" licensing—have not worked out as envisioned, leading some new reactor applicants to reconsider using the older, two-step procedures instead. And in fact, the

[2] Parth Vaishnavand Ahmed Abdulla, "The Myth of Technology-Neutral Regulation." Online at http://www.theenergycollective.com/parth-vaishnav/2376107/the-myth-of-technology-neutral-regulation.

one-step licensing approach seems to be at odds with the staged licensing process that this bill now proposes.

While S.2795 may not have significant benefits, it could impose an unfair burden on taxpayers. For example, the proliferation of new reactor designs has caused a problem for the NRC since many prospective new reactor vendors seek design certifications from the agency in order to obtain a stamp of approval that they hope to use to attract domestic and foreign customers. However, even with funding provided through user fees, the NRC does not have the staff resources—in terms of numbers or expertise—to certify designs that do not already have any committed end users. As a result, the NRC has a policy of generally limiting licensing reviews to vendors that have a utility partner. The changes mandated by S.2795 could result in the frivolous use of taxpayer resources to support licensing activities that are de-facto marketing exercises.

Moreover, the changes mandated by the legislation could put Americans at increased risk. For instance, requiring the NRC to introduce so-called "risk-informed, performance-based" licensing for advanced reactors could lead to less rigorous standards for approval of novel and untested technologies. These terms are ill-defined and should not be enshrined in statute. Moreover, UCS has many concerns with the way the NRC carries out "risk-informed" activities with regard to existing reactors, including an undue reliance on the results of risk studies based on paper analyses and computer models. These risk assessments are riddled with uncertainties, even for reactor types with decades of operational experience that provide copious quantities of data to validate the models. Relying on poorly validated theoretical models for licensing new reactors would be even more problematic. Thus, licensing of advanced reactors should not use potentially

inaccurate risk information, but should wait until operating experience with new technologies provides adequate information on demonstrated performance.

The research and development needed to commercialize any novel advanced reactor design is painstaking and requires great patience. Qualifying a new type of reactor fuel alone can take decades, given the time needed to conduct the necessary irradiation testing and post-irradiation examination. The process cannot be rushed without compromising safety. And the licensing process must be comparably diligent. We have seen no evidence that NRC staff are nitpicking and causing unnecessary delays in reactor licensing approvals. By and large, they are just trying to do their jobs and fulfill their responsibilities to keep the American public safe and secure.

In sum, it is not at all clear that the current licensing process for advanced reactors is a hindrance to their deployment, and even if it were, the highly complex and bureaucratic staged licensing process outlined in S.2795 may not be the right way to proceed.

Consequently, UCS believes that it is premature for Congress to prescribe a way forward until there is an independent review of these questions. UCS encourages Congress to first commission a National Academy of Sciences study to identify all the systemic obstacles to licensing and deployment of advanced reactors. This would encompass a range of issues, including selection processes for promising concepts; vendor financing and government subsidies; utility commitment and investment; gaps in the R&D infrastructure needed to address safety issues of novel designs; the role of prototypes (who should pay for them and how they should be licensed); and the critical issue of how the NRC can obtain the necessary expertise on staff in

order to license new reactor designs in a timely way without wasting resources on hiring and training experts in technologies that may not pan out. (Although S.2795 requires the NRC to develop a plan to enhance expertise, we think that solving this problem will require broader government engagement.) Such a study could provide useful insights as to where the real bottlenecks are and help guide congressional action. The study should also review whether the current licensing framework poses impediments to advanced reactor deployment, and if so, whether the processes outlined in S.2795 would be effective and efficient. A three-year study would still provide plenty of time for the NRC to implement regulatory reforms by 2025, should the report indicate a need for such reforms.

Moreover, UCS believes that comprehensive legislation to strengthen safety and security of both operating reactors and new reactors is needed, and we would welcome the opportunity to work with Congress to craft such a bill. There are numerous issues of concern to us that are not addressed in S.2795.

For example, one of the major problems with NRC's approach to advanced reactors, as articulated in the NRC's Advanced Reactor Policy Statement, is that it does not *require* new reactors to be safer than existing reactors. UCS believes that this policy inhibits true innovation in reactor design that could lead to significantly safer nuclear power in the future. For instance, the NRC recently rejected a staff proposal that new reactors should be designed to be more robust than operating reactors, and to rely less on portable emergency equipment, in the event of a Fukushima-like station blackout.[3] Legislation to mandate that new reactors be safer and more

[3] U.S. Nuclear Regulatory Commission. Staff requirements – SECY-15-0065 – Proposed rulemaking: mitigation of beyond-design-basis events. August 27, 2015.

secure than operating reactors could help to build confidence in the enduring safety of next-generation reactors in the United States.

Below we address additional specific aspects of S.2795.

User fee provisions (Sections 5 and 6). S.2795 would substantially revise the user fee schedules for NRC activities. We have concerns about the potential impact of these revisions on the ability of the NRC to carry out its statutory responsibilities to protect public health and safety.

In general, UCS opposes exempting advanced reactor licensing activities from user fee recovery. If further government subsidies for new reactor licensing activities are determined to be appropriate by Congress, mechanisms such as providing funding through the DOE "advanced nuclear energy licensing cost share grant program" proposed in Section 9 could be used rather than altering the existing user fee structure. This would be a more transparent and predictable approach in that the expenditure of resources would be clearly aligned with specific projects.

UCS also opposes the blanket cap on annual fees for operating reactor licensees proposed in Section 6. The justification for this cap and its relationship to the stated purpose of the bill to "modernize the regulation of nuclear energy" is unclear. We believe that NRC funding must retain a measure of flexibility to allow the agency to respond in a timely way to emerging and potentially serious safety and security problems. The waiver provision does not appear to provide

sufficient relief because it introduces uncertainty into the NRC's budgeting process that could hamper its planning and regulatory effectiveness.

UCS also notes that the bill would increase reporting requirements for various NRC tasks while also restricting the funding for such administrative activities (corporate support costs). This has the potential to put additional burdens on the NRC's staff time and resources that could be better spent directly on safety and security activities.

Elimination of the NRC mandatory hearing requirement (Section 8). UCS opposes this provision. Mandatory hearings provide an important independent review of uncontested issues addressed in new reactor license approvals and allow the Atomic Safety and Licensing Board (or the NRC commissioners themselves) to examine the adequacy of the NRC staff's review of license applications. Diane Curran, a lawyer, has identified numerous examples from past mandatory hearings in which serious deficiencies in the NRC staff's review were uncovered. These issues would not have come to light in the absence of mandatory hearings. This process helps to provide public confidence that all technical issues have been thoroughly and adequately considered by the NRC.

In conclusion, the future of nuclear power depends crucially on the NRC's credibility as an effective and thorough regulator. Congress should reject any attempt to short-circuit the NRC's safety reviews for either operating or new reactors, and instead help ensure that the reactor

oversight and licensing process will result in clear improvements in safe and secure operation.

Thank you for your attention.

BIOGRAPHY

Edwin Lyman is a senior scientist at the Union of Concerned Scientists in Washington, DC. He earned a doctorate in physics from Cornell University in 1992. From 1992 to 1995, he was a postdoctoral research associate at Princeton University's Center for Energy and Environmental Studies (now the Science and Global Security Program). His research focuses on the prevention of nuclear proliferation, nuclear and radiological terrorism, and nuclear accidents. He has published articles and letters in journals and magazines including *Science*, *Nature*, *The Bulletin of the Atomic Scientists*, *Science and Global Security*, *Arms Control Today*, *Nuclear Engineering International* and *Energy and Environmental Science*. He is a co-author (with David Lochbaum and Susan Q. Stranahan) of the book *Fukushima: The Story of a Nuclear Disaster* (The New Press, 2014).

Senate Committee on Environment and Public Works
Subcommittee on Clean Air and Nuclear Safety
Hearing entitled, "Enabling Advanced Reactors and a Legislative Hearing on S.2795, the Nuclear Energy Innovation and Modernization Act"
April 21, 2016
Questions for the Record for Dr. Edwin Lyman
Senator Whitehouse:

1. Dr. Lyman in your testimony you say that some of the barriers for advanced reactor commercialization are lack of support for government-funded energy R&D and the long time needed for bringing an advanced reactor project from design to commercialization.

a. Can you discuss how the DOE cost-sharing program (included in this bill) for pre-application and application review could help with some of the barriers advanced reactors face to get to commercialization?

UCS is not persuaded that the cost of licensing is a significant barrier to advanced reactor commercialization. In addition to NRC licensing costs, far greater resources—billions of dollars—would be required to support the technical work, both analytical and experimental, an advanced reactor applicant would need to prepare a high-quality submittal.

However, if Congress elects to provide taxpayer funds for supporting the cost of advanced reactor licensing, then in our view a DOE cost-sharing program would be a more transparent and predictable mechanism for providing the funding than through a direct appropriation to the NRC.

b. Does UCS support a measure like this DOE cost share program?

UCS generally supports limited and focused government support for research and development of advanced reactors that meet stringent safety, security and nonproliferation criteria. This support could extend to activities necessary for the licensing of a demonstration unit for a reactor concept that meets these criteria and passes rigorous independent peer review. However, UCS does not have a position at this time as to whether taxpayer resources should be used to license reactors for commercial deployment.

c. Can you specifically highlight what the major "red flags" are in provisions or language in the bill that would cause UCS concern over reduced safety measures currently in place for NRC licensing?

Please see my responses to questions #4 and #5 in my April 25, 2016 submittal to the committee. I would further note that adding the modifier "where appropriate" to the provisions referring to a "risk-informed, performance-based" NRC licensing framework provides the NRC with the needed flexibility to maintain a deterministic licensing procedure for advanced reactors in cases where the agency determines that a risk-informed framework is not appropriate. It is our view that risk-informed, performance-based licensing is generally not appropriate for novel and untested advanced reactor concepts.

Senator CAPITO. Thank you.

Our next witness is Mr. Victor McCree, Executive Director of Operations, Nuclear Regulatory Commission.

Welcome.

STATEMENT OF VICTOR MCCREE, EXECUTIVE DIRECTOR OF OPERATIONS, U.S. NUCLEAR REGULATORY COMMISSION

Mr. MCCREE. Thank you, and good morning.

Chairman Capito, Ranking Member Carper, and distinguished members of the subcommittee, I appreciate the opportunity to testify this morning. I appear before you today representing the technical staff of the U.S. Nuclear Regulatory Commission.

I plan to briefly discuss the NRC's current and planned activities to prepare to review an application for an advanced non-light water reactor design and to offer NRC staff views on S. 2795, the Nuclear Energy Innovation and Modernization Act.

A number of advanced non-light water reactor designs that employ innovative design features are under development. The NRC has the necessary licensing and oversight authority over commercial advanced reactors and is ready to work with the potential applicants to prepare for and review applications for these reactors. However, the NRC is also considering the extent to which enhancements to the existing licensing framework could increase the efficiency, timeliness and predictability of our safety and environmental reviews.

Our objective for the activities I will discuss with you today is to strategically prepare for non-light water reactor applications commensurate with the development of vendor and industry plans. However, our overall goal is to create a more effective, efficient, clear and predictable licensing process for advanced reactor safety reviews.

With this in mind and within available resources, the NRC staff is pursuing a multipart strategy to prepare for our review of non-light water reactor technologies. The President's fiscal year 2017 budget request includes $5 million in non-fee recoverable activities to execute this strategy. If Congress appropriates this funding, it will be used to facilitate the NRC's preparation to undertake efficient and effective safety reviews of advanced reactor technologies.

We plan to pursue activities in three primary areas: licensing infrastructure, technical preparation, and stakeholder outreach.

First, within licensing infrastructure activities, we will optimize the regulatory framework and licensing process for advanced reactor safety reviews.

Second, our technical preparation activities will evaluate, clarify and resolve critical technical and policy issues that need to be addressed for effective, efficient advanced reactor safety reviews.

Finally, we will expand upon our outreach activities to proactively engage key stakeholders to ensure all parties will be ready to proceed in the development and review of new reactor designs.

Our strategy reflects insights we have gained from many years of interaction with the Department of Energy and the non-light water reactor community. We believe this strategy will enable the resolution of novel policy issues and lead to the development of de-

sign criteria, regulatory guidance and industry codes and standards for non-light water reactor designs.

By enhancing the efficiency and effectiveness of non-light water reactor reviews, this strategy will reduce uncertainty and business risk.

The NRC's Advanced Reactor Program is one of several topics addressed in S. 2795. Consistent with my role as the NRC's Executive Director for Operations, my comments represent the NRC staff's assessment of factual issues associated with a draft version of the bill.

Based on our preliminary review, the bill would require the NRC to undertake a number of activities related to developing plans, strategies and rulemaking associated with the licensing of advanced reactors and of research and test reactors and report on those to Congress. Significant time and resources would be required over several years to implement the full range of additional activities described in the bill, particularly with regard to the rulemaking required by the bill.

Another area covered by the bill is performance and reporting. These provisions would require the NRC to develop performance metrics and milestone schedules for any activity requested by a licensee or applicant and to report to Congress for certain delays.

This would require NRC to develop performance metrics and milestone schedules for many activities beyond those for which such metrics and milestones are currently prepared. We believe we currently have appropriate performance metrics to provide the desired outcome.

These measures recognize the need to adapt to schedule changes that may arise to an applicant, licensee or NRC performance and account for emerging safety or security issues, changes in licensee plans and so forth. As written, the proposed requirements may limit NRC's flexibility in this area.

In closing, I welcome the committee's interest in and ideas for enhancing the NRC's performance and the success of our mission.

Chairman Capito, Ranking Member Carper and distinguished members of the subcommittee, this concludes my formal remarks. I thank you for the opportunity to appear before you and would be pleased to respond to your questions.

[The prepared statement of Mr. McCree follows:]

STATEMENT OF VICTOR M. McCREE
EXECUTIVE DIRECTOR FOR OPERATIONS
U.S. NUCLEAR REGULATORY COMMISSION
BEFORE THE
CLEAN AIR AND NUCLEAR SAFETY SUBCOMMITTEE
April 21, 2016

Chairwoman Capito, Ranking Member Carper, and distinguished Members of the Subcommittee, I appreciate the opportunity to testify this morning. I appear before you today representing the technical staff of the Nuclear Regulatory Commission. I plan to briefly discuss the NRC's current and planned activities to prepare to review an application for an advanced non-light-water reactor design, and to offer NRC staff views on S.2795, the "Nuclear Energy Innovation and Modernization Act."

ADVANCED REACTOR ACTIVITIES

Designers are developing a number of advanced non-light-water reactor designs that employ innovative solutions to technical nuclear power issues. The NRC has the necessary licensing and oversight authority over commercial advanced reactors, and is ready to work with potential applicants to prepare for and review applications for these reactors. However, the NRC is also considering the extent to which enhancements to the existing framework could increase the efficiency, timeliness, and predictability of such safety and environmental reviews.

The NRC's mission is to license and regulate the use of radioactive materials to ensure adequate protection of public health and safety and promote the common defense and security. Our statutory authority does not extend to promotion or implementation of nuclear energy design or technology. The NRC remains committed to continued planning and engagement with stakeholders to effectively and efficiently accomplish the agency's potential advanced reactor licensing workload. Our ongoing work in this area adheres to the NRC's Principles of Good

Regulation, while we verify through oversight the safe operations of the current fleet of operating nuclear power plants.

Our objective for the activities I am discussing with you today is to strategically prepare for non-light-water reactor applications commensurate with the development of vendor and industry plans. With this as our goal, we expect the result of our efforts to be an effective, efficient, clear, and predictable licensing process for advanced reactor safety reviews.

In pursuit of this goal, and within available resources, the NRC staff is pursuing a multi-part strategy to prepare for efficient and timely reviews of non-light-water reactor technologies. We expect to complete the first draft of that strategy soon and will discuss it in a public meeting with the Commission in June. The President's FY 2017 budget request includes $5 million in non-fee-recoverable activities to execute this strategy. If Congress appropriates this funding, it will be used to facilitate the NRC's preparation to undertake effective and efficient safety reviews of advanced reactor technologies.

The NRC plans to pursue activities in three primary areas: licensing infrastructure, technical preparation, and stakeholder outreach.

First, within licensing infrastructure activities, we will optimize the regulatory framework and licensing process for advanced reactor safety reviews. We plan, for example, to conduct a gap analysis of regulations and guidance to find areas where revisions may be needed, and to fill those gaps by beginning to revise our regulations and guidance for advanced reactors. We will also complete development of advanced reactor design criteria, evaluate new approaches to review conceptual designs on an incremental (or staged) basis, and evaluate novel policy issues for Commission consideration. Of note, the NRC recently published draft design criteria for

advanced reactors on our public web site, and we are seeking public comments on the draft document. We look forward to continuing to engage with stakeholders on this issue.

Second, our technical preparation activities will evaluate, clarify, and resolve critical technical and policy issues that need to be addressed for effective and efficient advanced reactor safety reviews. For example, the NRC recently expanded an existing interagency agreement with the U.S. Department of Energy for exploring regulatory issues and research needs for novel fuel designs, and held a seminar on advanced reactor and accident-tolerant fuels. We also have completed some training, and plan further training for staff on different reactor technologies. Additionally, we will work with others to develop proposed revisions to industry codes and standards to address certain advanced reactor designs and develop related requirements. Further, we will conduct a hazard analysis to better understand the potential hazards and safety requirements necessary to prevent or mitigate these hazards.

Finally, we will pursue outreach activities that proactively engage key stakeholders to ensure all parties will be ready to proceed. These activities will include the continuation of engagements with designers of advanced reactors and members of the public; participation in standards development for advanced reactors; and information sharing with various national and international groups, including the U.S. Department of Energy, the Organisation for Economic Co-operation and Development's Nuclear Energy Agency, the International Atomic Energy Agency, and the NRC's international regulatory counterparts. I am happy to share with you that a second joint DOE/NRC workshop on advanced non-light-water reactors will be held June 7th and 8th here in the Washington area.

Our strategy reflects insights we have gained from years of interaction with the Department of Energy and the non-light-water reactor industry. We believe this strategy will enable the resolution

of novel policy issues, and lead to the development of design criteria, regulatory guidance, and industry codes and standards for non-light-water reactor designs. By enhancing the efficiency as well as the effectiveness of non-light water reactor reviews, this strategy will reduce regulatory uncertainty and business risk.

S.2795, THE NUCLEAR ENERGY INNOVATION AND MODERNIZATION ACT

The NRC's advanced reactor program is one of several topics addressed in Senate Bill 2795. Consistent with my role as the NRC's Executive Director for Operations, my comments represent the NRC staff's assessment of factual issues associated with the bill.

The bill would require the NRC to undertake a number of activities related to developing plans, strategies, and a rulemaking associated with the licensing of advanced reactors and of research and test reactors; and report on those to Congress. As my testimony indicates, the NRC currently has extensive ongoing and planned activities in these areas. Significant time and resources would be required over several years to implement the full range of additional activities described in the bill, particularly with regard to the rulemaking required by the bill and any other activities that may require rulemaking.

Another area covered by the bill is performance and reporting. These provisions would require the NRC to develop performance metrics and milestone schedules for any activity requested by a licensee or applicant and to report to Congress for certain delays. This would require the NRC to develop performance metrics and milestone schedules for many activities beyond those for which such metrics and milestones are currently prepared. We believe we currently have appropriate performance metrics to provide the desired outcome. These measures recognize that schedule performance can be affected by applicant, licensee, or NRC performance, and may need fluidity to

account for emerging safety or security issues, changes in licensee plans, and the like. As written, the proposed requirements could limit the NRC's flexibility in this area.

CLOSING

In closing, I welcome the Committee's interest in, and ideas for, enhancing the NRC's performance and the success of our mission.

Chairwoman Capito, Ranking Member Carper, and distinguished Members of the Subcommittee, this concludes my formal testimony. I thank you for the opportunity to appear before you and would be pleased to respond to your questions.

The Honorable James Inhofe

QUESTION 1. **In your testimony, you state that "Significant time and resources would be required over several years to implement the full range of additional activities described in the bill...". Your testimony also states that "...the NRC currently has extensive ongoing and planned activities..."**

a) Please describe in detail the extent to which NRC's "ongoing and planned activities" would be mutually exclusive of the activities envisioned in S.2795 and the extent to which they could be complementary.

b) Please describe in detail the challenges with regard to implementing the advanced reactor provisions in S.2795.

c) Are the milestones in S.2795 achievable? If not, please provide specifics with detailed explanations.

ANSWER.

a. The U.S. Nuclear Regulatory Commission (NRC) is developing a vision and strategy document that outlines the NRC's plan to ensure readiness for effective and efficient review of future non-light-water reactor (non-LWR) applications. It contains three key strategic objectives: enhance technical readiness, optimize regulatory readiness, and optimize communication. The document addresses activities that need to be undertaken in three timeframes: near term (0–5 years), midterm (5–10 years), and long term (beyond 10 years). Specific implementation action plans will be developed by early calendar year (CY) 2017. The vision and strategy

document has recently been shared with Department of Energy (DOE) staff for its comment, and the NRC expects to seek broader stakeholder comment in the coming weeks.

Key near-term strategies include acquiring or developing sufficient knowledge, technical skills, and capacity to perform non-LWR regulatory reviews; acquiring or developing sufficient computer codes and tools to perform non-LWR regulatory reviews; and establishing a more flexible, risk-informed, performance-based, non-LWR regulatory review process within the bounds of existing regulations. The goal is for the staff's review efforts to be commensurate with the safety performance of the non-LWR design being considered. Of particular interest to some stakeholders is the development of both a conceptual design assessment process and a staged review process. Outreach activities will particularly focus on vetting the proposal for these processes over the next few months.

Within the limited resources in the current budget, the NRC has worked with DOE in developing design criteria that are specific to non-LWR technologies. Staff is currently taking public comments on these criteria as input to consider as a draft Regulatory Guide is prepared and published for formal comment; it is currently expected to be issued for comment by the end of CY 2016.

There are many similarities between the requirements in S.2795 and the NRC's ongoing activities, although S.2795 would require the NRC to undertake these activities on an accelerated schedule and would require development of additional reports to Congress with coordination through the Secretary of Energy. The fundamental requirements related to advanced reactors in S.2795 are complementary in concept to the NRC's ongoing activities.

b. As noted in the response to question (a), significant progress is being made within the limited resources in the current budget. The increased reporting requirements in the bill, in the near-

term would challenge limited resources. The longer-term requirements would have a lesser impact on NRC activities, but would nevertheless reflect an increase in workload on limited resources.

c. Yes, the milestones in S.2795 are achievable. However, as noted in the response to question (b), achieving those milestones with limited resources would be a challenge to implementing the NRC's ongoing activities.

QUESTION 2. **Would a limit on annual fees limit the NRC's safety and security inspections of operating reactor licensees? If so, please describe any impacts in detail including why costs for safety and security inspections of operating reactor licensees would not be recovered under 10 CFR Part 170 (hourly fee for service).**

ANSWER.

A limit on annual fees has the potential to limit the NRC's safety and security inspections of operating reactor licensees because the NRC's safety-and-security inspections depend upon certain generic activities that benefit the operating reactor fleet. The NRC cannot bill generic activities through Title 10 of the *Code of Federal Regulations* (10 CFR) Part 170 (fees for services). Instead, the costs of generic activities are recovered through 10 CFR Part 171 (annual fees). Some examples of the generic activities that support safety and security inspections are as follows:

- Guidance—Development of enforcement guidance memorandum and interim enforcement policy in coordination with Office of Enforcement and technical divisions
- Inspection Manuals— development of and revision to Inspection Manual chapters, such as IMC 0612 "Inspection Reports" and office protocol instructions

- Replacing the outdated Reactor Program System used by the inspection program offices and the regions as the primary tool to plan and schedule work assignments and inspection activities and to record inspection findings
- Completing Fukushima lessons-learned activities

QUESTION 3. **For all international activities for the last five years, including vendor inspections, please provide the annual spending for each activity and indicate whether the costs were recovered through net appropriations, 10 CFR Part 170 fees, or 10 CFR Part 171 fees.**

ANSWER.

The NRC's international activities are recovered through 10 CFR Part 170, "Fees for Facilities, Materials, Import and Export Licenses, and Other Regulatory Services under the Atomic Energy Act of 1954, as Amended;" 10 CFR Part 171, "Annual Fees for Reactor Licenses and Fuel Cycle Licenses and Materials Licenses, including Holders of Certificates of Compliance, Registrations, and Quality Assurance Program Approvals and Government Agencies Licensed by the NRC;" and net appropriations (fee relief). Export and import license applicants and holders are assessed 10 CFR Part 170 fees. International cooperation activities that benefit a group of licensees are assessed as annual fees to that specific fee class. These activities include regulatory information exchanges and policy and priority formulation activities, both of which provide direct input into how the NRC regulates its licensees. Finally, the NRC's international assistance activities to foreign regulatory counterparts for improving safety and security are recovered through net appropriations (fee relief).

All NRC vendor inspection activities are recovered through 10 CFR Part 171's annual fees, assessed to NRC licensees. Reactor vendors are not NRC licensees and not directly subject to most NRC regulations.

The following are the 5-year resources for international and vendor inspection activities recovered by 10 CFR Part 170, 10 CFR Part 171, or net appropriations.

(dollars in thousands)

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
International Activities Budgeted Resources*	25,773	28,264	27,014	30,089	32,434
Recovered through:					
10 CFR Part 170 fees	2,529	6,121	5,278	5,480	6,649
10 CFR Part 171 fees	8,176	13,479	12,130	13,685	16,523
Net appropriations	15,068	8,664	9,606	10,924	9,261

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Vendor Inspection Budgeted Resources*	8,471	10,756	12,226	12,777	9,714
Recovered through:					
10 CFR Part 171 fees	8,471	10,756	12,226	12,777	9,714

* budgeted resources were calculated using full-costed FTE rate for fee recovery purposes per the fee rule.

QUESTION 4. **Please provide a list of the activities encompassed within S.2795 for which the NRC does not currently have performance metrics and milestone schedules.**

a) For each activity, please indicate why performance metrics and milestone schedules do not exist and describe in detail any hindrances to developing them.

b) Please describe how the NRC measures performance and manages workload without performance metrics and milestone schedules for those activities.

ANSWER.

The NRC has performance metrics and milestone schedules for all "requested activities of the Commission," as defined in S.2795, except for "any other activity requested by a licensee or applicant" (Section 4(9)(B)).

a. The words "any other activity requested by a licensee or applicant" could be read as comprising a potentially very broad range of actions, including many routine interactions with licensees and applicants that often may involve "requests by licensees and applicants." The agency may establish performance metrics for these activities on a case-by-case basis. However, many such requests are simple and of short duration and can be effectively and efficiently resolved by staff-to-staff interactions without agency performance metrics and milestone schedules.

b. The NRC staff establishes performance metrics and milestone schedules in all situations for which it believes such measures are necessary and appropriate. In other cases, based on the short duration of the task, the NRC does not believe they are required for effective workload management and efficient and effective decisionmaking.

QUESTION 5. **Your written testimony states: "We believe we currently have appropriate performance metrics to provide the desired outcome."**

a) Please describe what the desired outcome is.

b) Please describe the extent to which timeliness is a desired outcome.

ANSWER.

a. The desired outcome is to meet our safety and security mission through an effective and efficient process that provides a thorough, transparent, and timely review or decision under the specific circumstances presented consistent with the NRC Principles of Good Regulation.

b. Timeliness is an important aspect of achieving our desired outcome; but getting to the right safety decision takes precedence.

QUESTION 6. Please describe in detail how performance metrics, schedule milestones, and reporting requirements would limit the NRC's flexibility in conducting safety and security reviews.

ANSWER.

Schedule adherence can be affected by applicant or licensee performance or by the actions of the NRC. In addition, emerging safety or security issues, changes in licensee plans, and other unplanned events can affect schedules. S.2795 would reduce flexibility by requiring set performance metrics and milestone schedules and requiring reporting for certain delays, instead of allowing the metrics and schedules to be revised if there are emerging safety or security issues, changes in licensee plans, or other unplanned events that can affect schedule performance. Accounting for these various factors and unknowns, the NRC has in place the performance metrics that the agency believes support the desired outcomes.

S.2795 would also require the NRC to develop performance metrics and milestone schedules for any activity requested by a licensee or applicant. As explained in response to Question 4, this would potentially require the NRC to develop and manage performance metrics and milestone schedules for many activities beyond those for which such metrics and milestones are

currently prepared and may not be necessary. Establishing such metrics and milestones is of uncertain value, adds to management burden and workload without having a meaningful effect on transparency, and ultimately could affect flexibility to effectively and efficiently manage a dynamic process.

QUESTION 7. **Please describe whether additional performance metrics, schedule milestones and reporting requirements would increase or decrease transparency at the NRC.**

ANSWER.

The NRC does not believe that additional performance metrics, schedule milestones, and reporting requirements would have a meaningful effect on the transparency the agency currently seeks to achieve and the openness cross-cutting strategy on transparency in the NRC's strategic plan.

QUESTION 8. **The NRC's Principles of Good Regulation state: *"The American taxpayer, the rate-paying consumer, and licensees are all entitled to the best possible management and administration of regulatory activities.... Regulatory decisions should be made without undue delay."* Please describe whether additional performance metrics, schedule milestones and reporting requirements would help or hinder the agency's effort to abide by this principle.**

ANSWER.

Schedule adherence can be affected by applicant or licensee performance or by the actions of the NRC. In addition, emerging safety or security issues, changes in licensee plans, and other

unplanned events can affect schedules. S.2795 would reduce flexibility by requiring set performance metrics and milestone schedules and requiring reporting for certain delays, instead of allowing the metrics and schedules to be revised if there are emerging safety or security issues, changes in licensee plans, or other unplanned events that can affect schedule performance.

QUESTION 9. **Please explain why a need to reduce corporate support spending would jeopardize the NRC's ability to provide physical protection of its personnel and facilities, particularly in light of the NRC's plans to reduce the size of its housing footprint at NRC headquarters. Please describe in detail the justification for doing so rather than reducing other lower priority corporate support costs.**

ANSWER.

The NRC believes that corporate support spending can continue to be reduced without jeopardizing the agency's ability to provide physical protection of its personnel and facilities. In light of the NRC's continuing work to reduce the size of its housing footprint at headquarters, the FY 2016 enacted budget reflects a reduction of $370,000 in guard services for the NRC headquarters Three White Flint North building (3WFN), following the release of four floors in May 2015 to the Food and Drug Administration (FDA). As FDA became the majority tenant in 3WFN, the corresponding reduction in guard services had no impact on the NRC's ability to provide physical protection while still maintaining a security level 4 facility. Additionally, in order for the agency to adhere to the corporate support limits specified in the appropriations act for FY 2016, $1.9 million was reduced from the FY 2016 enacted budget for guard services; however, this was a one-time reduction in the amount of forward funding on the contract, which had no adverse impact on the agency's overall security. Beyond the items mentioned above,

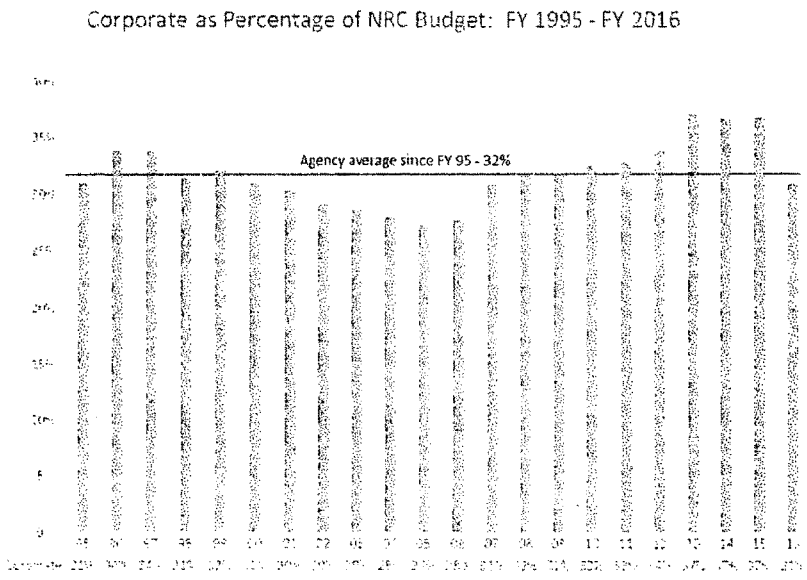
there were no additional reductions in the FY 2016 enacted budget in the areas of physical and personnel security. The NRC continues to look for efficiencies in corporate support that reduce costs without jeopardizing safety and security.

Since 2012, the NRC has been reducing its office space and corresponding costs at its headquarters location in Rockville, MD. The NRC has identified additional reductions of approximately 48,122 square feet of usable office space in 3WFN, including a space that previously housed a cafeteria, and two full floors. These planned reductions will begin in FY 2017 and continue through FY 2019. The NRC will continue to work with the U.S. General Services Administration to review requirements and identify opportunities for space and cost savings based on staffing levels.

As the NRC continues to identify efficiencies and reduce spending within the Corporate Support budget, lower priority corporate costs would be considered before corporate costs related to the NRC's ability to provide physical protection of its personnel and facilities. It should be noted that the agency's fixed costs have continued to increase over the years (including a substantial increase in rent associated with 3WFN). Additionally, there are rising costs associated with personnel security mandates. The recently revised Federal Investigative Standards, now require the agency to conduct reinvestigations for all employees and contractors every 5 years ("L"-cleared personnel were previously reinvestigated every 10 years, and there was no requirement to reinvestigate contractors who did not hold security clearances), increasing annual costs and efforts to ensure compliance with the requirement.

QUESTION 10. **Given the NRC's corporate support spending rate of 28% of total budget authority in 2006, please describe in detail why that same corporate support spending rate of 28% would not be achievable in 2023.**

ANSWER.



As the chart above indicates, the percent percentage for corporate in FY 2006 was lower than the historical level required to adequately support the agency and was an artifact of unequal ' growth in corporate and program resources during a period of budget increases in the early part of the decade. Over this period, information technology has become even more important to all aspects of the NRC's work, driving increased costs. In FY 1995, corporate costs were equal to

approximately 31 percent of the agency's budget. Five years later, in FY 2000, the agency's total budget had decreased by10 percent, but the corporate percentage was the same (31 percent). Beginning in FY 2001 and continuing through FY 2006, as the agency's overall budget began to increase, program resources grew at twice the rate of corporate. As a result, corporate dropped as a percentage of the budget, reaching a low of 27 percent in FY 2005.

This was followed by two years of large corporate budget increases to provide the organizational infrastructure required to hire an additional 500 full-time equivalents through FY 2009. The added resources allowed the agency to acquire and configure additional office space; manage increased personnel, facility, and cybersecurity requirements; cover growing telecommunication and IT seat management costs; and replace obsolete equipment and software. The corporate percentage rose to 28 percent in FY 2006, the first year that corporate growth outpaced program, and rebounded to 31 percent in FY 2007, close to the agency's historical average of 32 percent over the past twenty years.

The period from FY 2008 to FY 2010 saw the funding trend reverse, as corporate increases outpaced program budget growth by 10 percent. By FY 2010, corporate was 33 percent of the overall agency budget, with the increase still largely driven by increased infrastructure costs related to rapid growth in agency staffing levels. Over the next 3 years, FY 2010 through FY 2013, the corporate percentage spiked to 37 percent as the agency expanded the definition of corporate support to encompass a range of costs previously included in program budgets. The "expanded" definition of corporate support included $15.0 million for the Integrated University Program, first added to the agency's budget in FY 2008, as well as resources for International Activities and the Regulatory Information Conference, both of which had previously been included in program budgets. The percentage held at 37 percent until FY 2016, when the corporate portion of the budget returned to the historical norm of 32 percent. This was achieved

in part by acting on EY's recommendations to realign resources in accordance with the more standard definition of corporate support used before FY 2011 and by instituting corporate budget cuts to reflect declining program staffing levels. The FY 2016 figure is in line with the 32 percent identified for Peer Agency C in the EY report, as well as the historical norm for the NRC.

Historically, corporate resources equal to approximately 31 percent to 32 percent of the budget have been adequate to cover the agency's fixed infrastructure costs, fund normal service levels, and make strategic investments (e.g., increasing work space density and modernizing IT systems) necessary to achieve future corporate efficiencies. When the agency briefly operated with lower levels of corporate resources for a few years in the mid-2000s, service gaps, outmoded systems and facilities placed noticeable burdens on the programs, prompting a reinvestment in corporate support.

QUESTION 11. **During [the] course of various types of licensing reviews, the NRC often issues Requests for Additional Information (RAI) to individual licensees or applicants for information that is needed for decision-making purposes. These requests can often be resource-intensive for licensees and applicants. Reports to Congress may be as important for the purposes of decision making as RAI's are for the NRC's decision-making. Hence the agency's concerns about the resource burden of reporting to Congress suggest a double-standard. Please clarify whether the NRC is prepared to be responsive to Congress in its request or whether the agency considers reporting to congress to be an excessive burden.**

ANSWER.

The NRC is prepared to be fully responsive to Congress. The NRC always strives to provide timely and competent reports to congressional committees, when requested, and has managed the competing needs and priorities. The agency will continue this practice.

QUESTION 12. **The NRC's Independence Principle of Good Regulation states:**

"Nothing but the highest possible standards of ethical performance and professionalism should influence regulation. However, independence does not imply isolation. All available facts and opinions must be sought openly from licensees and other interested members of the public. The many and possibly conflicting public interests involved must be considered. Final decisions must be based on objective, unbiased assessments of all information, and must be documented with reasons explicitly stated."

The NRC has raised concerns that a cap on a portion of its fee collection might compromise the NRC's ability to demonstrate its independence. However, the NRC lacks concern over how failing to budget for the statutorily-mandated review of the Yucca Mountain license application has raised questions about the NRC's independence. Please explain the apparent discrepancy between those two positions.

ANSWER.

The NRC has always strongly and successfully maintained its position as an independent regulator, regardless of the perceptions that may exist in some quarters on this matter. The implementation of a cap on annual fees per operating reactor licensee has the potential to limit the amount of funding the NRC may request to meet its independent statutory mission. Linking the NRC's budgets to the availability of fees it is able to collect could limit the resources available to carry out regulatory responsibilities. Furthermore, the NRC's ability to demonstrate its independence as a regulator could be compromised if there was a perception that a capped annual fee was driving the agency's safety and security activities for a given year.

The NRC budget request is the product of a Commission deliberation and vote. There has not been majority support for requesting funds for continuing and completing the Yucca Mountain licensing process. Thus, the NRC's FY17 budget request did not include funding for the Yucca Mountain review.

QUESTION 13. **The cap on annual fees in S. 2795 sets the ceiling near the all-time-highest rate to account for the costs of the NRC's post-Fukushima workload and is indexed for inflation. Given the NRC's efforts to right-size the agency through Project Aim 2020, the declining number of operating reactors, the workforce and office space reductions, and the conclusion of post-Fukushima work, please indicate whether there are specific years between now and 2020 when the agency anticipates exceeding the level of FY 2015 budget authority.**

ANSWER.

The NRC FY 2016 enacted budget and FY 2017 budget request are smaller than the FY 2015 enacted budget. As referenced in SECY-15-015, "Project Aim 2020 Report and Recommendations, Appendix D, NRC Financial Environment", the NRC expects its budget to continue to be smaller than the FY 2015 enacted budget, and there are no years between now and 2020 when the agency anticipates exceeding the level of FY 2015 budget authority.

QUESTION 14. **If the NRC's concerns about a cap on annual reactor fees is driven by the need for resources to respond to a severe accident, please describe why NRC budgeting decisions would be driven by events that exceed the NRC's safety goal and which the NRC legally requires licensees to protect against. Is it accurate to say that much of the cost of responding to a severe accident is fee recoverable under 10 CFR Part 170 (hourly fee for service)? Beginning with 2011 and for each following year, please provide a breakdown for Fukushima-related costs recovered under 10 CFR Part 170 versus those recovered under 10 CFR Part 171.**

ANSWER.

The NRC's budgeting decisions are driven by its mission to license and regulate the Nation's civilian use of radioactive material to protect public health and safety, the common defense and security, and the environment.

The cost of responding to a severe accident would be fee recoverable under 10 CFR Part 170 (fees for services) to the extent that the response to the event is specific to an NRC-licensed

facility or results in modifications specific to an NRC-licensed facility. There may also be fees recovered under 10 CFR Part 171 (annual fees) for activities as a result of severe accidents. These annual fees would be for activities that are not specific to an NRC-licensed facility that stemmed from the event response, including guidance development, development of new or modified requirements, generic communications, or new research.

The following is a breakdown for Fukushima-related costs recovered under 10 CFR Part 170 versus those recovered under 10 CFR Part 171. The majority of the activities from the Fukushima lessons learned project were associated with improving the safety of the reactor fleet; therefore, the budgeted costs were recovered under annual fees.

Fukushima-Related Resources (dollars in thousands)

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Budgeted Resources*:	-	15,260	37,558	48,650	54,410
Recovered through:					
10 CFR Part 170 fees	-	113	13,553	18,786	22,302
10 CFR Part 171 fees	-	15,147	24,005	29,864	32,108

*Budgeted resources were calculated using a full costed rate for fee recovery purposes per the fee rule.

Senator CAPITO. Thank you.

Our final witness is Hon. Jeffrey S. Merrifield, Chairman, USNIC Advanced Reactor Task Force.

Welcome.

STATEMENT OF HON. JEFFREY S. MERRIFIELD, CHAIRMAN, ADVANCED REACTORS TASK FORCE, U.S. NUCLEAR INFRASTRUCTURE COUNCIL

Mr. MERRIFIELD. Chairman Capito, thank you very much.

It is indeed a pleasure to be here today before a committee on which I used to work as a counsel, and on which I testified on many occasions as an NRC Commissioner.

I am appearing here today in my role as Chairman of the U.S. Nuclear Infrastructure Council Advanced Reactors Task Force, although my full time occupation is as an attorney and partner with the Pillsbury law firm.

In addition to my full testimony, I would ask that letters from seven advanced reactor developers supporting this legislation be included in the record.

[The referenced letters were not received at time of print.]

Mr. MERRIFIELD. My testimony on S. 2795 will focus on how the NRC conducts its business as well as mixed views regarding the advanced reactor portion of the bill.

NIC applauds the overhead and fee caps within S. 2795 as well as the elements supporting the development and deployment of advanced reactor technologies. On February 22, 2016, NIC issued a framework for advanced reactor licensing modernization white paper which outlined many of the advanced reactor provisions contained in the bill.

While we will suggest a few additional areas for improvement not included in the legislation, we are committed to working with the committee and its staff to promptly move this legislation forward.

When I first became a Commissioner in 1998, the then Chairman of this committee, Senator Inhofe, led the way in efforts to oversee NRC. Consistent with maintaining the NRC's mission of protecting people and the environment, the Commission, with the full support of this committee, worked to right size the agency consistent with the level of licensing activities before the NRC.

At that time, the agency had approximately 3,400 employees, and within the next few years we were able to reduce it to about 2,800, principally through attrition yet with no sacrifice to the mission of the agency. Today, the agency faces the same challenge. I understand and sympathize with the concerns voiced by this committee regarding the size of the agency, the increase in licensing review time and the growth in overhead activities at the agency which is inconsistent with the current number of NRC licensees.

While the NRC has made great strides in right sizing the agency through Project AIM, I believe further reductions can be accomplished while at the same time effectively maintaining safety and inspection activities and improving the timeliness of licensing actions.

I support the provisions of S. 2795 which would limit the overhead of the NRC and place appropriate caps on the growth of agen-

cy fees. As was the case when I appeared before this committee over 15 years ago, I believe the amount of fees placed on individual licensees is not appropriate and should not cover inherently governmental functions and overhead.

I believe the fee provisions of S. 2795 appropriately balance the important non-licensee activities which should be borne by general revenues and those licensee activities that should be borne by user fees.

During the past decade, the U.S. has maintained its technology leadership through progressive light water reactor designs including passive Generation III+ reactors currently being deployed in Georgia and South Carolina as well as small modular light water nuclear reactors now headed toward deployment.

If the U.S. is to be successful in maintaining its lead in developing and deploying a new advanced reactor fleet in the late 2020s and 2030s, Congress must consider significant new policy changes.

In addition to funding an infrastructure, a modern licensing framework is needed to enable development and deployment of advanced reactor technologies. Currently, the licensing process of the agency is perceived as one of the largest risk factors confronting private developers of advanced reactors.

The proposed licensing process changes envisioned by S. 2795 will help to address this gap. Additionally, Congress should provide additional resources to both NRC and DOE as well as direct them to focus and mobilize their resources and expertise to enable the deployment of advanced reactors.

We believe section 7 will allow the agency to create a modern, risk informed, technology neutral framework to enable the development of appropriate advanced reactor regulations without passing these costs to the existing utilities or advanced reactor developers.

Advanced reactor technical performance criteria are also critically required to finalize advanced generic design criteria as well as short term emergency planning and similar requests.

We believe there are two areas where further enhancements are warranted: appropriate funding to reduce the licensing fees borne by advanced reactor developers and a specific pre-licensing review program.

While the NRC is not a promoter of nuclear technologies, it is appropriate for the Commission to engage in early, enhanced dialogue with advanced reactor developers. Currently, the NRC has very limited communication with these developers, and when it does, it must charge hourly fees, $268 per hour, per NRC staff member who attends these meetings. As members of the advanced reactor community are early stage and entrepreneurially driven private companies, they lack the resources necessary to finance these activities.

NIC supports section 9 of the bill regarding the DOE licensing cost share grant program. We believe this is an appropriate development. We would say we think it could be further enhanced by allowing for early stage engagement with the advanced reactor community at no cost with perhaps a 50/50 share in later stages of the licensing process.

Collectively, we believe this will allow the free market to pick winners and losers rather than DOE and the NRC. While section

7(b) calls for the NRC to "establish stages in the commercial advanced nuclear reactor licensing process," we believe, and it is generally consistent with our white paper, the bill would be strengthened by incorporating specific language requiring that the NRC provide a pre-licensing design review.

A process which requires the NRC to clearly and promptly articulate where advanced reactor designs do and do not need additional work would enable developers and investors to have a clearer picture of where they stand in meeting NRC requirements.

Finally, we support the elimination of the mandatory hearing requirements contained in section 8. I would be pleased to discuss my views on this during the question and answer portion.

We believe it is time to make appropriate reforms to the NRC overhead and fee process as well as to modernize the agency's licensing program to spur innovation and enable advanced reactor technologies to achieve their full promise. We believe S. 2795 makes significant progress toward achieving that goal. We are committed to working with this committee toward prompt and successful passage.

Thank you for allowing me to testify today.

[The prepared statement of Mr. Merrifield follows:]

UNITED STATES NUCLEAR
INFRASTRUCTURE COUNCIL
www.usnic.org

Hearing on Enabling Advanced Reactors and a Legislative Hearing on S. 2795, "The Nuclear Energy Innovation and Modernization Act

The Honorable Jeffrey S. Merrifield Commissioner, U.S. Nuclear Regulatory Commission (1998-2007)
Partner, Pillsbury Winthrop Shaw Pittman &
Chairman, USNIC Advanced Reactors Task Force
April 21, 2016

Chairman Capito, Ranking Member Carper and members of the Subcommittee, it is indeed a pleasure to be here today before a Committee on which I used to work as a counsel, and one on which I had the opportunity to testify on many occasions during the time I served as a Commissioner of the U.S. Nuclear Regulatory Commission (NRC). I am appearing here today in my role as Chairman of the U.S. Nuclear Infrastructure Council (NIC) Advanced Reactors Task Force, although my full time occupation is as a Partner in the nuclear energy practice group of Pillsbury Winthrop Shaw Pittman.

Before I begin my testimony, I want to make it clear that, while I am testifying on behalf of NIC, the views I am presenting do not necessarily reflect all of the members of NIC, nor those of the law firm on which I am a partner. Further, I would provide the disclaimer that our firm represents a diversity of nuclear suppliers and utilities, and I personally serve as outside counsel for two Advanced Reactor developers.

Today my testimony will reflect on the Agency at which I had the pleasure of serving and the provisions included in S. 2795 regarding how the NRC conducts its business. I will also discuss the status of Advanced Reactors including NIC's views regarding the proposed legislation as it relates to Advanced Reactors. In the main, we applaud the Subcommittee's focus and support S. 2795's measures to limit the overhead of the NRC along with caps on the growth of Agency fees -- as well as urgently needed reform to enable the development and deployment of Advanced Reactor technologies. For its part, NIC issued a Framework for Advanced Reactor Licensing Modernization White Paper on February 22, 2016, which envisioned many of the elements contained in this legislation as they relate to Advanced Reactors. There are a few additional areas that the bill did not address which we believe would further strengthen the legislation. While I will outline these later in my testimony, I want to assure the Subcommittee we stand committed to work with the Committee and its staff to move this legislation forward.

NRC Fee Policies and Overhead

When I first became a Commissioner in 1998, the Agency, much as the case today, was hearing calls that a number of nuclear reactors may shut down in the near future and Congress was "encouraging" the Agency to reduce the size of its budget and staff. Indeed, the current Chairman of this Committee – Senator Inhofe – led the way in efforts to oversee the Agency and assure that the Commissioners were working diligently to "right size" its staff consistent with the NRC's mission of protecting people and the environment while also increasing the efficiency of inspection and licensing activities. In 1998, the Agency had approximately 3,400 employees and within the next few years we were able to reduce that down to about 2,800 – principally through attrition.

As we know, in the early 2000's the size of the NRC began to expand, and with the subsequent events of September 11 and Fukushima, the Agency has not had the opportunity since the late 1990's to fully reassess the size of its staff or budget. I applaud the Agency for undertaking Project AIM 2020 and believe it will contribute to meaningful reductions in the size of the NRC.

That said, I understand and sympathize with the concerns previously voiced by members of this Committee regarding the size of the Agency, the decrease in efficiency of the Agency's licensing actions and a view that the overhead activities at the Agency have grown to a level which is not commensurate with the number of licensees currently under the purview of the NRC. As it relates to the size of the Agency, it is my view that this Committee is appropriately focused on further encouraging the NRC to "right size" its staffing below the level initially envisioned in Project AIM. Consistent with the activities taken by the Commission in the late 1990's, I believe that it is possible to appropriately reduce the size of the NRC while at the same time effectively maintaining safety, inspection activities and improving the timeliness of licensing actions.

I commend the Committee for continuing to encourage the Agency to focus on providing more timely and risk informed decision-making. Consistent with this focus, I support the provisions in S. 2795 which would seek to limit the overhead of the NRC and place appropriate caps on the growth of Agency fees. Frankly, as was the case when I appeared before this Committee over 15 years ago, I believe the amount of fees placed on individual licensees is not appropriate and should not cover inherent government functions and overhead. At that time, this Committee supported an increase in the ratio of fee based to non-fee based costs from 95/5 to the current level of 90/10. While S. 2795 eliminates the specific ratio, I believe it is intended to achieve the same goal, which is to appropriately balance the important non-user fee activities – which should be borne by general revenues – and those user-specific activities that should be borne by licensees. As it did in the late 1990's and early 2000's, I believe that the Commission and its staff, ably administered by the Executive Director of Operations, Victor McCree, can rise to meet the efficiency challenge envisioned in S. 2795.

Further, and consistent with my earlier testimony, I believe that this Committee, and Congress, should review and reassess the amount of money dedicated to nuclear energy research,

development and deployment. As a country, we continue to invest huge sums of government funding toward renewable technologies. Given the enormous amounts of clean, carbon free energy provided by nuclear energy, Advanced Nuclear Reactor technologies deserve equal treatment at a minimum.

Status of Advanced Reactors

Over the last year, NIC has identified a confluence of environmental, energy security and competitiveness considerations that are accelerating the need for the expedited development of Advanced Nuclear Reactors in the United States and worldwide. These Advanced Reactors can be used globally to provide economical, carbon-free electricity and industrial heat generation while providing a new option for the looming replacement of America's nuclear energy fleet as existing nuclear reactors reach the end of their licensing life beginning as early as 2030.

Ranging widely in size from micro-reactors of a few megawatts electric (MWe) to large gigawatt ("GW") -size reactors of 1000 MWe, these non-light water Advanced Reactors embrace enhanced passive safety features as well as the prospect for improved nuclear energy economics and competitiveness with other energy sources including natural gas for baseload supply. These Advanced Reactors also bring with them significant interest from the financial community which is seeking gateway technologies to invest in this arena. In addition to funding and infrastructure, a modern licensing framework is needed to enable development and deployment of Advanced Reactor technology in the U.S. and to extend U.S. nuclear energy technology leadership that has featured progressive light water reactor designs including passive Generation III+ designs currently being deployed in Georgia and South Carolina as well as small, modular, light water nuclear reactors now headed toward deployment.

U.S. Nuclear Energy in Context

Today, U.S. nuclear energy plants provide almost 20 percent of the nation's electricity and over 60 percent of America's carbon emissions-free electricity. The U.S. fleet is comprised of 99 units that are based and adapted on light-water reactor ("LWR") technology directly developed by the U.S. Navy propulsion program. Utilities and the nuclear industry have improved upon and optimized the LWR technology and the current fleet is now operating at world-class high levels of safety and reliability. The U.S. fleet turned in another record setting year of world class operating performance, achieving a fleet-wide capacity factor of 91.9 percent in 2015.

However, the existing U.S. nuclear energy fleet is among the oldest in the world with over a third of the current plants being over 40 years old. Many of the reactors could be retired beginning around the 2030 timeframe, although there is a strong basis for extending their life to 80 years through a second license renewal.

With the worldwide impetus to reduce global carbon emissions -- along with a significant increase in electricity demand -- the U.S has a compelling need to develop and deploy the next generation of Advanced Reactors. Deployment of this new generation of reactors will require a new model, one that is more dynamic and capable of forming private-public partnerships in

support of private-sector-led innovation driven initially by private-sector investment. Already in the U.S., there are a number of Advanced Reactors that have progressed to the design and engineering stage and are supported by meaningful investments from the private sector.

While there is wide recognition regarding global climate change and the vital role that nuclear energy plays in meeting carbon reduction targets, the current level of government investment in nuclear technologies is markedly insufficient. According to the Energy Information Agency, with tax incentives, the U.S. government "spent" over $15 billion on renewable and biomass programs in 2015 – but "spent" $1.66 billion for nuclear energy in the same period.

Additionally, the current framework of U.S. government policy, legislation, regulation, research and development support, and fee-based licensing is more aligned with the past than what is needed for the future to commercialize a new generation of Advanced Reactors.

This is particularly true of the NRC licensing process, which presents one of the largest risk factors confronting private developers of Advanced Reactors. It does not easily accommodate a staged investment approach as the technology development and licensing risks are addressed and resolved.

Revitalizing the U.S. Advanced Reactor Development Mission

Currently, the DOE and NRC share responsibilities for supporting and overseeing the U.S. nuclear energy program under the Atomic Energy Act ("AEA") and the Energy Reorganization Act ("ERA"). This latter Congressional Act assigned the promotional and development responsibilities to the U.S. Department of Energy (DOE – the successor agency to the Energy Research and Development Agency ("ERDA"). A companion agency, the NRC, was assigned the responsibilities for assuring public health and safety and carrying out the regulatory and licensing program.

Over the course of time, DOE increasingly focused on basic and applied research, while the NRC moved to focus exclusively on its primary mission of safety oversight and regulation. Today this framework is struggling to foster the private capital formation required to advance promising private-sector nuclear innovation, as those companies are isolated from the types of support that has been offered historically and, in a contemporary setting, support that is offered to other innovative but non-nuclear energy technology companies.

If the U.S. is to be successful in developing and deploying a new Advanced Reactor fleet as early as 2030, Congress should consider significant policy changes. It should provide additional resources to both agencies as well as direct them to focus and mobilize their resources and expertise on the goal of expanding nuclear energy options with Advanced Reactors.

Both the DOE and NRC must be proactive in developing their capabilities and engaging with the Advanced Reactor community. Today, the NRC interprets its mission as an exclusive safety mission with a caveat that that its processes and activities must not place an undue burden on the industry. The NRC typically awaits applications and only reviews design certification applications that are full and complete. While the NRC has long recognized that its paramount

goal is to ensure public health and safety, the ERA also requires that the Agency enable the use of nuclear technologies for safe, beneficial uses. The unique features being trail blazed by Advanced Reactors justify an updated and modernized NRC design review and licensing process which is consistent with S. 2795.

Congress should reinforce and support the NRC's efforts to enable the use of Advanced Reactors by setting appropriate deadlines for design reviews and licensing activities, engaging in appropriate oversight of the NRC's review of these technologies and providing sufficient funding to allow the agency to execute accordingly.

Advanced Reactor Regulatory Capabilities

The NRC currently lacks sufficient capabilities for the licensing of non-light water reactors. In order to develop the appropriate regulatory basis to regulate Advanced Reactors, the NRC needs to better understand how these technologies work, how they can be regulated and how unnecessary regulatory conservatism can be avoided in the oversight of these designs. Because of the current funding formula wherein the NRC must recover 90 percent of its costs through fees, the resources for these activities must be borne principally by U.S. nuclear utilities – which are understandably concerned about the regulatory burden currently faced by the U.S. nuclear energy fleet in a highly competitive marketplace. Given that Advanced Reactor companies primarily rely on private funding, this NRC funding paradigm poses an extremely difficult challenge for this new industry's design advancement.

We believe the language in Section 7 will allow the Agency to conduct the activities needed to create a modern, risk informed, technology neutral framework which will enable the development of appropriate Advanced Reactor Regulations, without passing these regulatory development costs to the existing utilities or the Advanced Reactor developers who are not in a position to bear these costs. We believe this change is consistent with the approach proposed in the NIC Framework for Advanced Reactor Licensing Modernization White Paper issued in February.

Consistent with the above, there are two areas where we believe further enhancing of S. 2795 is warranted: 1) appropriate funding to reduce the licensing fees borne by Advanced Reactor developers; and 2) a specific pre-licensing design review program.

Graduated licensing fees commensurate with design review activities

While the NRC is not a promoter of nuclear technologies, it is appropriate for the Commission to engage in early and enhanced communications and dialog with Advanced Reactor developers to allow new market entrants to fully understand what is needed to successfully prepare and undertake design review and licensing. Currently, the NRC has very limited dialog with Advanced Reactor technology developers, and when it does, it must charge hourly review fees (approximately $270+ per hour/per NRC staff member) to these companies. As members of the Advanced Reactor community are early stage and entrepreneurially driven private companies, they lack the traditional resources to finance what can be very expensive regulatory fees.

NIC believes that S. 2795 would be strengthened by providing that the early stage engagement between an Advanced Reactor developer and the NRC should be conducted at no or limited cost to the developer, with an appropriate cost share – perhaps 50/50 for latter stages of the licensing process. While Section 9 of the bill does create a DOE licensing cost-share grant program, we believe this maintains the DOE's current role of picking "winners and losers" within the Advanced Reactor community. In our view, the private sector, not a large, lab-driven Department, is better placed to identify and promote innovation and the NRC licensing fees should not hinder these entrepreneurial efforts.

A graduated licensing model congruent with graduated private capital commitment

Additionally, in order to align with the staged private investment model of step-wise investment based on project de-risking, the NRC needs to develop a staged conceptual design review process for the review of Advanced Reactor designs similar to that developed by the Canadian Nuclear Safety Commission ("CNSC").

The CNSC process is robust and graduated. It requires vendors to reach discrete milestones that allow investors to assess the technology's licensablity and identify any potentially significant issues. It features an upfront Vendor Design Review to provide an early verdict on the licensing feasibility of potential designs for less than $5 million (US).

The early phases of this program would provide interim indications to allow the investment community to understand the licensablity of the design without having to wait until the end of the licensing process, which can take 8 to10 years. The current NRC process lacks transparency in cost and time, requiring potentially hundreds of millions in dollars of up-front investment while strongly discouraging private capital commitment.

The CNSC's graduated process has the potential to enhance the ability of Advanced Reactor designers to attract vital sources of capital because it allows them to build confidence along the way that the design has the potential to be licensed. In order to foster a new generation of Advanced Reactor technologies, this is precisely the type of phased design review and licensing process that needs to be adopted by the NRC.

While Section 7(b) calls for the NRC to "establish stages in the commercial Advanced Nuclear Reactor licensing process" – which we support and is generally consistent with the recommendations in the NIC White Paper – we believe the bill would be strengthened by incorporating specific language requiring that the NRC provide a pre-licensing design review. A clear articulation by the Commission about the areas where specific designs do and do not need additional work would enable Advanced Reactor developers and investors to have a clearer picture of where they stand in the NRC process and in meeting NRC safety requirements. In turn, this would give greater transparency about the licensibility, or lack of licensabilty of a given design, and would provide more efficient use of Agency and developer resources.

Conclusion

It is time to make dramatic changes to reform the NRC as well as modernize the licensing process to spur innovation and enable Advanced Reactor technologies to achieve the full measure of their promise and the success the nation needs for the future. While this will require a sustained focus and investment of resources by government in support of private stimulus and ingenuity, the return on investment will be pivotal in ensuring the U.S. maintains its technological leadership in nuclear energy's vital and carbon-free source of clean energy while providing jobs, economic competitiveness and energy security while improving our nation's environment and health.

Thank you very much for allowing me to testify today.

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The USNIC Advanced Reactors Task Force is a project of the U.S. Nuclear Infrastructure Council (www.usnic.org), the leading business consortium for new nuclear energy and promotion of the U.S. supply chain globally. The views above represent a consensus of the USNIC's Advanced Reactors Task Force and the Council, but do not necessarily represent the specific views of individual member companies and organizations.

Submitted Answers of Jeffrey S. Merrifield
to Questions from Senator Inhofe
Senate Environment and Public Works Committee QFR
June 6, 2016

Question 1: Mr. Merrifield when could NRC expect to see advanced nuclear reactors (molten salt and fast reactors) show up at NRC for licensing?

Answer: While each Advanced Reactor technology developer is proceeding at a different pace, I would expect that initial contacts between the developers and the NRC will continue during the remainder of 2016 into 2017 and beyond. If the NRC were to adopt the Pre-Vendor Design Review Process which has been proposed by the Nuclear Infrastructure Council, we would expect that there are between 1-4 Advanced Reactor Developers who would be prepared to undertake this pre-licensing process in the next 2-3 years. Several of those may be in a position to submit their design certification or other equivalent application by 2021-2022.

Question 2: Mr. Merrifield as a former NRC commissioner do you think that establishing the advanced reactor licensing framework as laid out in the legislation by 2023 is feasible for NRC to do?

Answer: I believe that the NRC has the technical capability to establish an Advanced Reactor licensing framework envisioned by the legislation. While the NRC will need to be provided with sufficient financial resources to accomplish this goal, they can certainly do so. Indeed, it is the view of the Nuclear Infrastructure Council that 2023 could be easily achieved by the agency and we would actually urge the Committee to adopt a more aggressive goal (36-48 months) for this effort.

Question 3. In your testimony you lay out several ways for the advanced reactor licensing framework to be improved. Could you outline those briefly?

Answer: There are four modifications NIC would suggest for the bill. They are as follows:

1. Vendor Pre-Licensing Design Review. This would be a pre-application review conducted by the Commission as part of phased licensing approach that is requested by a developer of an Advanced Reactor for all or specified portions of an Advanced Reactor Design. Such vendor design review would be conducted by the Commission to provide an early indication of the licensablity of the Advanced Reactor vendor's design approach consistent with the Commission's regulatory requirements under Parts 50 and Part 52.

   While the underlying language in S. 2795 envisions a staged process for licensing Advanced Reactors, we believe that the Agency should be specifically required to conduct a pre-licensing review. We would expect that this review would be similar to the process conducted by the Canadian Nuclear Safety Commission, and could be accomplished within a year and would only require the expenditure of less than $5 million per design.

2. Fixed Cost for Vendor Pre-Licensing Review- NIC believes that greater certainty could be provided to Advanced Reactor developers by establishing a fixed fee schedule for the pre-licensing review of Advanced Reactor designs. As it currently stands, the developers of these reactors have no ability to plan on how much the NRC review fees will cost. Given the fact that the early stages of the development process are when funding is most uncertain for technology developers, a fixed fee process would provide greater predictability and cost certainty.

3. Risk-Informed Performance-Based Rulemaking – NIC believes that the Commission should move forward on a priority basis to resolve a variety of risk-informed, performance-based Advanced Reactor design requirements including emergency planning, control room staffing, need for containment and security among others, based on source term criteria. We believe this action is needed to ensure appropriate design criteria are being applied to non-light water reactors and encourage a risk-informed design review process. Having the Commission resolve these issues up front, rather than waiting for the submission of individual designs will significantly reduce the cost and time needed for Advanced Reactor designers to adapt their designs to the NRC requirements. Given the advanced analysis that the NRC and DOE have been conducting on these issues over the past decade, we believe that these matters can be resolved in 2-3 years.

4. Specific Timetable for Licensing Review – NIC believes that Congress should direct the NRC to complete a rulemaking to establish a technology-inclusive regulatory framework for the licensing of Advanced Reactors within a 36-48 month period. We believe this schedule should apply to all Advanced Reactor applications submitted to the Commission under part 50 or 52. As stated above, having a more predictable timetable would provide greater certainty for the developers of Advanced Reactor designs. As this proposal is not outcome determinative – the Commission would be free to make an approval or disapproval of individual designs– it is intended to keep the Commission disciplined in making a timely decision.

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Senator CAPITO. Thank you. Thank you all very much.

I will begin the questioning with asking Mr. McCree, a lot of what we heard in the testimony and certainly what is contained in the bill has to do with right sizing the agency in terms of license fees and support.

In 2006, the NRC spent $208 million on corporate support spending which amounts to 28 percent, you can see it on the chart, of the NRC's budgetary authority. This was at a time when the NRC was regulating more reactors and materials, licensees, with fewer people and resources.

Mr. McCree, I would say, do you recall any impairment of the NRC's safety and security mission in 2006 as a result of this level of corporate support?

Mr. MCCREE. Chairman, thank you for your question. In response to your question about impairment of our safety and security mission, I would indicate that answer is no.

Senator CAPITO. Thank you.

I would say, if corporate support spending equaled 28 percent of the NRC's budget, the amount would be $275 million, which is only $30 million less than what the NRC is expecting on corporate support.

I would ask, in light of the fact that there was more work and more licenses in 2006 with this 28 percent, do you have any reason to believe this amount of corporate spending at the top part, which would be $30 million less than what you would expect, could impair the NRC's ability on safety and security?

Mr. MCCREE. Comparing NRC now to 2006, we are certainly a different agency. While there are about 100 more operating reactors than there were in 2006, there is additional work that we have now that we did not have then with the four AP1000s that we are overseeing as well as completion of oversight of Watts Bar Year 2. The workload is different than in 2006. Certainly our staff size is different as well.

Senator CAPITO. Are you saying you think if it were to be right sized to the 28 percent, there could be some concerns over safety and security?

Mr. MCCREE. That is not what I am saying. I am simply saying that we are comparing a different agency now in 2016 to 2006. As far as right sizing, we are taking under Project AIM significant steps to right size the agency for the work that we have and the work we anticipate in the future.

That right sizing includes right sizing our corporate support area where we have taken significant reductions, about $30 million in reductions this year, in 2016. Additionally, the Commission just acted on a number of recommendations under the Project AIM rebaselining that will result in additional reductions in 2017.

Several weeks ago, the Chief Financial Officer and I assigned a tasking for several of our larger corporate support offices to look at additional reductions that we would plan to submit to the Commission in planning for our fiscal year 2018 budget.

As the Chairman noted yesterday in the House hearing, we are not done. The Project AIM right sizing continues. I do believe the corporate support portion of our budget will continue to go down.

Senator CAPITO. Ms. Korsnick, you spent a lot of your testimony addressing this issue. Do you have a reaction to what the gentleman testified in answer to my question?

Ms. KORSNICK. Yes, and I think I included in my testimony the fact that when we looked at the peer agencies to the Nuclear Regulatory Commission, we would like even more attention paid to those peer agencies which appear to be effective at the corporate support level even less than 28 percent.

The other thing in this fee structure we are very interested in is the way the current bill is structured. It not only asks for the NRC to allocate for certain licensee requests, but that the money needs to be spent on that and on that alone.

Right now, there is the ability to move some money around, if you will, and in fact, move it to corporate support. We would like a stronger fiscal responsibility on that.

Senator CAPITO. Thank you.

Dr. Back, in your testimony you mentioned the four principles: cost competitiveness, safety, less waste and reducing proliferation risk as your four corners of developing an advanced reactor. I think I am hearing that the NRC would get in on the front end, maybe raise red flags in the beginning of the licensing procedure rather than at the back end where the timelines are leaking and making even incurring more expense.

It would be more helpful to you in order to reach these four benchmarks? Is that a correct assumption?

Ms. BACK. Yes, although it is not at the point where the reactor is not performing well. We are looking for input early because the technologies are different, so the way you evaluate the kind of metrics you assess, the safety, cost competitiveness and other factors of the reactor are different.

Senator CAPITO. At this point in your development, you have had no internal conversations with the NRC on your advanced reactor?

Ms. BACK. We have had one conversation because we are allowed one conversation which is free, so to speak, before the hourly rates come up. In our development of the reactor, because of the way it is structured now, it is not well suited for our particular technologies.

When we looked at where we were investing our research dollars versus funds to try and get input from the NRC because we now it is a long path, there has been a history with NGNP with many white papers without a clear decision.

There is an uncertainty that is very difficult to manage at this early, early stage. That is why a very small investment from NRC funds in the beginning would be very helpful.

Senator CAPITO. Thank you.

Senator Carper.

Senator CARPER. I would be happy to yield to others who may have urgent business to attend to. I will be here for the duration. Is anyone in a tight squeeze right now? If not, who would be next under the early bird rule?

Senator Crapo.

Senator CRAPO. Thank you very much, Senator Carper.

Madam Chairman, at this point, we have received 19 letters of support for this legislation. I would like to ask unanimous consent that these letters of support be included in the record.

Senator CAPITO. Those will be included in the record, without objection.

[The referenced letters were not received at time of print.]

Senator CRAPO. Thank you very much.

I would like to direct my first question to you, Mr. McCree. As you know, we have been working very hard to understand the budget of the NRC and its inner workings. There is, in my view, a relative consensus that the NRC budget process is very opaque.

In addition to concerns about fee structure, I am deeply concerned about lack of clarity on how the NRC budgets for its overhead functions. Will you commit to working with my staff and the staffs of other Members to provide timely and clear responses to our questions about your overhead functions and your budget requests?

Mr. MCCREE. Yes, absolutely.

Senator CRAPO. I appreciate that. We really need a commitment to provide more detail about how the NRC allocates and spends its resources so that we can more effectively understand how the budget works.

I want to use the rest of my time to talk to the whole panel. I know that is going to be hard in 4 minutes. The point I want to get at is Dr. Lyman, in his testimony, has two points and many more. One of them was that we should not weaken the NRC regulatory structure. It is the gold standard, and we need it to continue to be the gold standard.

I do not view this legislation as weakening the regulatory structure in any way. I view it as increasing transparency and efficiency. Maybe I will turn to you first, Mr. Merrifield. What is your view of that issue?

Mr. MERRIFIELD. I fundamentally disagree with Mr. Lyman in that regard. What we are really asking for and what I think this legislation will accomplish is risk informing the regulatory activities of the NRC and tailoring those activities to be appropriate for the licensing of advanced reactor technologies.

This will in no way reduce the level of safety. In fact, arguably, it will allow the agency to appropriately tailor resources to make sure these technologies are regulated in the right way. It will also hopefully have the successful accomplishment of doing it at lower cost which is important as well.

Senator CRAPO. The earlier that the agency is involved in the development of the technologies and the understanding of them, the more efficient and effective the regulation can be.

Mr. MERRIFIELD. That is exactly right. I think it would allow much better utilization of resources. I would say a couple things.

One, I think what Mr. McCree's staff really needs to do is elevate, as quickly as possible, many of the generic policymaking decisions that can be made to the Commission and by the Commission to reduce the uncertainty for advanced reactor technologies.

Second, we talked a bit about the fee process. It is very important to provide fee relief in the early stages of the program to allow active discussion between the developers and the NRC.

As discussed by one of the other witnesses, there is a lack of engagement because once you start talking to the NRC besides your initial meeting, the $268 per hour fee is going to start triggering. That is not good. We really should be encouraging very active discussion between the developers and the NRC right now.

Senator CRAPO. Thank you.

I probably only have time for one of the other witnesses. I will turn to Dr. Finan because of your charts.

The other issue that was raised which I focused on is the probably really is not the regulatory system but the fact we cannot get investment at the early stages of the development of these new technologies.

To me that seems to be exactly the point that because of our regulatory structure, at least a big part of that issue is if you do not have the staged development or something like that, which this bill contemplates, you have a situation in which it is very hard to get early investment in these expensive technologies. Could you address that?

Ms. FINAN. That is right. I think there are a lot of other challenges to deploying advanced reactors as there are for renewable and carbon capture and other energy options. The investors and innovators have made it very clear that their most immediate and pressing concern is regulatory uncertainty.

I do not think we need to have another study. There have been a lot of studies on that. I would be happy to provide a list of references but climate change is urgent. The private sector is engaged and eager. The time to fix this is really right now.

Senator CRAPO. Thank you very much.

My time has expired. It looks like I am now chairing the hearing.

Senator CARPER. I think you are doing a great job.

Senator CRAPO [presiding]. I would turn, Senator Booker, to you next.

Senator BOOKER. Mr. Chairman, thank you for that.

My staff and I were just talking about how incredible your staff has been, not just in working on the bill, but in reaching out to all these groups. The letters you submitted are really a testimony to the kind of inclusion that you have had in this process. Thank you very much.

Ms. Korsnick, in your testimony you make the point that a reduction in the number of existing licensees increases the fee burden on the remaining licensees. I think we all hope we do not see this rash of additional premature closings within our nuclear fleet. That would be bad for the overall energy picture in the United States.

That said, if we did, can you explain how, under current law, that would impact the reactors that remain and whether this bill would alleviate that scenario?

Ms. KORSNICK. In fact, the current bill is structured to alleviate that very concern. As the current structure is in place with the obligation to collect 90 percent of the budget, it is 90 percent of whoever is there to pay.

If those plants close down and are no longer part of that fee structure, then the remaining plants, remaining operating reactors, have to pay that 90 percent bill. Our experience has been, based

on the chart you just saw and our experience with the NRC budget historically, the budget has not reduced commensurate with the operating reactors shutting down.

Senator BOOKER. Thank you.

Dr. Finan, besides the fact you mentioned those two terrible words, climate change, I will forgive you for that, I am into innovation and innovators. I have a problem since I have been 2 years in the Senate from the FAA to the Patent Office; we do a lot to constrict innovation. In this space, innovation is I think critically important.

The GAO last year did an incredible report that looked at the challenges facing companies attempting to deploy new reactor concepts. In this report, the GAO noted that for first of a kind technologies, the design review costs for these folks can be exceptionally higher than for subsequent projects.

Do you believe this is a real problem as noted in this report? Do you think the DOE matching grant program in the bill can help solve the problem?

Ms. FINAN. I agree. I think that is a critical problem for innovators. There is really a need not only to make sure the costs are under control but also to make them more predictable so that investors and innovators can plan accordingly. I think the DOE matching program could certainly assist them in that immensely.

Senator BOOKER. These are innovators who are really critical for advancing nuclear in terms of the safety, in terms of being able to better deal with challenges we have like the waste from current light water reactors as well as deal with problems we have including proliferation of this material, is that correct?

Ms. FINAN. That is right. I actually think this is very exciting because in the past nuclear was developed initially for the Navy for submarines. Then it was adapted to land. Today's innovators are really putting a priority on our values today, those key values being safety, proliferation, cost and all of the other things that nuclear can provide.

I think these new designers and innovators are going to bring that to the table, and we need to help them move forward.

Senator BOOKER. We need to create a Government regulatory climate where these folks can flourish, and we are not putting undue cost burdens on them, correct?

Ms. FINAN. Absolutely.

Senator BOOKER. Can you expand a bit on your testimony in the little bit of time I have left as to why the existing nuclear framework is really problematic for reactors, a bit more about specifically what is so problematic about the framework?

Ms. FINAN. As an analogy, if we looked at our emission standards for vehicles, those are very performance based. They set maximum emission levels. If instead they were prescriptive and required particular catalytic converter technologies, TESLA, with an electric car, would have to come in and seek exemptions to those technology requirements.

For a nuclear reactor, that is much more complex and has a lot more regulation. Those exemptions would be multiplied and have a lot of issues where you need to come in and seek different treatment.

That is something that is a big barrier for new technologies because every time they have to do that, that is an uncertain process that has not been done before. That uncertainty creates a great problem for investors and innovators.

Senator BOOKER. I appreciate that.

In the minute I have left, obviously Senators Crapo and Inhofe come at this from a different direction than we do. It is beautiful how we were able to meet and make this a bipartisan bill.

Senator Whitehouse and I, however, come at this with real concerns and fears about overall climate change. There is a massively expanding demand for energy globally which is rapidly expanding, as I said in my opening remarks, at a rate that people like me have visions for solar, wind, and battery storage.

There is no way that renewable pace will keep up with the demands we are having. Right now, 60 percent of our clean energy is being produced by nuclear. Do you believe this is a place where we have to actually expand innovation if we are going to deal with the overall problem Senator Whitehouse and I see of climate change?

Ms. FINAN. Absolutely. That is very important because this is not just a political issue; it is not even just about climate change or energy security. This is a humanitarian issue. There are a billion-plus people on this earth who do not have electricity. We need to provide that energy. We need to have all the tools on the table and that has to include nuclear, so I think this is critical work.

Senator BOOKER. Thank you very much, Dr. Finan.

Senator CRAPO. Thank you very much, Senator Booker. It looks like I still have the gavel.

Senator Inhofe.

Senator INHOFE. Confession is good for the soul. I confess that you did a much better job of pointing out something than I did.

The interesting thing about this is there are those on your side whose lives are driven by climate change and those on this side who are realists, but we still agree on this bill. We know this is going to serve everyone's best interest.

I am not sure what all was covered because I had to go down to Armed Services which is one problem we have on this committee. We have nine members on both this committee and Armed Services. Somehow I have never been able to convince John McCain that we are a committee, too.

I have a chart. Ms. Korsnick, I want you to look at this. The fees on reactors increased substantially over the last few years. In this bill, we capped the annual fee for operating reactors at the 2015 level based on the most recent fee recovery rule.

This level is very near the all time highest amount that reflects the post-Fukushima workload. That workload is now declining. We also provide for inflation adjustment.

Ms. Korsnick, do you believe this amount is an appropriate ceiling to ensure the NRC is adequately resourced to execute the safety and security mission?

Ms. KORSNICK. Yes. In fact, as you just described, we think fiscal year 2015 is the high water mark, quite frankly, for the agency. We feel, in fact, that it should not need to approach that ceiling.

As you described, some of that workload, in fact, is declining from post-Fukushima, and we feel a more efficient agency should be able to operate with a corporate spending more in line with their peer agencies.

Senator INHOFE. Whether or not you would want to reach that cap, it is adequate to take care of what our needs are now?

Ms. KORSNICK. It is adequate, yes, Senator.

Senator INHOFE. Under S. 2795, the amount of annual fees the NRC collects would increase when newly operated plants begin to pay their fees or would decrease when reactors close. Do you believe that is an appropriate way to account for increases and decreases?

Ms. KORSNICK. Yes, Senator, we do. It obviously speaks directly to workload. We think that is a fair process.

Senator INHOFE. I would agree with that.

When companies decide to close nuclear reactors, do they give the NRC adequate notice such that the NRC can account for the decrease in fees in their budget process?

Ms. KORSNICK. We believe so, Senator. The individual plants also need to go through a planning process. They need to inform the regional transmission operator in advance. It is typically a 12- to 18-month timeframe that you are making these types of announcements.

Senator INHOFE. Mr. Merrifield, I think back to when you first started or actually I first chaired this committee, you were then the attorney here. You were not a Commissioner at that time?

Mr. MERRIFIELD. No, I was a counsel to this committee.

Senator INHOFE. You might remember at that time this committee had no oversight for 4 years.

Mr. MERRIFIELD. That is true. You did a very good job of correcting that problem.

Senator INHOFE. We did correct it. We got busy, set goals and priorities as to when we would be coming in and what we were supposed to be doing. I think that did work.

Mr. MERRIFIELD. It did, Senator.

Senator INHOFE. During your tenure as Commissioner, you led an effort to improve the efficiency of new plant licensing. One of your recommendations was to eliminate the mandatory hearing, is that true?

Mr. MERRIFIELD. That is true, Senator.

Senator INHOFE. Would you explain what that was all about?

Mr. MERRIFIELD. The mandatory hearing process the agency has right now dates back to the early days of the Atomic Energy Commission. When you look at the legislative history, the reason for its imposition was because the AEC actually approved several reactors with no public involvement whatsoever. The outcry caused Congress to impose a mandatory hearing requirement which was appropriate at the time.

Over the years, with changes under the Administrative Procedures Act and the wide number of opportunities for the public to be involved in the many steps of the licensing process, in my view is, then as it is now, that is an antiquated notion that is no longer necessary.

If there are specific issues, those can be brought up in a contested proceeding that the Commission can go over, but I believe a mandatory hearing is not necessary. Indeed, frankly the requirement right now causes significant staff resources, which ultimately must be borne by a combination of the Federal Government and the licensees, to deal with the mandatory hearing. It would be a significant reduction of fees if that was eliminated.

Senator INHOFE. I have one last question. I would like a short answer because my time has expired.

I described the lax situation that was there having gone 4 years. Oversight is important. Do you think since that time we have slipped a little and need to become a bit more forceful in overseeing the NRC?

Mr. MERRIFIELD. As a Commissioner, I welcomed involvement with the committee.

Senator INHOFE. I know you did. You were very helpful.

Mr. MERRIFIELD. It was helpful to us to have our feet held to the fire; it gave us the discipline to make sure we oversaw the agency and its mission. The Commissioners have the responsibility to oversee what Victor McCree and his staff does.

I think further reductions of staffing are appropriate, and I think the involvement of this committee in oversight is welcome.

Senator INHOFE. Thank you, Mr. Merrifield.

Senator CRAPO. Thank you, Senator Inhofe.

Senator Whitehouse.

Senator WHITEHOUSE. Let me say first how happy I am that the Chairman had a twinkle in his eye when he made that comment about Senator Booker and me.

Second, let me say to Dr. Lyman that it is very much not our intention in this bill to short circuit the safety review of any nuclear facility.

My concern is the review process at the NRC has become so light water reactor specific that another technology looking at getting through that obstacle course is facing hazards that have nothing to do with short or long circuitedness, but simply not being appropriate to the technology in the same way that if you had to pass a test for how solid the canvas was on the wings of your proposed aircraft when you were actually proposing an aluminum winged aircraft, or where the pilot's goggles needed to be and what they needed to be made of, when in fact you were proposing a closed cockpit aircraft. It is an issue of relevancy, not of shortcuts.

I would invite you and any other member of the panel who wishes to put in writing some benchmarks for us you think would indicate the departure from moving the regulatory process more toward relevance to new technologies and into simply short circuiting safety because I do not think there is a person who supports this bill who wants to short circuit safety.

It would be helpful to have this conversation in a more specific way about what the red flags might be rather than speaking generally about that.

I worry that we have technologies that effectively are smothered in the crib because they cannot figure out what their regulatory process is going to look like, and therefore they cannot raise capital

and proceed. There is a big X factor, a big question mark around the process if you are not a traditional light water reactor.

That is how I think of the problem. I would be interested in not only your response but everyone else's in writing, if you care to make that known.

The last point I will make goes back to something I said in my opening remarks. I think it is a tragedy in a carbon constrained environment to have nuclear plants closing that are producing carbon free power for no other reason than no one has figured out how to pay them for what we all almost agree is the value of the carbon freeness of their power.

We have an Administration that has an Office of Management and Budget that has a $42.50 per ton social cost of carbon. If someone has a suggestion as to how we can figure out a way to pay the existing nuclear fleet $42.50 per equivalent of voided ton of carbon, I am down for that. We need to find the revenues.

I do not think it is a good thing to run up the deficit, but I do think there ought to be a way to provide that revenue stream to these facilities so that artificially driven economic decisions that are in fact wrong from both an environmental and economic perspective are not being driven across this industry by this market failure.

I know that is a bit beyond the scope of this particular bill, but if any of you have ideas on that, I would encourage you to please go ahead and offer them. I would offer that solicitation to my colleagues as well.

Again, Mr. Chairman, thank you very much.

Mr. MERRIFIELD. Senator, if I may, on the first point you made.

Senator WHITEHOUSE. The one about Chairman Inhofe?

Mr. MERRIFIELD. Not that one.

Senator WHITEHOUSE. You saw the twinkle in his eye, too?

Mr. MERRIFIELD. I did see the twinkle in his eye.

Senator WHITEHOUSE. There you go.

Mr. LYMAN. I would like an opportunity to respond.

Senator WHITEHOUSE. You will have an opportunity to respond. I would just like it in writing because I think it is going to be a long response. This is a continuing conversation that I think we need to have to make sure we stay on the right track.

Mr. MERRIFIELD. On your first point, I think you were entirely correct. I think the process does need to be tailored for these advanced reactor technologies.

As a country, we have had a leadership role historically in the nuclear energy field. It is a different world today. There are lots of opportunities for advanced reactor developers to work with regulators around the world.

If we do not maintain our lead in having them come before the NRC for review, they may well decide there are other countries better suited to have those licensed. That is not in the best interest of our country.

Senator WHITEHOUSE. I have been to China and heard the reports on the facilities that were designed in the United States but are being constructed over there.

My time has expired.

Senator CRAPO. Senator Fischer needs to go next. I do not know if anyone else wants a second round but I have one more question. Then I will give you a chance, Dr. Lyman, to respond at that point.

Senator WHITEHOUSE. I do look forward to working with you. I am not trying to be hostile; I am trying to open a conversation that separates what I think is a good way point that you have indicated for us.

Mr. MERRIFIELD. I appreciate that.

Senator CRAPO. Senator Fischer.

Senator FISCHER. Thank you, Mr. Chairman.

Nebraska hosts two nuclear reactors that provide clean, affordable, reliable energy to our ratepayers and also our families. This important legislation we are discussing today will provide our nuclear innovators the transparent framework that is necessary to launch this nuclear fleet into the future.

It will also enable our utilities to continue to provide affordable and reliable energy. I am appreciative of the discussion we are having today and also that we are recognizing the outstanding job that our nuclear reactor utilities perform every single day.

Mr. McCree, the legislation we are considering today creates an Advanced Nuclear Energy Cost Share Grant Program that enables the Department of Energy to establish a grant program.

I understand there have been criticisms regarding the DOE grant programs that share the costs of NRC licensing as picking winners and losers. In your experience, do you believe it would be appropriate for the NRC to manage such a grant program to reduce review fees for applicants, or would the NRC consider that promotional and in conflict with its role as a regulator?

Mr. MCCREE. Again, we reiterate that the Commission has not expressed its view on the bill, but I would note as written, NRC would not manage the grant program but the DOE would. In that sense, it is not too dissimilar from a grant that the DOE made available for the combined operating license holders for the AP1000s in Georgia and South Carolina.

To that extent, it has worked well and has not impacted our fundamental safety and security mission or our independence principle to which the Chairman referred earlier.

Senator FISCHER. You would not be supportive of the NRC becoming involved in the grant program in any promotional way? You do recognize there is a conflict there?

Mr. MCCREE. Yes, ma'am, I do. Again, although the Commission has not weighed in on this, it would appear, I believe, to represent a conflict. Again, I would feel confident that the Commission would weigh in on that with a similar view.

Senator FISCHER. Thank you.

Ms. Korsnick, in your testimony you stated that the cost and duration of reviews for license renewals and new plants have dramatically increased rather than decreased as the NRC and the industry gains experience with processes.

S. 2795 directs the NRC to ensure funds are available to complete reviews that the industry needs. The bill also has provisions, as you know, requiring performance metrics and reporting.

Do you believe this two-pronged approach will improve the efficiency and the timeliness of these reviews?

Ms. KORSNICK. Yes, Senator, we do. The fact that the NRC will budget specifically for licensing requests of the industry, we think will help provide the necessary focus and attention on those. We do think this bill will be helpful in that area.

Senator FISCHER. Do you believe it will also help lay the groundwork so we can have more predictable reviews in the future?

Ms. KORSNICK. I think so. The challenge is when we say performance metrics and reporting. Of course the devil is in the detail on that in terms of what performance metrics are developed, but in concept, I think having metrics and reporting is absolutely helpful in demonstrating the success. Quite frankly, if the NRC is so successful, it is an opportunity to share that.

Senator FISCHER. As we look at developing those metrics, how important is it that we have all the stakeholders at the table? You said it is very important, and the devil is in the details. Can you give me an example where you would be representing a view that might not be available that other stakeholders would present?

Ms. KORSNICK. I think stakeholder engagement would be very helpful in that way. As with any performance metric, you get what you measure. You can perform in a way that you say we are making the metric look good but it is actually not satisfying the greater good.

I think the way to avoid that is to get stakeholder engagement and review what the metrics would be to make sure all of the stakeholders' concerns would be reflected appropriately in the metric.

Senator FISCHER. Thank you.

Mr. Merrifield, during your service as a Commissioner, you helped prepare the NRC to review new plant applications. This bill directs the NRC to undertake several activities to develop a regulatory framework and get prepared to review the applications.

Do you think the scope of this work is too ambitious, or do you think it is feasible?

Mr. MERRIFIELD. I think it is absolutely feasible. Credit to the NRC staff, I think they will throw themselves at making this work. They are talented people led by Vic McCree, who is a talented gentleman.

I think it is very achievable for the agency to do this. I think they can come up with a process that is risk informed, predictable, transparent and done in such a way as to allow these technologies to move forward. I think the bill encourages that.

I have one point on the earlier issue I would like to mention given my having been on the Commission. I do think the oversight this committee provides on the timing of various activities of the agency, license renewals and new license applications, are important metrics to look at.

The timing of those has increased since I left the Commission. That is an area of productivity I think certainly needs some attention.

Senator FISCHER. Thank you.

Thank you, Mr. Chairman.

Senator CRAPO. Thank you, Senator Fischer.

Senator MARKEY. Thank you so much, Mr. Chairman.

Mr. McCree, sequestration and the early closure of a number of nuclear plants have already put the NRC in a declining budget environment. At the same time, the revelation that ISIS recorded video at the home of a Belgian nuclear official underscores the need for additional resources for security and safety at U.S. nuclear power plants. It is at the top of the terrorist target list for ISIS.

Instead, the bill under consideration in this committee would constrain the NRC's resources by imposing a blanket cap on fees for operating reactor licensees.

Do you agree there is a possibility that such a cap could adversely impact safety and security by reducing resources and support for NRC staff working to protect reactors against insider threats or physical attacks?

Mr. MERRIFIELD. I would reiterate that the Commission has not weighed in on the proposed bill including the caps described in the bill. If they would become law, of course then the NRC would abide.

Senator MARKEY. Fewer resources are not good for the agency in protecting against a potential terrorist attack, is that true?

Mr. MERRIFIELD. Quite frankly, Senator, we are in a declining budgetary environment, and we are doing our due diligence to assure that our resources are appropriately allocated to ensure our safety and security.

Senator MARKEY. Now you are pulling it away from other nuclear and safety issues in order to deal with a terrorist attack when both are very real in our country. I just think we have to be realistic, that the Belgian warning that they were looking at a nuclear power plant and that they were trying to attack it is clearly something we have to take into account here in the United States.

When we talk about the Nuclear Regulatory Commission's budget, yes, we might want to do a favor for utilities and reduce their fees, but where is the money to come from in order to produce the level of safety we are going to need in our country?

The findings in this bill state that nuclear energy provides for just short of 20 percent of electrical generation in the United States. There are currently 99 reactors producing electricity in our country. At least three are closing very soon, Fitzpatrick, Oyster Creek and Pilgrim.

According to the Department of Energy data for nuclear energy to stay at 20 percent of total energy generation by 2025, we need to bring 13 large reactors online in the next 9 years. We are currently building four and one more. Watts Bar 2 is scheduled to produce electricity this year. That leaves us at least eight reactors short of the goal.

Do any of you disagree that there is little or no possibility that eight additional new reactors that we have not begun to build will come online by 2025? Do any of you disagree that there are not going to be eight new plants operating between now and 2025? Do any of you disagree with that?

Mr. MCCREE. No, sir.

Senator MARKEY. Let the record reflect that no one disagreed with that. Remember, eight new nuclear reactors are what we need to maintain nuclear share of electricity generation in our country.

There would be a need to replace even more of that to replace fossil fuel generation as coal plants go offline. We need even more electrical generation capacity. The two reactors under construction at Vogel have experienced years of long delay, billions of dollars in cost overruns, and it took 43 years to complete construction of Watts Bar 2.

Do any of you disagree that problems that caused the cost and schedule overruns at Vogel would need to be solved before any significant number of new reactors could be built in the next 10, 15 or 20 years? Do any of you disagree with that?

Let the record reflect that no one disagrees.

In recent years, the price of renewable energy sources has declined considerably. Here is the big number. Since 2010, the price of solar panels has declined by 80 percent. We are talking 5 years, an 80 percent decline.

By contrast, the cost of constructing nuclear plants has remained stubbornly high. In light of these facts, it simply is not realistic to expect that nuclear power will continue to provide the majority of emission free electricity in the United States let alone be part of a solution for climate change.

In 2005 in the United States, there was 79 total new megawatts of solar installed. This year, it is 16,000 new megawatts of solar, in 1 year. You can see where the trend lines are. Increase solar deployment and wind deployment as the price of both declined radically in total cost where stubborn regulatory issues in terms of safety and design still plague the nuclear industry.

Dr. Lyman, this bill would scrap the requirement that the Nuclear Regulatory Commission hold a mandatory hearing on each application for a construction permit or operating license. Instead, such hearings would only occur if they are requested by a person whose interest might be affected.

Is there any evidence that mandatory hearings have uncovered weaknesses in NRC staff evaluations of construction permits or operating license applications that otherwise would never have come to public view?

Mr. LYMAN. In our view, the mandatory hearing does establish a unique and important role in filling a gap in the event that a contested hearing does not occur. Even if a contested hearing does occur, the mandatory hearing scope examines other issues including the adequacy of the NRC staff review.

A colleague of mine, a lawyer, Diane Kern, has compiled a number of instances where the mandatory hearings have uncovered significant inadequacies in the NRC staff review. I would offer that list for your inspection.

We believe the mandatory hearing process is important. It is also important for transparency. We heard a lot about the need to maintain transparency in the NRC review process.

The fact is the public does not always have the resources to be able to contest a hearing even if there are very important safety issues that need adjudication. For those reasons, we think the mandatory hearing should be preserved.

Senator MARKEY. I agree with you. There are mandatory hearings if you want to build a new house next door to someone else. We had public hearings at town hall. They were building a nuclear

power plant and mandatory hearings for a construction permit, for an operating permit would no longer be mandatory. That makes no sense whatsoever. That is an inherently dangerous technology that needs all kinds of tough questions to be asked about it.

I understand the wish list of the industry would say no more hearings, no more public input, no more questions asked by the Union of Concerned Scientists in public hearings questioning the underlying premise of building a nuclear power plant in somebody's neighborhood.

I do not think the public will be happy when they are told no hearings on this dangerous technology. Again, it still needs insurance protection from the Federal Government. That is how inherently dangerous it is. The private sector still is not willing to provide the insurance. You need the Government to intervene, to provide that insurance coverage.

I thank you for your indulgence, Mr. Chairman.

Senator CRAPO. Thank you.

Senator Carper.

Senator CARPER. If I were the Chairman, you never would have gotten those extra 3 minutes and 6 seconds.

Mr. Chairman, I would say it is probably safe to assume that Senator Markey is probably not going to co-sponsor this legislation any time soon.

Senator CRAPO. I got that figured out.

Senator CARPER. One of our colleagues is not here today, Mike Enzi. He and Ted Kennedy used to lead the Committee on Health, Education, Labor and Pensions for a number of years. Enzi was a very conservative Republican, and Kennedy was a very liberal Democrat. Somehow or other, they managed to get a huge amount done.

I used to say to Mike Enzi, how are you and Ted Kennedy able to bridge the divide and get so much done? He always talked about the 80/20 rule. I said what is that? He said, Ted and I agree on 80 percent of the stuff; we disagree on 20 percent. What we decide to do is focus on the 80 percent on which we agree.

Chairman Inhofe and I have co-sponsored legislation, and I used to do this with George Voinovich on diesel emission reduction, and we are making great progress on that front. We decided to focus on what we agree on.

In the spirit of the 80/20 rule, I want to ask this panel, we will start with you Dr. Back, what is the 80 percent where you folks agree, or maybe 70 or 60 percent? Where is the agreement of this panel on some of the important issues? Just take a minute, nor more than a minute.

Ms. BACK. I am not quite sure I understand the question.

Senator CARPER. I am asking you what are the points of consensus for this panel. Where do you think you guys agree?

Ms. BACK. I believe we agree that early interaction with the NRC is helpful for new technologies for advanced reactors. I believe a staged approach is also very helpful. I believe some kind of cost share to help with the fees or change the burden of having an all fees due for the design certification or licensing application is maybe not appropriate.

Senator CARPER. Thank you.

Dr. Finan.

Ms. FINAN. I think there is a very important area where we all agree. Even Senator Markey laid out some of the challenges faced by nuclear.

This is an industry that desperately needs innovation to address those challenges. Solar and wind have done really well and benefited from a great deal of innovation in that space. Nuclear energy is ready. There are innovators and investors who are ready to really take on that innovation challenge.

I think we need to have a more efficient and transparent regulatory framework to enable the work we need to do to address those challenges that Senator Markey outlined.

Senator CARPER. Thank you.

Ms. KORSNICK. I think we all agree that nuclear power is very important and very necessary for a baseload, carbon free future for how we generate electricity. I think we also agree that we need a strong, effective regulator.

Earlier, we used the term gold standard. I think we do not want the NRC to be a weakened regulator. I do not think that is helpful for the industry. We do feel that we can have an efficient and strong regulator, a regulator that is more transparent from a cost perspective.

Senator CARPER. Thank you.

Dr. Lyman, where is the consensus?

Mr. LYMAN. I would hope the consensus is that there needs to be a structured process to ensure that NRC safety reviews of new reactors are not spent, that those resources are actually used to end up with a product that generates electricity and are not just academic exercises. That is one concern we have with the bill, and we hoped the panel would agree.

Also, I would point out that we do not agree that the stage process outlined in the bill necessarily would be helpful.

Senator CARPER. Dr. Lyman, I was looking for points of agreement. We will come back to the 20 percent in some other hearing.

Commander McCree, a Navy captain, right?

Mr. MCCREE. Yes, sir.

Senator CARPER. Naval Academy?

Mr. MCCREE. Yes, sir.

Let me first agree with my fellow panel, Ms. Korsnick, on NRC remaining a strong and credible regulator is essential. We are committed to our efficiency principle of good regulation and are making strides to become more efficient in this important area. The most important thing we do is assure the safety and security of the 100 operating nuclear power plants and the materials license holders.

Within that, earlier, I alluded to the three-pronged strategy, the multipart strategy. I believe that is in perfect alignment. NRC needs to improve its regulatory infrastructure to make the prospective reviews of advanced non-light water reactors more efficient, more effective, more clear and predictable.

We are committed to build that framework, to have it in place, by 2019 so that if, and, or when an application is submitted for advanced non-light water reactors, we can conduct those reviews in a timely, efficient and effective manner.

We are on path to do that including considering stage reviews, conducting additional outreach with folks at the table, as well as other stakeholders, both domestically and internationally to make sure we are ready.

Senator CARPER. Thanks very much.

Mr. Merrifield.

Mr. MERRIFIELD. I think there is a consensus that we can build safer nuclear reactors.

Going forward, I do also want to mention there are small modular reactors in the pipeline contemplated to be built by 2023. As a country, we have the capability of building more nuclear reactors by 2025.

We can have savings in the building of new reactors if we replicate and learn from the experiences at Summer and Vogel.

Obviously we need to make sure that the NRC has the resources necessary to protect public health, safety and security. Ultimately, it is the nuclear power plants that physically have to defend against potential ISIS threats.

From my view as a former Commissioner, those are the safest industrial facilities in the United States from a security standpoint and would well be able to defend against the kind of threats we have from that particular adversary.

Senator CARPER. Mr. Chairman, let me go back to you. Maybe you can give me some more time later.

Senator Markey, I did not take my earlier time so I am catching up.

Senator CRAPO. Do you have more questions, Senator Markey?

Senator MARKEY. It would just be a comment, Mr. Chairman.

Dr. Lyman, do you agree that granting safety exemptions to advanced reactor licensees could lead to a net reduction in overall safety?

Mr. LYMAN. Yes. To elaborate on that concern, the industry is pressing for generic decisions to be made on certain policy issues including the size of emergency planning zones for advanced reactors or small modular reactors, the level of security that is needed, whether or not the containment needs to be robust against large pressure increases and whether the number of operators needed to staff a nuclear reactor complex should be reduced. They want these decisions to be made based on the expectation or the assertion that advanced reactors are so much safer than current reactors that we do not need these extra levels of protection.

Our concern is that assertion is not always based on a full enough body of evidence and experimental data to justify making those decisions, so there could be a net reduction in safety if exemptions and other relaxations in safety procedures are granted based on a presumption that a nuclear reactor is safer without a full examination of that claim.

Senator MARKEY. Mr. Chairman, laced throughout the bill as it is drafted is an assumption that there are inherent safety features built into advanced design reactors that make it safer automatically.

That is a nice assumption to make. It is a nice assertion to make, but that is going to be tested. We have to make sure that any one additional, potentially successful safety feature interacts with the

totality of the rest of the nuclear power plant in terms of assuming the power plant is safer.

We do not know that. That is an assumption built into the language of the bill. This just goes to the question, and it is an 80/20 question, what are the big issues that we have to deal with. Eighty percent is still going to remain is there enough money for the NRC to do their job, having enough personnel asking all the right questions, having the right supervision and the fees are going to be reduced.

Are these new technologies actually inherently safer? We have to have the capacity to be able to determine that. Will the public be able to ask questions? The industry has always tried to get the public out but after Three Mile Island, Chernobyl and any number of other incidents, the people do not trust the experts anymore. They want to be able to ask questions too because these power plants are going into their neighborhoods. You cannot wall out whole areas of the country.

These have historically always been big questions. From my perspective, public input is vital and should actually be strengthened. The new reactors should not be exempted from important safety requirements that historically have been required and that the NRC budget should not be capped.

These are the central areas, the big questions that we are going to have to answer in this legislation. It is going to keep coming back to the same questions we have asked for the last 7 years on technology. The questions do not change. We will be the ones that have to decide.

I thank you, Mr. Chairman, for having this very important hearing. We know one thing, that these power plants are now 20, 30 and 40 years old. You have to go to the doctor more the older you get. There are more things that can go wrong the older you get.

To reduce the budgets of these aging power plants in densely populated areas all across the country and say at the same time we are going to have lower numbers of personnel, lower amount of fees and revenues going in is totally contrary to how we think about it.

There are issues like embrittlement in nuclear power plants that are the same as cholesterol going through the veins of older Americans. They cause issues that require a lot of additional attention.

To say that is not as accurate for technology as it is for humans just belies the reality of what we have already learned about nuclear power plants in our country.

I thank you for the courtesy, Mr. Chairman, and the additional time to question.

Senator CRAPO. Thank you, Senator Markey.

I will take my last round right now, and then you will be able to finish, Senator Carper.

I just want to make the comment that this legislation does not make assumptions. It sets forward a new process, a more transparent and I think effective process for the decisions you are talking about to be made.

It definitely does not give any exemptions to any technology. It puts the NRC directly in charge of improving and strengthening

our safety. I would actually like to use my time to ask Mr. Merrifield and Ms. Korsnick to respond to that very issue.

Mr. MERRIFIELD. I think the NRC is going to be able to continue to meet its mission of appropriately looking at these technologies and ensuring they are assured that they are safe. I think it will be able to do so in a way which is risk informed such that it will be able to judge is there a need for a large, emergency planning zone, where the amount of radiation in that reactor zone may be much less.

Senator CRAPO. This legislation does not choose technologies. It does not define standard.

Mr. MERRIFIELD. No, it does not. Those tools remain with the NRC.

The other point I would make is it is not as if these technologies are entirely new. Indeed, most of the advanced reactor technologies being brought forward today were originally developed by the Atomic Energy Commission and DOE during the 1950s and 1960s.

There is a significant amount of research information available to demonstrate the safety of these reactors today and justify the NRC making changes which would more appropriately tailor their regulations for advanced reactor technologies fully consistent with public health and safety.

Senator CRAPO. Thank you.

Ms. Korsnick.

Ms. KORSNICK. I have a couple of comments. Clearly the industry and the folks representing advanced reactors, none of us are interested in reducing safety margins. The conversation and structure in this bill that provides a licensing process really informs that licensing process that these safety margins might in fact be met in a new and different way with this innovative technology. That needs to be acknowledged through the licensing process.

We are not in any way lowering the bar or lowering the standard. Quite frankly, we are meeting or maybe even exceeding the standard but just in a new way.

The other item I wanted to mention, and I appreciate Senator Markey is not here, but the mandatory hearings that were mentioned earlier, these are uncontested hearings. That means the public does not participate.

The hearings that are referenced in this bill in fact are held between the Commission and the staff on construction permits and combined license applications. It is not cutting the public out, if you will, of any conversation. We are very interested in the public being involved in dialogue.

Senator CRAPO. If there is any public interest, the bill allows for a hearing to be held.

Ms. KORSNICK. Absolutely. There are many ways the public can request a hearing on an application and be involved. This does not take away any of the public engagement and involvement.

I just wanted to make that clear because I felt a different impression was left with the committee.

Senator CRAPO. Thank you very much.

Senator Carper.

Senator CARPER. Thank you, Mr. Chairman. You are doing a great job, by the way. I look forward to the day when you chair this more often.

Senator CRAPO. Thank you for that, too.

Senator CARPER. Unless, of course, I could be the Chairman. In the meantime, I will be your wing man.

I have an old car. In 2001, I stepped down as Governor and became a Senator. I went out with my oldest son, Chris, who was then 12, to buy a new car. We drove Porches, Mustangs and Corvettes. We bought a Chrysler Town and County minivan. He said it was bait and switch.

Yesterday, I was driving back to Delaware. We usually take the train, but we drove back last night to Delaware in my 2001 Chrysler Town and Country minivan. Along the way, the odometer crossed 419,000 miles.

When I first got my minivan, there were some warranty clauses, things that needed to be fixed from the factory, so we had a warranty to pay for that stuff. For a long period of time, we almost spent no money on it. I could get it washed every 2 weeks and maybe change the oil. In recent years, to be honest with you, I spent more and more money on my minivan.

We have all these old nuclear power plants out there. My guess is when they first came online there were some problems with them sort of like the warranty stuff. We dealt with that and continued to monitor them as time goes by.

Like Ed Markey said, your body gets old, and you have to spend more money. I always spend more money on my minivan. I will say this. About a month ago, I went out to start it one night down in southern Delaware after a meeting, and it would not start.

The guy came from AAA and he said, you need a new battery. I said OK. He said, we have a 2-year and a 6-year, which would you prefer. I said the 6-year. Some people say that is confidence. That is optimism. I am Mr. Glass Half Full.

Here is where I am going with this. If I am a utility, and I am paying 90 percent of the cost for running NRC. I see the NRC having fewer reactors because we are shutting down reactors and have fewer reactors to monitor.

We are adding four new ones, but it is not a huge increase. Why does the NRC continue to need all this money? I think you knocked your budget down by $5 million. That is not very much in the scheme of things. I am trying to figure it out. Maybe you can help me with this, Commander.

In terms of cost, four new power plants, monitoring and shepherding them through is not cheap. You have, as I understand, closures.

I had a Ford Explorer about a year or two ago and was going to retire it or decommission it, if you will. We just took it to a place, and in 1 minute, they squashed my Explorer. That was it, and they gave me a check.

It does not work that way with these nuclear power plants. It is an expensive process to decommission them. I guess that is a cost for you.

Fukushima, we have all these recommendations from Fukushima that we are implementing. We are making some progress, but we had a hearing a week or two ago and said we are not there yet.

Plus, you have all these advanced technologies, all these people with brilliant ideas, I hope, who are saying look at my idea, so it takes money to pay for all this.

After thinking about it a bit, my sense is that what you are asking for in the budget is not unreasonable, but this guy here is interested in how we get better results for less money and finding out how to save some more money.

If I was the utilities, I would say you guys have to sharpen your pencils a little bit more and figure out how to save some money if you expect us to continue to pay through the nose. React to that for me, if you will.

Mr. MCCREE. I appreciate the analogy to your minivan.

Senator CARPER. Never tell my wife I bought a 6-year battery, she would die.

Mr. MCCREE. A nuclear power plant is much more complex.

To your point, the NRC is reducing its costs. We are committed to doing so. If you look at the trend from 2014, we are reducing our costs. Our fiscal year 2017 budget request is another $20 million below our fiscal year 2016 request.

The Commission has accepted a number of the recommendations from our Project AIM re-baselining which will enable us to reduce our fiscal year 2017 appropriation request by at least another $31 million. Those are significant reductions. We are still not done.

Lowering our costs will translate to reduced fees, both the user fees and the annual fees to this industry that we regulate. While there may be a delay or reaction, there is a commitment to reducing our fees. It is tangible. I believe the industry will recognize those reduced costs.

Senator CARPER. Thank you.

I have one last quick question. As the budget is reduced in the future, would the work force reflect the reduced workload? Take a minute to talk about the ramifications of cutting nuclear engineers today which might arguably be needed for tomorrow's advanced nuclear applications.

Mr. MCCREE. One of the more significant challenges I think any organization experiences, one that is human capital dependent and dependency on people to get work done, that is certainly NRC, is to manage cost reductions, reductions in staffing in a way that you retain your core capability to fulfill your mission.

Of course our mission is safety and security, so we are working very closely, as a leadership team, using a strategic work force plan, to make sure the work we have now and the work we predict in the future will have the right people in the right place at the right time with the right skills.

Again, that is our commitment. We are working very closely to get that done, including nuclear engineers who are one capability, one competence that we need within the NRC.

Mr. MERRIFIELD. Senator, may I make a comment about planning?

Senator CARPER. Real short.

Mr. MERRIFIELD. Seventy-three of the nuclear power plants in the United States have sought and received an extension to run for 60 years. That has allowed the utilities to invest large amounts of money to make sure those plants are up to date and fully meet the safety requirements.

Like your minivan, they have been making a lot of investments along the way to make sure those are useful. Similar to the way the U.S. Air Force 1950s era B–52s are currently being deployed in the Middle East in the right shape to do their mission, nuclear power plants are doing the same here in the U.S.

Senator CARPER. Mr. Chairman, I want to make sure I get my 6 years' worth out of that battery I just bought. We will see how it works.

Mr. MCCREE. For the record, that would be 83 licenses, 11 under review and 6 expected to come in. The NRC is a bit more successful.

Senator CARPER. Thank you for that clarification.

Thank you all for being with us today. Let us continue to look at that 80 percent and see if we can build on that.

Thank you very much.

Senator CRAPO. Thank you, Senator Carper.

I do appreciate your constant focus on trying to find solutions and get to that 80 percent. I agree with it.

Dr. Lyman, I indicated I would give you a chance, but I think you got your chance to make your comment. Do you feel you have not fully had that opportunity yet?

Senator CARPER. I think we have heard enough from him.

Senator CRAPO. Go ahead.

Mr. LYMAN. I would like just a very short time to explain why we think some of the language in the bill could potentially be interpreted as a reduction in safety standards. That primarily has to do with the language "risk informed" and "performance based."

In my experience with the NRC in its attempts to implement what it calls "risk informed" regulation, it often implies trying to justify what is called a reduction of unnecessary conservatism. Unnecessary conservatism means different things to different people.

Our concern is that this bill would put pressure on the NRC to develop processes that would essentially force them to accept lesser standards for the experimental data for the analytical work that is needed to support an advanced reactor application.

In particular, if you have designs based just on paper studies, the risk analyses do not have operational data to actually validate the studies. There is a concern that over-reliance on or over-confidence in paper studies insufficiently validated to meet say less restrictive safety criteria could lead to an overall reduction in safety. That is our concern.

On the question of innovation, Mr. Merrifield pointed out many of the reactor types currently being considered were developed by the Atomic Energy Commission decades ago. We agree with that. Actually there is less innovation today than meets the eye.

I would submit that argument could also be used to say the NRC has considerable expertise and experience in those reactor types. We think the concern that the NRC is not ready to license non-

light water reactors is somewhat exaggerated for that very reason. For the most part, these are old technologies.

Mr. MERRIFIELD. If I may respond quickly, when I was on the Commission, we did create about $5 million in funding to better understand pebble bed reactors but molten salt reactors, lead bismuth and some of the others being proposed are significantly different from what the NRC has experience in, so they do need additional funding and resources to bridge that gap.

Senator CRAPO. Thank you. I know we have opened some issues here that everyone would like to jump into more, and I would, too, but I believe we just had a vote called or will shortly have a vote called, so we are going to have to wrap this up.

I do want to remind all of the witnesses that Senator Whitehouse had asked each of you to respond in writing to the question about the safety implications of the legislation on the NRC's capacity to protect safety in its regulatory structure. I would encourage you to do that and respond to these issues.

Each of the Senators may have further questions. It is customary for them to submit those in writing. Since this is a legislative hearing, and we expect committee action on S. 2795 next week, I am asking our Senators and committee staff to provide those questions regarding this bill to the majority office by 4 p.m. tomorrow, Friday.

I am asking the witnesses to be sure to respond in writing by 5 p.m. on Monday, April 25. I know that is a short time, but we are going to be moving ahead. If you can respond to those questions quickly, we would appreciate it.

All questions for the record regarding the general topic of advanced reactors will be due within the usual 2-week deadline.

To our witnesses, again, I want to thank you all for coming and sharing your views.

This hearing is adjourned.

[Whereupon, at 11:52 a.m., the subcommittee was adjourned.]

[An additional statement submitted for the record follows:]

STATEMENT OF HON. BENJAMIN L. CARDIN,
U.S. SENATOR FROM THE STATE OF MARYLAND

Madam Chair, Ranking Member Carper, thank you for holding this hearing. Nuclear power provides a critical share of the Nation's electricity—about 20 percent of the total—and an even larger share—about 60 percent—of our carbon-free electricity. It is a crucial supplier of baseload power.

Nuclear power will be part of the energy mix for the foreseeable future: there are nearly 100 reactors currently operating in the U.S., including the two units at Calvert Cliffs.

In 1954, Lewis L. Strauss, who was Chairman of the Atomic Energy Commission (AEC), famously said, "It is not too much to expect that our children will enjoy in their homes electrical energy too cheap to meter."

Chairman Strauss, who was addressing the National Association of Science Writers, was making a general prediction that science would continue to improve the human condition. But his statement came to be misinterpreted as referring to nuclear power specifically. It is, perhaps, an understandable mistake, given his affiliation with the AEC, which was charged with promoting nuclear energy as well as regulating it.

Nuclear energy isn't too cheap to meter, as it turns out, but there are ways to reduce its cost while protecting human health and the environment.

The current fleet of commercial light water reactors has reached or is reaching its original "design basis" of operating for 40 years. While the Nuclear Regulatory Commission (NRC) has determined that it is safe to allow these reactors to continue

operating, scientists and engineers are coming up with new reactor designs that will improve or replace existing light water reactor (LWR) technology.

As existing reactors are retired over the next several years or decades, we have the opportunity to replace them with safer, less costly, modular reactors utilizing either enhanced LWR technology or advanced non-LWR technology.

I am confident the nuclear industry can solve technical problems. Scientists and engineers are problem solvers; it's what they do and what they do well.

The question is whether the NRC has the resources and regulatory framework to review and license the new designs in a fashion that encourages—or at least doesn't discourage—the large private capital investments that will be necessary to commercialize advanced reactor technology.

Of course, the NRC will have to continue its oversight of the existing fleet, too.

The NRC's job as an independent agency is neither to promote nor hinder the nuclear power industry or a particular technology but rather to regulate it, as effectively and efficiently as possible, in a manner that protects human health and the environment.

The NRC's mission is enormously important and technically challenging. For that reason, and because the Commission is headquartered in Rockville and much of its staff lives in Maryland, I would like to focus on workforce issues during today's hearing.

Statistics the Commission provided to my staff indicate that 19 percent of the NRC's employees are over the age of 60, and another 33 percent of the employees are between the ages of 50 and 59. Conversely, just 27 percent of NRC's employees are 39 or younger. Twenty-two percent of NRC's employees are eligible to retire this year; on a cumulative basis, that number rises to 37 percent by fiscal year 2020.

The NRC has a highly educated and skilled workforce with a strong esprit de corps. The Commission's older workers especially have vast experience and expertise.

The Commission has embarked on "Project AIM 2020" to "right size" its workforce relative to its workload. As long as safety isn't jeopardized, that's a logical step, considering that the "nuclear renaissance" many people predicted with respect to conventional light water reactors a decade ago hasn't occurred—at least not yet. But now small modular reactors (SMRs) and advanced reactors are coming down the pike.

The number of NRC FTEs—"full-time equivalents"—was over 3,700 in fiscal year 2014; that number would decline to fewer than 3,500 under the President's fiscal year 2017 budget request.

I'm hopeful that the Commission can meet its workforce reduction targets through voluntary attrition since so many NRC employees are eligible to retire now or in the near future.

But even if the targets are met in the least disruptive fashion possible, the Commission must avoid a "brain drain."

Nearly 1,300 NRC employees will be eligible to retire over the next 5 years. Will retirements over the next several years exceed the planned reduction in the size of the workforce? If so, what measures is the Commission taking to attract, train, and retain the next generation of our "best and brightest"? How is knowledge being transmitted to younger NRC staffers and new hires?

The current fleet of nuclear power reactors may not be growing as previously envisioned, but it is aging—that much is certain.

An aging fleet presents unique safety challenges that will require continued diligence by the NRC to protect human health and the environment.

And reviewing the designs and license applications of SMRs and advanced reactors will present a different set of challenges.

I look forward to learning how the NRC plans to maintain the workforce capable of addressing these twin challenges in the face of a likely retirement wave.

Thank you, Madam Chair.