S. HRG. 115–52

HEARING ON S. 512, THE NUCLEAR ENERGY INNOVATION AND MODERNIZATION ACT

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

MARCH 8, 2017

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ONE HUNDRED FIFTEENTH CONGRESS
FIRST SESSION

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HEARING ON S. 512, THE NUCLEAR ENERGY INNOVATION AND MODERNIZATION ACT

WEDNESDAY, MARCH 8, 2017

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The committee met, pursuant to notice, at 10:04 a.m. in room 406, Dirksen Senate Office Building, Hon. John Barrasso (chairman of the committee) presiding.

Present: Senators Barrasso, Carper, Inhofe, Capito, Boozman, Wicker, Fischer, Moran, Rounds, Ernst, Sullivan, Cardin, Whitehouse, Merkley, Gillibrand, Booker, Markey, Duckworth, and Harris.

OPENING STATEMENT OF HON. JOHN BARRASSO, U.S. SENATOR FROM THE STATE OF WYOMING

Senator BARRASSO. Good morning. I call this hearing to order.

I am a strong supporter of American nuclear energy. It is a vital component of our all-of-the-above American energy plan.

My home State of Wyoming plays a key role in the American nuclear energy supply by producing more uranium than any other State.

Nuclear energy is clean, safe, reliable, and affordable. It is also a major boost for the economy. American nuclear plants provide thousands of jobs and millions of dollars in benefits to local communities. U.S. nuclear power plants have run safely for decades, and many will serve our Country for years to come.

After decades of reliable power from our traditional nuclear plants, innovation is taking shape in the nuclear industry. Increased private investment in nuclear energy has led to advancements in safety, security, and cost. These advantages and advancements are exciting.

The biggest challenges these innovators face, however, are delays and costs from regulatory red tape. Many of these delays come from trying to navigate a regulatory system that was developed around one specific technology, water-cooled reactors. Traditional water-cooled reactors have powered our Navy and our electricity grid for decades. Today's innovators are pursuing very different designs that are using high temperature gases, molten salts, and other high tech materials to advance the safety, efficiency, and reliability of nuclear energy.

The nuclear regulatory system needs to be updated to enable these innovations. That is why I am joined by my colleagues, Senators Whitehouse, Inhofe, Booker, Crapo, Fischer, Capito, Manchin,

Casey, and Duckworth to introduce the Nuclear Energy Innovation and Modernization Act. This bipartisan bill seeks to modernize the Nuclear Regulatory Commission by providing a flexible regulatory framework for licensing advanced nuclear reactors.

The NRC needs a modern regulatory framework that is predictable and efficient. Reactor operators from both traditional and advanced reactors need timely decisionmaking from the NRC. At the same time, the Commission needs to maintain the ability to assess a variety of technologies and still meet its mission of ensuring safety and security.

Additionally, our legislation will update the Nuclear Regulatory Commission's fee recovery structure. This measure will bring increased transparency and accountability to the NRC, while improving the Commission's efficiency and timeliness.

This bill will also help preserve the uranium producers who are essential to powering this technology. The Energy Information Administration reported that uranium production in 2016 was at its lowest level since 2005.

One challenge that uranium producers face is the need for clear, predictable regulations. Under current law, the EPA sets standards of general application and the NRC implements these standards. Yet, there is no definition in the Atomic Energy Act for "standards of general application."

Paul Goranson, from Energy Fuels Company in Casper, Wyoming, submitted written testimony for today's hearing in which he states, "Clearly defining standards of general application, without reducing any oversight of the industry, would help clarify the roles and responsibilities of the EPA and NRC, reduce regulatory conflict, and provide for a more effective regulatory framework."

I am going to continue to work with other sponsors to address this more fully.

Finally, the bill addresses the Department of Energy's mismanagement of the public's stockpile of excess uranium. Since 2009, the Department has repeatedly violated its own written policy and written law when managing the public's excess uranium. As a result, the Department of Energy has failed to obtain a fair return on this uranium for American taxpayers.

For example, the Government Accountability Office found that the Department of Energy's transfer of excess uranium in 2012 may have actually cost taxpayers up to $195 million. The Department of Energy's mismanagement has also contributed to volatility in the uranium market and has led to job losses in many States like my home State of Wyoming.

So I want to thank Senator Ed Markey and his staff for helping with these specific provisions. This bipartisan legislation will enable the development of innovative reactors with bold new technologies.

America needs to be a leader of nuclear development. We need to create an environment where entrepreneurs can flourish and create jobs here at home that will revitalize our nuclear energy sector. The Nuclear Energy Innovation and Modernization Act does just this. This broadly bipartisan bill will strengthen American energy independence, foster innovation and job creation.

With that, I would like to turn to the Ranking Member of the Committee, Senator Carper.

[The prepared statement of Senator Barrasso follows:]

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

Senator CARPER. Thank you, Mr. Chairman.

I yield my time to the Senator from Maryland, Ben Cardin.

Senator CARDIN. I don't want your time, Mr. Ranking Member.

Senator CARPER. Five seconds of my time.

Senator CARDIN. Thank you. Appreciate that.

As the home State for the NRC's headquarters, I ask consent to put in my statement in regards to work force challenges.

Senator BARRASSO. Without objection.

[The referenced information follows:]

STATEMENT OF THE HONORABLE BENJAMIN L. CARDIN (D-MD)

SENATE COMMITTEE ON ENVIRONMENT & PUBLIC WORKS

HEARING ON ADVANCED NUCLEAR REACTORS AND S. 512,

THE "NUCLEAR ENERGY INNOVATION & MODERNIZATION ACT"

March 8, 2017

Mr. Chairman, 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 base-load 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 upon 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 the 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 discuss its workforce in the context of this hearing.

Statistics the Commission provided to my staff indicate that 21 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 26 percent of NRC's employees are 39 or younger. Twenty-four percent of NRC's employees are eligible to retire this year; on a cumulative basis, that number rises to 36 percent by Fiscal Year (FY) 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" – peaked at 3,960 in Fiscal Year (FY) 2010 and was over 3,700 in FY 2014; that number will decline to fewer than 3,400 under the FY 2017 "re-base-lined" budget request and continue to drop after that.

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".

Roughly 1,200 NRC employees will be eligible to retire over the next five 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.

Senator CARPER. Thanks so much.

Welcome, everybody. Delighted to see you again. Thank you for taking this time with us.

My colleagues have heard me tell this story before. I want to tell it again; I think it is appropriate.

Both my boys are, I am proud to say, Eagle Scouts and my wife and I are very much involved in their troop. I am a retired Navy Captain. I used to take our Boy Scout troop to Norfolk Naval Station about every 3 years to spend a weekend and to have a chance to climb over the ships, submarines, aircraft carriers, sleep in the barracks and even the galley; and it was a great adventure for them and, frankly, for all of us.

One day, one Sunday, we went and visited the Teddy Roosevelt nuclear power carrier and we had the opportunity, the captain of the ship came out to welcome us. We were up on the bridge and he addressed 25 scouts, 5 adults, and here is what he said. To the boys, he said, boys, when Teddy Roosevelt goes to sea, it is 1,000 feet long. The boys went, ooh. He said, boys, when the Teddy Roosevelt goes to sea, it is 35 stories high. And the boys went, ooh. And he said, boys, when the Teddy Roosevelt goes to sea, it has 5,000 sailors onboard. Five thousand. And the boys went, ooh. And he said, boys, when the Teddy Roosevelt goes to sea, it has 75 different aircraft onboard. And the boys went, ooh. And then he finally added, and, boys, when the Teddy Roosevelt goes to sea, it refuels every 25 years. And the adults went, ooh.

[Laughter.]

Senator CARPER. And I think that says almost not everything that we need to say, but a whole lot about what we need to say.

I agree very much with what our Chairman has said. A lot of people I served with in the Navy actually were on ships and submarines and aircraft carriers that were nuclear powered, and the safety record is good. We have to continue to focus on that not only at sea, but on land as well, and we have.

Today's hearing is very timely as the nuclear industry faces real challenge. The industry is what I describe as a crossroads, and which the path the industry decides to take will have ramifications on our Country and our citizens, I think, for decades to come.

Let me begin by noting that it is important to examine the benefits. There are many. The Chairman has mentioned a number of those, of nuclear energy. There are some drawbacks, as well, and we need to be honest about those and address them.

First and foremost, the energy from nuclear power plants helps curb our Nation's reliance on dirty fossil fuels and reduces air pollution emissions that threaten our health and our climate.

Second, nuclear energy can be a major economic driver. Many Americans may be unaware that the United States invented nuclear technology. In fact, for many years our Nation led the world in nuclear manufacturing, construction, and production. The jobs and the economic benefits of this stayed here at home for the most part. Unfortunately, that is no longer the case.

If our Country decides to retake its leadership in nuclear energy, I hope we do, and is successful in that endeavor, history has shown there will be economic benefits in the form of manufacturing and construction jobs and, frankly, operating jobs.

It turns out there is, as we know, two test cases, examples in Georgia and South Carolina, real-life tests where the construction of two new reactors in each of those States has provided thousands of good paying jobs and spurred economic development in the surrounding communities.

Despite all the benefits of nuclear power, I should mention also some of the potential adverse consequences of nuclear energy. We have seen, from serious incidents like places in Fukushima, the damage that nuclear power can cause if the proper safety precautions are not in place, not up to date, and, most important, not adhered to.

With nuclear energy, safety has been, and must remain, a top priority in the operation of nuclear reactors. I salute everyone, whether it is the NRC, the folks in the industry themselves, everybody who has been involved to try to make sure that that safety record remains unblemished here in this Country.

Unfortunately, the costs of safety precautions, along with the costs of construction, operation, and maintenance of current nuclear reactors can be expensive, especially when compared to the costs of other sources of energy, including natural gas. In fact, some of the U.S. reactors are retiring, as we know, sooner than expected due to market forces.

At the same time, our Country's nuclear reactors are getting older and will need to be replaced in the years to come. Some people believe our Nation's nuclear success story is ending. They may be right, but I believe that success story may just be getting its second wind. I sure hope so. And if we are smart, we will replace our aging nuclear reactors with new technology developed in this Country that is safer, that produces less spent fuel, and is cheaper to build and to operate.

If we seize this opportunity, seize the day, the U.S. can be a leader once again in nuclear energy, reaping the economic benefits that flow from that leadership.

I am not the only one who sees the opportunity. U.S. companies have already invested in an estimated, I am told, $1.5 billion in next generation nuclear technology, and today we will hear directly from General Atomics, a company that is investing in a design that is much smaller than current reactors, doesn't need water for cooling, is able to use spent fuel as a fuel, and is passive in design so that it will shut down easily if a significant concern rises.

As we will hear today, if this design works, this type of reactor may well be competitive in today's energy markets. This technology, like the dozens of other types of nuclear energy technology that are being actively researched, developed, and invested in today still face real material and design challenges before it is ready to be commercialized.

I should hasten to add that as companies like General Atomics make advances in the technologies, 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 evolves, so must the NRC.

We also need to make sure that the NRC has the resources it needs to review these new technologies and ensure our current nuclear reactor fleet remains safe. At the same time, we must be con-

scious of how change to the NRC fee structure might impact the funds required from taxpayers.

Finally, it is also important to remember that the current Administration wants to cut domestic spending to the bone, while increasing funding for defense and homeland security. If this Administration is successful, we may ultimately face a situation where there are insufficient taxpayer dollars for the NRC to work on advanced nuclear energy issues and meet its other responsibilities. We need to keep that in mind. I don't want to see that happen. I suspect that none of us in this Committee do either.

I believe advances in nuclear energy can help us sustain that nurturing environment for job creation, cleaner air for our people and our planet. We need that.

I want to again thank our Chairman and the cosponsors of the legislation he has mentioned before us for their work, the work of their staffs, and for working closely with my own staff. We look forward to building on that working relationship.

I am just happy to be here for a hearing on something we agree on. It is a good thing. We are having a series of hearings on things we agree on, and maybe we can get some good work done for this Country.

Thank you, Mr. Chairman.

Senator INHOFE. That is right. That is right.

Senator BARRASSO. Thank you very much, Senator Carper.

Would any of the original cosponsors like to be recognized? Senator Inhofe.

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

Senator INHOFE. Well, you know, it is hard for me to accept the fact that it was 20 years ago, 19 years ago that I became chairman of the subcommittee of this Committee that deals with nuclear energy, and I remember when I became chairman they had not had an oversight hearing before the NRC in 10 years. Now, you can't let a bureaucracy, no matter how wonderful everyone is, go without oversight. And, of course, we changed that; we became very active at that time.

I dramatically shortened my opening statement because they have already spoken for me. I agree with the comments that were made.

It is important for everyone to understand this is the second time around for this, because we introduced this bill last year, and last year we had Senators Whitehouse, Booker, Crapo, myself, and others working on essentially the same bill that we have.

Now, I have to say confession is good for the soul, and Senator Whitehouse and I don't always see eye-to-eye on every issue. That is a shocker to a lot of people, but on this issue we do. So it shows the broad base of support that we have, and I think this is the time that we can get it through. We didn't get it through last time. It always surprised a lot of people, when I chaired this Committee, how many times Barbara Boxer and I agreed, and we got a lot of things done that we couldn't have otherwise, if it hadn't been for a close friendship. I could never sell her, though, on this one, so she opposed that. This time, I think, that is going to happen.

It bothers me, when I look at countries like China and Russia, to see that they are advancing ahead of us at this time. New technologies are out there. We know we can reach them. And this is what we have to pass to make sure that it does happen, so I am very enthusiastic about this. And I agree with you, Senator Carper, that it is a lot fun when we can work on issues that we agree on, so let's get it done.

Senator BARRASSO. Thank you very much, Senator Inhofe.

Senator INHOFE. One other comment I want to make. There are several members over here on this side that are also on the Commerce Committee, so we will be going back and forth, so you know why we are doing this at the same time.

Senator BARRASSO. Any other cosponsors like to make a statement? Senator Whitehouse.

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

Senator WHITEHOUSE. I would be delighted to, Chairman. Let me first say that I believe I am now in the position, as Ranking Member on the subcommittee with Senator Capito, and I look forward to working with her to move this legislation quickly forward through the Committee, and, of course, with our Chairman and Ranking Member.

I want to particularly thank Senator Inhofe and Senator Crapo, who are the two opening cosponsors on the Republican side, along with myself and Senator Booker. Senator Fischer is here, and I am delighted that she has joined us as a cosponsor of this legislation; and, of course, Chairman Barrasso is now a cosponsor of this legislation. So I think we have a good opportunity to move forward and get it done.

To me, one of the elements of this that is most attractive is the potential down the road for advanced nuclear technology to begin to direct its attention to our existing nuclear waste stockpile and find a way to turn it from a massive and unbooked liability for this Nation into an asset for this Nation. If that scientific achievement can be reached, all of our work will not have been in vein and very good things will have been done.

Mr. Chairman, I would just like to close by recognizing Dr. Ashley Finan, who is here from Jamestown, Rhode Island, a particularly beautiful part of our State, and I am very pleased to have her here and thank her for her work advising us on this legislation.

Thank you, Chairman. Thank you to the Ranking Member.

Senator BARRASSO. Thank you very much, Senator Whitehouse. Thank you, Dr. Finan, for being here as well.

Senator FISCHER.

OPENING STATEMENT OF HON. DEB FISCHER, U.S. SENATOR FROM THE STATE OF NEBRASKA

Senator FISCHER. Thank you, Mr. Chairman, for convening this hearing. I am very pleased to be able to cosponsor this Act. At a time when we see it is hard for us to agree on things, it is nice to be part of a bipartisan effort.

I am especially pleased with the addition of the new uranium recovery provisions that strengthen the bill and provide benefits to

my State. We have a nuclear plant in the southeast corner of Nebraska and we have a uranium mine in our western panhandle.

So this bill will make regulatory reviews more efficient and costs more predictable without compromising safety. It also enables the licensing of advanced technologies, which can revitalize our industry and ensure that nuclear energy is a robust energy source for decades to come.

So I am glad to be here today, Mr. Chairman. I thank you again for the hearing. I am eager to hear what the Committee will have for consideration of the bill. Thank you.

Senator BARRASSO. Thank you, Senator Fischer.

Senator WHITEHOUSE. May I ask for unanimous consent?

Senator BARRASSO. Senator Whitehouse, yes, please.

Senator WHITEHOUSE. Senator Lamar Alexander is another Senator who is keenly interested in nuclear advancements, and he and I wrote together an op-ed at the end of last year, and I would like to ask unanimous consent that that editorial piece by the two of us be included in the record of this hearing.

Senator BARRASSO. Without objection.

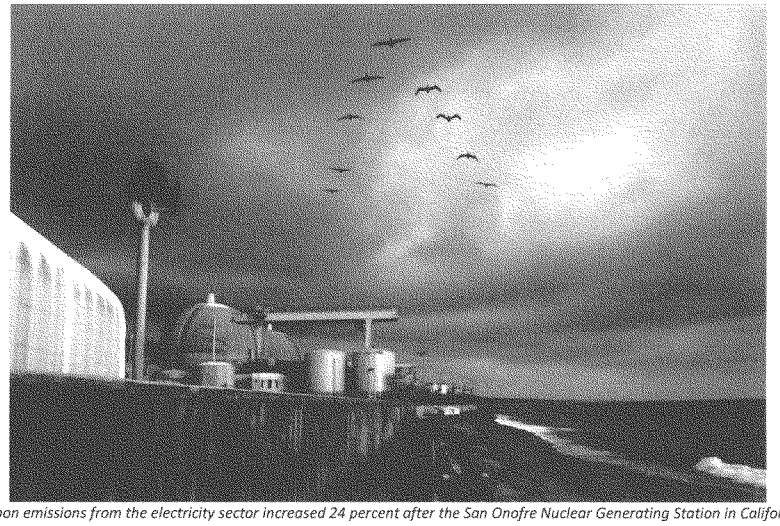
[The referenced information follows:]

The New York Times

The Opinion Pages | Op-Ed Contributors

To Slow Global Warming, We Need Nuclear Power

By LAMAR ALEXANDER and SHELDON WHITEHOUSE
December 21, 2016



Carbon emissions from the electricity sector increased 24 percent after the San Onofre Nuclear Generating Station in California closed. Credit Allen J. Schaben/Los Angeles Times, via Getty Images

If 20 fire marshals came around and told us our houses were about to burn down, we'd buy some fire insurance. So when the leading science academies in 20 developed countries, along with several major American corporations and the national security community, all tell us that burning fossil fuels is causing dangerous changes to the climate, we think it's time for the United States to get serious about clean energy. It also means supporting safely operating nuclear power plants that produce carbon-free electricity.

Already, 60 percent of our carbon-free electricity comes from the 99 nuclear reactors that dot the nation's map, from Avila Beach, Calif., to Seabrook, N.H. These reactors provide low-cost, reliable electricity for the United States, which uses nearly 20 percent of the world's electricity. But over the next decade, at least eight of these reactors are scheduled to shut down. That will push up carbon emissions from the American electricity sector by nearly 3 percent, according to the United States Energy Information Administration.

In California, the closing of the San Onofre Nuclear Generating Station in 2012 contributed to a 24 percent increase in carbon emissions from the electricity sector, according to data from the California Environmental Protection Agency Air Resources Board. Carbon emissions from the electricity sector in New England rose 5 percent in 2015, the first year-to-year increase since 2010, largely because of the closing of the Vermont Yankee Nuclear Power Station in December 2014, according to ISO New England, the region's grid operator.

In roughly two decades, the United States could lose about half its reactors. That's because, by 2038, 50 reactors will be at least 60 years old, and will face having to close, representing nearly half of the nuclear generating capacity in the United States. Without them, or enough new reactors to replace them, it will be much harder to reduce carbon emissions that contribute to climate change.

To encourage clean energy, such as the Clean Energy Incentive Program within President Obama's Clean Power Plan, do not explicitly include or incentivize nuclear power. Likewise, some states have chosen to adopt policies, such as renewable portfolio standards, that do not include or incentivize nuclear power.

At the same time, our energy markets do not currently account for the value of carbon-free power, a failure that puts nuclear power at an unfair and economically inefficient disadvantage to fossil fuels like coal and natural gas.

We come from different political parties, but we agree on the overall goal of leveling the playing field for nuclear power, and the need to find a bipartisan solution to achieve it. This matters because the investments we make today, in new plants and transmission infrastructure, will be around for decades. Every time new fossil energy replaces nuclear, we're locking ourselves in to

Some states and utilities are working to reduce carbon emissions with the understanding that nuclear power can be part of the solution. In the Southeast, there are four new reactors under construction that will provide 4,470 megawatts of carbon-free electricity — enough for 3.3 million homes. New York established a clean-energy standard in August that might help the state's reactors stay open, including one that had been announced as closing. Gov. Andrew M. Cuomo's office explained that "maintaining zero-emission nuclear power is a critical element to achieving New York's ambitious climate goals." And the private sector is pitching in, too: According to Energy Secretary Ernest J. Moniz, there are dozens of entrepreneurs focusing on ways to improve and expand the nuclear power industry.

The federal government should support these efforts.

For one thing, we should extend existing reactor licenses from 60 to 80 years, in cases where the Nuclear Regulatory Commission says it is safe to do so.

We should also invest more in research to develop advanced nuclear reactors, including small modular reactors and accident-tolerant fuels. Advanced reactor designs may substantially reduce the threat of a meltdown. Many new, modular designs are much smaller than their predecessors, meaning they can be built in factories at lower cost and plugged into the grid as needed.

Some of these new reactor technologies could actually use waste from traditional reactors as fuel, helping to alleviate a major challenge facing the industry. The Nuclear Regulatory Commission licensing framework, developed to support the last generation of reactors, should be updated to encourage and promote new investment in the next wave of advanced nuclear technology. And finally, we need to resolve the stalemate over where to store used nuclear reactor fuel.

If we want to clean the air and reduce carbon emissions to deal with climate change, we need a stronger, not weaker, nuclear energy sector. Congress, federal agencies and the Nuclear Regulatory Commission must work with utilities to preserve our existing reactors in the safest possible way, and to develop the next generation of reactors that will provide cheaper, reliable, carbon-free electricity.

Senator Lamar Alexander, Republican of Tennessee, is the chairman of the Senate Appropriations Subcommittee on Energy and Water Development. Senator Sheldon Whitehouse is a Democrat from Rhode Island.

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Senator BARRASSO. I also ask unanimous consent to submit a statement from Senator Crapo, a long-time member of this Committee, into the record. Without objection.

[The referenced information follows:]

Senator Mike Crapo
Legislative Hearing on S. 512, the Nuclear Energy Innovation and Modernization Act
U.S. Senate Committee on Environment and Public Works
March 8, 2017

Thank you, Chairman Barrasso and Ranking Member Carper, for holding this hearing today regarding S. 512, the Nuclear Energy Innovation and Modernization Act (NEIMA).

It has been my pleasure to be part of the team working to develop and advance this important piece of legislation. Thank you, Senator Barrasso, Senator Carper, Senator Whitehouse, Senator Booker and Senator Inhofe, for all of your help and partnership during the past year of working on this measure.

NEIMA is a bipartisan bill that would ensure the Nuclear Regulatory Commission (NRC) could develop an appropriate regulatory framework for licensing a diverse set of advanced reactor technologies. This measure is critically important to ensure the private-public partnerships supporting advanced reactor work at the Idaho National Lab are able to result in advanced reactor designs that have a chance to make it to the market. Such reactors are technologically diverse with different performance features and characteristics. The NRC must have a transparent and predictable process for licensing technology beyond the light-water reactor.

NEIMA also makes important transparency and accountability reforms to the NRC's budget and fee structure. Such reforms will be important to maintaining trust between the industry and the agency should some reactors close prematurely.

Again, it has been my pleasure to work with so many talented Senate colleagues on this measure. I look forward to working with my colleagues in the Senate to enact this legislation. Thank you for the opportunity to share a few words, and thank you to the witnesses for your contributions to this discussion. All of you have very valuable perspectives on this subject, and your assistance with this effort is productive.

Senator BARRASSO. We will now turn and hear from our witnesses. I would like to start with Maria Korsnick, who is president and CEO, Nuclear Energy Institute.

Thank you so much for joining us.

STATEMENT OF MARIA KORSNICK, PRESIDENT AND CEO, NUCLEAR ENERGY INSTITUTE

Ms. KORSNICK. Thank you very much, Mr. Chairman. Good morning. I am Maria Korsnick, President and CEO of the Nuclear Energy Institute. And on behalf of the nuclear energy industry I want to thank the Committee for considering the Nuclear Energy Innovation and Modernization Act. We are very pleased that this bill is being reintroduced and are grateful for the opportunity to testify about the important matters that it brings today.

Our operating nuclear plants are the backbone of the U.S. electric system and a critical part of our Nation's infrastructure. Nuclear energy is the largest and most efficient source of carbon-free electricity in the United States. We currently have 99 reactors in 30 States that produce 20 percent of our Nation's electricity and approximately 63 percent of our carbon-free electricity. Nuclear produces electricity 24/7, regardless of weather, and with all its fuel onsite for 18 to 24 months.

Nuclear energy facilities are essential to the Nation's economy and to the local communities in which they operate. Collectively, the nuclear industry contributes about $60 billion every year to the U.S. economy, supports over 475,000 jobs, and produces over $12 billion a year in tax revenue, both Federal and State.

I am proud to report that since I last testified before this Committee last year, a new reactor has begun to operate in Tennessee. And, as you know, an additional four reactors are under construction, two in Georgia and two in South Carolina, and these are expected to come online in 2019 and 2020. The current nuclear fleet is a significant contributor to the Nation's infrastructure.

The newly constructed plants will likely provide valuable electricity for 80-plus years, and future nuclear innovations in the form of a variety of advanced design reactors are being developed to meet the needs of our society well into the next century.

But, for that to happen, the industry must be able to rely on a safety-focused, efficient, and technically expert regulator. That requires strong and focused leadership from the Nuclear Regulatory Commission.

Because the Senate is responsible for confirming qualified candidates to serve on Federal agencies, we wish to emphasize the importance of maintaining a five-member NRC board. The work of this agency should be conducted as Congress intended, with five commissioners. As the Commission currently has two open seats and potentially faces the lack of a quorum by the end of June, we do urge the Senate to act swiftly on Administration nominations.

We commend the bill's sponsors for taking the NRC's untimely, somewhat outdated and unnecessarily costly, regulatory process. The need to reform has become more pressing as companies are beginning to submit the NRC applications for certification of small modular reactors and development of advanced non-light water reactors are looking for their deployment within the next decade.

For years, the industry has raised concerns regarding the NRC's fee structure, only to be told by the NRC that its hands are tied by the current law. This bill makes several long-overdue changes to the NRC's fee recovery structure. It repeals the 90 percent fee recovery requirement and replaces it with a more predictable, transparent, and accountable fee recovery process that also ensures that the agency continues to be sufficiently funded to carry out its important safety mission. The legislation would create greater accountability and transparency by requiring the NRC to expressly identify annual expenditures anticipated for licensing and for other activities requested by applicants.

The legislation also would help drive greater efficiency in the NRC's operation. In turn, it would drive down annual fees by limiting the corporate support to 28 percent. The industry supports this provision and we believe there is an opportunity to reduce this percentage even further.

Complementing the limit on corporate support, the bill would cap annual fees for operating power reactors at the Fiscal Year 2015 levels. We commend this approach and we strongly believe that the cap should apply to all licensees, including uranium recovery and other fuel cycle facilities.

The bill also affirms Congress's view that this Country can, and in fact should, be a leader in advanced reactor technology. The bill directs the NRC to think differently about reactor licensing. It requires them to accommodate light water reactors, small modular reactors, and advanced non-light water reactors; in short, an all-of-the-above approach.

This bill directs the NRC to resolve the central issue standing in the way of innovation. In sum, we need to start planning today if we are going to meet the enormous demand for U.S. technology at home and abroad.

On behalf of the nuclear energy industry, I would like to thank Chairman and Senators Whitehouse, Inhofe, Booker, Crapo, Fischer, Capito, and Manchin for their commitment to innovation and to retain clean, reliable, and constant nuclear electricity. We look forward to continuing to work with you and your staff as the legislation progresses through the Congress, and I encourage you to enact the legislation expeditiously. Thank you.

[The prepared statement of Ms. Korsnick follows:]

Testimony for the Record
Maria G. Korsnick
President and Chief Executive Officer
Nuclear Energy Institute
Before the
Senate Environment and Public Works Committee
March 8, 2017

The Nuclear Energy Institute (NEI) appreciates the opportunity to provide testimony on the Nuclear Energy Innovation and Modernization Act, introduced on March 2, 2017.

I am Maria Korsnick, President and Chief Executive 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.

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 greater than 90 percent—higher than all other electricity sources. Nuclear produces electricity 24/7, regardless of weather and with all its fuel on site for 18-to-24 months. The long horizon for nuclear fuel procurements also means nuclear generation is not subject to price spikes occasionally experienced by other generation sources in recent years.

Nuclear energy facilities are essential to the country's economy and the local communities in which they operate. The typical operating plant generates $470 million each year in the sale of goods and services in the local community, and employs 700 to 1000 workers. Construction of a new nuclear plant provides in the range of 3500 jobs at peak periods. Collectively, the nuclear industry contributes about $60 billion every year to the U.S. economy, through supporting over 475,000 jobs and producing over $12 billion annually in federal and state tax revenues.

I am proud to report that, since I testified before this Committee last year, a new 1150-megawatt reactor has begun to operate in Tennessee. As you know, an additional four reactors are now under construction—two reactors in Georgia and two in South Carolina. Those reactors are expected to begin production in 2019 and 2020. At this point, the detailed design and engineering has been completed for the AP1000 reactors now being built, and the lessons learned from those projects should be applied by future applicants and licensees as well as the Nuclear Regulatory Commission (NRC). Certainly the authors of the Energy Policy Act of 1992 contemplated that applying the more streamlined NRC combined license process to these first-of-a-kind projects would pave the way for even more efficient regulatory reviews, in turn leading to lower costs and shorter time to market for subsequent projects.

The current nuclear fleet is an integral cog in and significant contributor to the nation's infrastructure given its environmental benefits, local and national economic value, grid support, reliability, and price stability. The newly constructed plants will likely provide this valuable energy for 80 years. And, future nuclear innovations in the form of various advanced design reactors are being developed to meet the needs of our society well into the next century and beyond.

Current operating plants, units now under construction, and plants of the future all must be able to rely on a safety focused, efficient, and technically expert regulator. It is imminently reasonable from the perspective of the industry as well as our nation's energy consumers to expect a regulatory process with those attributes. Those regulatory attributes are also a national imperative, as they directly affect the ability to maintain the diversity of America's energy portfolio. The industry believes that the NRC's untimely, somewhat outdated, and unnecessarily costly regulatory regime needs updating. The need for congressional action directing regulatory reform has become more urgent as companies are beginning to submit to the NRC applications for certification of small modular reactor (SMR) designs, which will be deployed in the mid-2020s, and developers of advanced non-light-water reactors are beginning interactions with the NRC and are looking to deploy their technologies around 2030.

The establishment and implementation of sound regulatory processes requires strong and focused NRC leadership. As the Senate is responsible for confirming qualified candidates to serve on federal agencies, we wish to emphasize the importance of maintaining a five-member Nuclear Regulatory Commission. The work of this agency should be conducted as Congress intended when it enacted the Atomic Energy Act, with five commissioners who each bring to their position knowledge and a commitment to sound agency decision-making. As the Commission currently has two open seats, and potentially faces the lack of a quorum by the end of June, we urge the Senate to act swiftly on Administration nominations. We also urge the Senate to consider adding to its bill a "holdover" provision to avoid the issues that arise when there is a delay in nominating or voting on Commission candidates. In doing so, the Commission could continue (*e.g.*, under a provision that would permit continuation at least until the next Congress) to perform its functions without disruption.

On behalf of NEI and its members, I would like to thank the bill's sponsors for recognizing the need for legislation to reform the NRC fee recovery structure for existing nuclear power plants, and to set the stage for developing and deploying innovative nuclear reactor technologies. I hope you will also consider acting to ensure that all Commission seats are filled.

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

Industry's concerns with the NRC's fee structure date back to the passage of the Omnibus Budget Reconciliation Act of 1990 (OBRA-90). Both NRC and industry identified equity issues with this fee recovery framework. OBRA-90 requires the NRC to recover approximately 90 percent of its budget through fees charged to licensees and applicants.[1] Congress provides the

[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.

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 $265 per hour. The industry is also charged annual fees, which are apportioned among licensee classes to cover the remainder of the agency's budget. This means industry is required to pay fees for many activities that provide no direct benefit to licensees.

Congress attempted to address these fairness and equity issues in the FY 2001 Energy and Water Development Appropriations Act but, by the late 2000s, significant problems with the NRC's fee recovery framework began to surface. Each year since then, in response to the NRC's proposed fee rule, NEI has raised concerns related to the level of fees to be collected and the issues caused by the fee structure. NEI has consistently emphasized the industry's concerns regarding: significant increases in overhead costs, large increases in the NRC's budgets, the failure to account for premature plant closures, and additional states becoming Agreement States without corresponding reductions in the materials program budget. Further, we have identified the need for a firewall between fee-recovery and fee-relief activities.

The NRC has responded to these comments by indicating that its "hands are tied" by the current statutory framework. Fundamental change to the NRC's fee recovery structure is long overdue, and the NRC is not on course to accomplish that change absent congressional direction.

The Nuclear Energy Innovation and Modernization Act would make several necessary changes. It would repeal the relevant provisions of OBRA-90 and replace them with a rational fee recovery process that will also ensure that 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 the bill 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 2020 and FY 2021. The percentage cap on corporate support is to be reduced by 1 percent every two years until reaching 28 percent in FY 2024. The bill thus would help to bring the NRC's spending on corporate support in line with other federal agencies. In an April 2015 congressionally-mandated report, Ernst and Young found that the NRC spends 37 percent of its budget on mission support costs, whereas the NRC's peer agencies spend only 20, 25, and 32 percent of their total budgets on mission support. In response to these excessive overhead costs, 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 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 proposed

increasing the agency's 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). The bill would preclude this type of backsliding by placing the NRC on a glide path to reduce its corporate support to 28 percent gradually by implementing cost reductions such as those already identified by the agency's Project Aim efforts.

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). The misalignment between the NRC's budget and its workload has recently resulted in an annual fee structure that essentially penalizes reactor licensees that continue to operate for another licensee's decision to discontinue operation. The cap on annual fees should mitigate the potential for excessive fees, which will be particularly important if the NRC does not adequately adjust its budget to reflect the declining workload with fewer operating reactors.

It is important to ensure that the NRC and the public understand that a cap on annual fees would not adversely affect safety. The cap in the bill is set at the 2015 fee rule level—among the highest in the NRC's history. This assures that the NRC would have significant resources to carry out its safety and security mission. The annual fee cap also 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. The cap on annual fees would not constrain the NRC's resources in a way that would compromise the agency's safety and security mission, and it appropriately provides for a waiver of the cap in the case of unforeseen and unlikely circumstances. In short, the bill gives the Commission authority to ensure that the cap on annual fees does not impede its mission.

The bill also would provide relief based on equitable considerations. For example, it appropriately prevents the NRC from recovering fees for activities that are not attributable to an existing NRC licensee or class of licensees. Additionally, the bill provides for federal funding for the development of regulatory infrastructure for advanced reactor licensing.

While these fee reforms go a long way toward addressing the problems the industry has identified, we suggest that the Committee add a few additional provisions.

1. The cap on annual fees should be applicable to decommissioning reactors, fuel cycle facilities, and other materials licensees. This would ensure that a reduction in the number of licensees does not increase the fee burden on the remaining licensees, as has been the case for these licensees in recent years. For example, the annual fee for a basic in-situ uranium recovery facility will increase by nearly 80 percent from FY 2012 ($29,900) to FY 2017 ($53,600).

2. The Committee should consider whether to further reduce the 28 percent cap on corporate support to ensure the NRC's overhead is consistent with its peer agencies. A lower cap would limit expenditures on corporate support, thereby encouraging 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. Additional opportunities for corporate support savings by the NRC are not speculative. A February 22, 2017, letter from the NRC Chairman to the Committee identified $8.4 million in corporate support savings the Commission has already approved under Project Aim. The letter also listed nearly a dozen other cost saving activities the NRC could implement in FY 2018 and beyond.

3. The NRC should be required to expressly identify in its budget request anticipated expenditures necessary for each rulemaking and other generic activities. Offering a clear picture of proposed NRC expenditures on each of these activities 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), 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. It is critically important that the U.S. nuclear industry maintain a leadership role in nuclear technology development and contribute to worldwide safety enhancements by continuing to design and build new nuclear plants.

Advanced non-LWR designs must be commercially available by the early 2030s to meet global energy needs. This is a challenging task but one that is necessary to accomplish if the U.S. is to maintain the reliable electricity service Americans now enjoy and meet its clean air commitments. Even at less than 1 percent annual growth in electricity demand, the U.S. Energy Information Administration forecasts a need for 285 gigawatts of new electric capacity by 2040 in the U.S.

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 extended operations between refueling and consumption of nuclear waste as fuel, reducing 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 strategic importance of U.S. nuclear technology development and sales should not be underestimated. A nuclear power plant is an enduring asset that forges a special century-long relationship between the host country and the nation that supplies the reactor and later the fuel, major components, operations, maintenance, and security services.

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 appreciate Congress' recognition of the challenges facing advanced reactor development. 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, activities needed to license advanced reactors must be a high priority. We highlight several of the ways in which the bill can advance Congress' and the industry's vision.

- The bill would require the Commission to establish performance metrics for licensing activities and would require that the NRC staff inform the Commission of delays in issuance of final safety evaluations.

- The bill would require the NRC to develop and implement enhanced strategies within 270 days for establishing stages in the licensing process for design approval. This will establish 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 enables developers to be coordinate financing and capital investments with achievement of each stage. Further, because perceptions regarding regulatory risk increasingly have become an impediment to new reactor development, successful completion of specific licensing milestones should reduce concerns about regulatory uncertainty. While a staged licensing process could provide significant benefits for some developers, its use should be optional, not mandatory. 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 that choose to build a research or test reactor before a commercial reactor 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. It directs the agency to develop and implement strategies within two years to increase the use of risk-informed, performance-based licensing evaluation techniques and guidance within the NRC's existing regulatory framework. This should lead to a more efficient regulatory process that will encourage continued private sector investment in advanced reactor development.

- Because advanced reactor technologies will need to be commercially available 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 2024. 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 to support the development of advanced technologies. As proposed, however, this program only addresses NRC-fees. We support the establishment of a broader cost-share program that would also support development of the license applications for advanced technologies.

Baffle bolt and emergency preparedness

The industry recommends that the Committee reconsider the need for the baffle bolt and emergency preparedness provisions. With regard to the baffle bolt issues that arose in 2016, the NRC has independently reviewed the affected units' analyses, inspections, and bolt-replacement plans to ensure safety. Ultimately, the NRC determined that the reactors were safe to operate. With regard to the emergency preparedness provision, we note that all nuclear power plants have comprehensive on-site and off-site emergency response plans and licensees routinely incorporate lessons learned from data and events. Further, this area already is closely regulated by NRC and the Federal Emergency Management Agency.

Uranium recovery, transfers, and sales

The bill directs the NRC to study the safety and feasibility of increasing the length of uranium recovery licenses from 10 to 20 years. This will reduce the costly burden of renewing the license every 10 years to continue operation. As uranium recovery is the lowest risk sector of the nuclear fuel cycle, consideration should be provided to increase the license length up to 40 years. A 40-year license period is consistent with other fuel cycle facilities and operating power reactors.

The bill also directs the NRC to evaluate the duration of licensing actions and areas to improve the efficiency and transparency of licensing reviews. This is a necessary step because the uranium recovery industry has faced excessive costs and lengthy reviews on issues not related to technical concerns but, rather, due to reinterpreted safety standards and increased costs of environmental and cultural resource reviews.

We support the initiation of a pilot program to establish a flat-fee structure for uranium recovery licensees. The flat-fee structure is a welcome first step and should be quickly implemented to help resolve invoicing and other issues.

The bill also addresses DOE's excess uranium inventory. The industry supports the timely and efficient cleanup of all of the Department's facilities, including the gaseous diffusion plants. We have previously recommended that the cleanup efforts be fully funded through congressional appropriations rather than a combination of congressional appropriations and bartering of excess uranium inventory, and have urged the Department to request sufficient funding for the cleanup efforts to proceed on the Department's desired schedule.

Conclusion

On behalf of NEI and its members, I wish to thank the bill's sponsors for reintroducing this important legislation. Passage of the Nuclear Energy Innovation and Modernization Act will benefit all Americans by helping to retain the energy diversity and clean air benefits nuclear plants provide. The legislation also will ensure that these economic engines can continue to be the backbone of the nation's electric infrastructure and, looking forward, will facilitate the development and deployment of innovative nuclear reactor technologies. We look forward to working with members of Congress to obtain enactment of this bill into law.

Senator BARRASSO. Well, thank you very much for your thoughtful testimony.

Dr. FINAN.

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

Ms. FINAN. Thank you, Chairman Barrasso, Ranking Member Carper, and distinguished members of this Committee. 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, a nonprofit 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 the emergence of a 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 drastically reduce global carbon emissions if we are to avoid the worst impacts of climate change, and clean air is essential to human health.

A more rapid expansion of nuclear power is a vital part of the solution. In the United States and elsewhere, dozens of innovative startup companies are pioneering advanced nuclear designs that offer opportunities for increased safety and affordability, resistance to proliferation, and a reduction in nuclear waste. These designs can revolutionize the nuclear industry and revitalize U.S. exports with products that take advantage of the latest manufacturing and competing technology, that are competitive in markets across the globe, and that exceed the expectations of customers and the public. 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 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 use novel operating approaches.

Over the past 3 years, the NIA has been developing strategies to facilitate the efficient, cost-effective, and predictable licensing of advanced nuclear power plants in the U.S. 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 some of our work into a report called Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing, which was issued in April 2016. The report has been provided to the Committee and is available to the public on the NIA website. It dis-

cusses 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 methods to provide an exhaustive safety review. The Nuclear Energy Innovation and Modernization Act, or NEIMA, provides for the NRC to do work in this area without impacting the costs incurred to the existing plants.

To address the investment challenge, the NIA recommends that the NRC offer a staged approach, one that would be more aligned with private sector development of innovative technology using a licensing project plan, topical reports, and other existing mechanisms; and one that would offer clear and early feedback to investors and developers through an optional conceptual design assessment. 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.

This approach can be achieved using existing regulatory tools at the NRC, with some adjustments on the development of additional guidance. The NRC has already begun doing this work, and has made considerable progress in the past year, but they have done so with extraordinarily limited resources. NEIMA authorizes the NRC to do the crucial work to further develop and implement this staged licensing process with dedicated funding.

When NEIMA was first introduced in this Committee in 2016, the bill was subjected to useful critiques and several concerns were raised and addressed. It ultimately passed out of Committee with strong bipartisan support. The bill under consideration today is stronger for that and I hope that the same support will be evident in 2017.

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. The Nuclear Energy Innovation and Modernization Act 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.

[The prepared statement of Ms. Finan follows:]

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

Before the U.S. Senate Committee on Environment & Public Works

Enabling Advanced Reactors
For a Legislative Hearing on the Nuclear Energy Innovation and Modernization Act
March 8, 2017

Summary of Testimony

Chairman Barrasso, Ranking Member Carper, and distinguished members of this committee, 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 drastically reduce global carbon emissions if we are to avoid the worst impacts of climate change, and clean air is essential to human health.

A more rapid expansion of nuclear power is a vital part of the solution. In the United States and elsewhere, dozens of innovative start-up companies are pioneering advanced nuclear designs that offer opportunities for increased safety and affordability, resistance to proliferation, and a reduction in nuclear waste. These designs can revolutionize the nuclear industry and revitalize U.S. exports with products that take advantage of the latest manufacturing and computing technology, that are competitive in markets across the globe, and that exceed the expectations of customers and the public. 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 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 use novel operating approaches.

Over the past three 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 some of our work into a report called "Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing," which was issued in April 2016. 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.

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To address the investment challenge, the NIA recommends that the NRC offer a staged approach – one that would be more aligned with private sector development of innovative technology using a licensing project plan, topical reports, and other existing mechanisms; and one that would offer clear and early feedback to investors and developers through an optional conceptual design assessment. 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.

This approach can be achieved using existing regulatory tools at the NRC, with some adjustments and the development of additional guidance. The NRC has already begun doing this work, and has made considerable progress in the past year, but they have done so with extraordinarily limited resources. NEIMA authorizes the NRC to do the crucial work to further develop and implement this staged licensing process with dedicated funding.

When NEIMA was first introduced in this Committee in 2016, the bill was subjected to useful critiques and several concerns were raised and addressed. It ultimately passed out of committee with bipartisan support. The bill under consideration today is stronger for that and I hope the same support will be evident in 2017.

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. The Nuclear Energy Innovation and Modernization Act 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 Barrasso, Ranking Member Carper, and distinguished members of this committee, 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, and clean air is an essential ingredient for human health.

A more rapid expansion of nuclear power, though a vital 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.

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

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

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.

Figure 1 illustrates the investment challenge showing 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

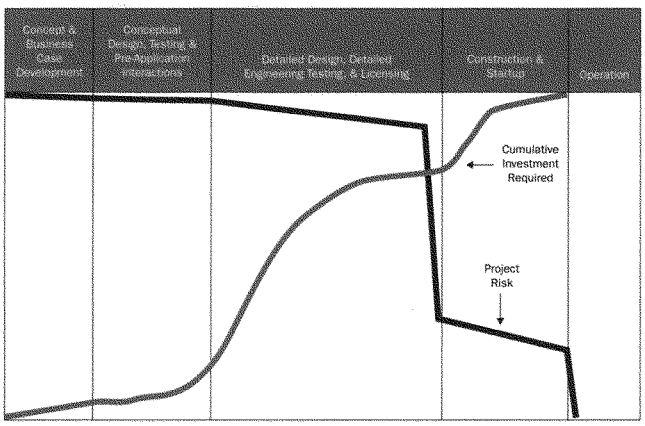
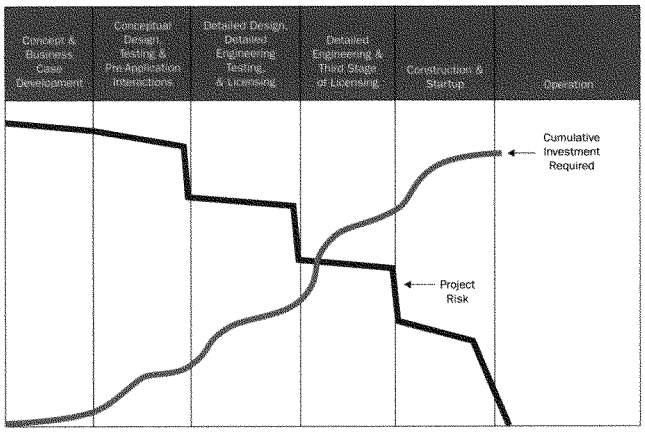


Figure 2 illustrates a staged approach – one that would update the current process to be more aligned with private sector development of innovative technology using a licensing project plan, topical reports, and other existing mechanisms; and one that would offer clear and early feedback to investors and developers through an optional conceptual design assessment. 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



This approach can be achieved using existing regulatory tools at the NRC, with some adjustments in the NRC's approach and the development of additional guidance. The NRC has already begun doing this work, and has made considerable progress in the past year, but they have done so with extraordinarily limited resources. NEIMA authorizes the NRC to do the crucial work to further develop and implement this staged licensing process with dedicated funding.

Over the past three 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 some of our work into a report called "Enabling Nuclear Innovation: Strategies for Advanced Reactor Licensing," which was issued in April 2016. 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 report offers the following nine regulatory, three policy, and four industry 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.

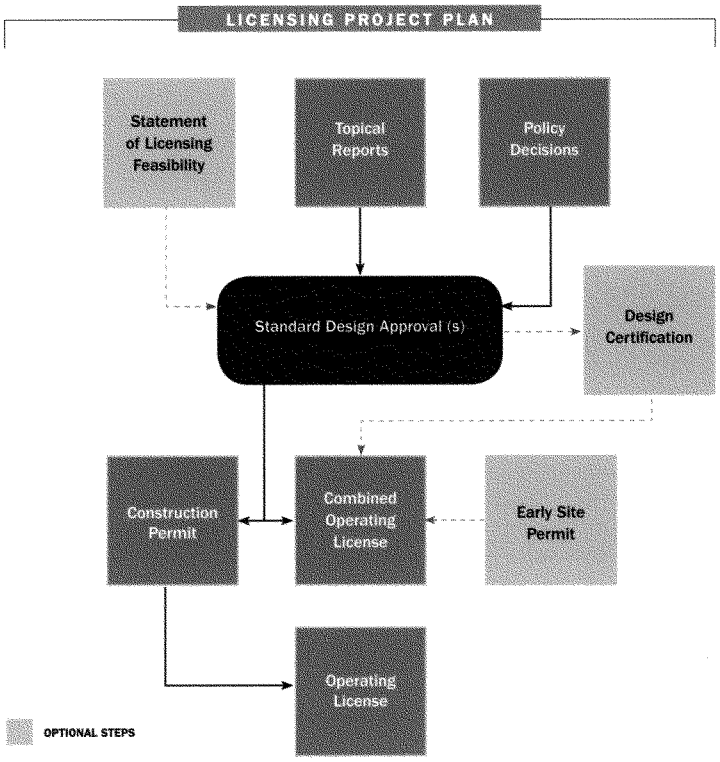
(2) The NRC should promote and applicants should use topical reports and the standard design approval as tools to introduce stages into the advanced reactor licensing process, while emphasizing the need to achieve a level of finality that supports staged decision making. These tools can be employed under 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[2] 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.

[2] The NRC is pursuing a "Conceptual Design Assessment," (CDA) which serves the purpose of the suggested "statement of licensing feasibility." The NIA supports the CDA as a substitute.

Figure 3: Elements of a Staged Licensing Process[3]



(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

[3] The NRC is pursuing a "Conceptual Design Assessment," (CDA) which serves the purpose of the suggested "statement of licensing feasibility." The NIA supports the CDA as a substitute.

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.[4] 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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[4] 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.

Over the past year, the NRC and industry have made significant progress in addressing the recommendations above, as well as in other areas. The NIA applauds that progress and appreciates the work being done at the NRC. However, the NRC has undertaken this work with extraordinarily limited resources that will not be sufficient to complete the tasks in the needed timeframe. The Nuclear Energy Innovation and Modernization Act will make it possible for the NRC to continue, to accelerate, and to expand the work that the agency has begun, in order to support advanced reactor licensing in the U.S.

Additional Detailed Comments on S.512: Nuclear Energy Innovation and Modernization Act

Section 103: Advanced Nuclear Reactor Program:

1. Staged Licensing: The need for staged licensing varies depending on a project's level of technology risk, stage of development, and phase of investment. While incremental licensing options will be crucial for some projects to move forward successfully, there are others for which speed, not risk reduction, is the highest priority, and others that are ready to proceed immediately, before the staged licensing options are fully developed at the NRC. For these latter categories of projects, it is important that a staged approach be optional, and that the existing "all in one" process continues to be available. Particularly in the case of companies currently pursuing licensing, it is imperative that their process does not change midway through their engagement with the NRC. The NIA believes it is the intent of NEIMA to offer the option of staged licensing without removing the existing options, but would support language adjustments to ensure that this is the effect of the legislation.

2. Reporting Requirements: Because the NRC currently has very limited resources to address advanced reactor licensing, it is worthwhile to ensure that NEIMA requests reports only where they are clearly useful. The NIA would support efforts to evaluate where reporting requirements might be reduced without negatively impacting progress or oversight. In particular, given the progress that the NRC has already made and the documents that they have published on this topic in the past year, the "report to establish stages in the commercial advanced nuclear reactor licensing process" may not be necessary, and the NIA would support removing this reporting requirement.

Section 203: Uranium Transfers and Sales:

This section usefully seeks to address concerns that DOE uranium sales are having a negative impact on the private market, and that the government is not capturing appropriate value for its fuel. The NIA supports this effort, but is concerned about an unintended consequence: the limits on DOE uranium sales could constrain advanced nuclear development by restricting the materials needed to produce advanced reactor fuels. There is currently no active domestic enrichment capability for low-enriched uranium above 5% enrichment, so DOE would not be competing with or displacing market participants by providing >5% LEU in the near term. In fact, DOE uranium supply will serve an important role as a bridge until a private capability has been established. Several companies are interested in providing this supply in the future, but all would need to see some successful advanced reactors prior to making the necessary investments. A bridge supply of fuel will be needed to support some of the early movers in the advanced reactor space before commercial enrichment capacity is developed. We believe this issue could be addressed by changing the language so that the restrictions do not apply to low enriched uranium sales for fuels with enrichment between 5% and 20%.

There may also be an opportunity to expand this section to include measures that would help to ensure such a bridge supply and supporting transportation methods are established for advanced reactors, and the NIA would be pleased to offer detailed suggestions if those would be useful to the Committee.

Conclusion

The Nuclear Energy Innovation and Modernization Act 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. With a few adjustments to avoid unintended consequences, NEIMA will play a critical role in bringing promising new technologies to commercial reality.

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*

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Amir Afzali, *Southern Nuclear Company*
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Gilbert Brown, *UMass Lowell*
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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*
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Josh Freed, *Third Way*
Kirsty Gogan, *Energy for Humanity*
Jeff Harper, *X-Energy*
Jane Hotchkiss, *Energy for the Common Good*
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Marilyn Kray, *Exelon*
Jessica Lovering, *The Breakthrough Institute*
Sam Mar, *Laura and John Arnold Foundation*
David B. Matthews, *NEC, Inc.*
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Paul Roege, *Creative Erg*
Robert Schleicher, *General Atomics*
Sam Shaner, *Massachusetts Institute of Technology*
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 Nuclear Innovation Alliance and as a Project Director for Clean Air Task Force. 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.

Senator BARRASSO. Thank you very much for your testimony, Dr. Finan.

I am glad you could join us today. I would like to next turn to Dr. Tina Back, who is Vice President of Nuclear Technologies and Materials at General Atomics.

Welcome.

STATEMENT OF DR. TINA BACK, VICE PRESIDENT OF NUCLEAR TECHNOLOGIES AND MATERIALS, GENERAL ATOMICS

Ms. BACK. Chairman Barrasso, Ranking Member Carper, thank you very much for the invitation to appear here today. I also thank the bipartisan group of Senators for introducing the Nuclear Energy Innovation Modernization Act, NEIMA, and for their interest in advanced nuclear reactors.

General Atomics is a high technology company that has long history of innovation in nuclear energy, which is detailed in my written testimony. Our long-term vision is embodied in GA's advanced reactor concept, the Energy Multiplier Module, or EM2. It has arisen from RD&D, Research, Development, and Demonstration, which has informed and shaped our beliefs of what nuclear innovation can achieve.

In the near-term, the vision is brought into sharper focus through projects such as Accident Tolerant Fuel, ATF, and Moly 99. ATF makes existing reactors less subject to a Fukushima-like event and more economically viable. The Moly 99 project establishes a domestic source of a medical isotope. Ultimately, both grew out of EM2 research and development and, in return, both deepen the skills and understanding needed to make EM2 a reality.

It might be helpful to explain why we believe nuclear power is critical for the energy future and the national defense of the U.S.

Nuclear power is the largest source of baseload clean energy available to our Nation.

At present, there are no U.S.-owned commercial vendors of nuclear reactors. Furthermore, the supply chain of nuclear grade materials and components has either gone offshore or gone out of business. This is in stark contrast to vigorous nuclear industries in China, Russia, and Korea. Unless the U.S. is able to stimulate its near-dormant nuclear industry, we will be one of their future customers.

On the bright side, there is a strong, nascent effort in U.S. private industry to innovate nuclear technologies. NEIMA will help us do that. There are many concepts that require different materials and technologies to advance beyond the light water reactors of today, all of which need NRC approval. The NRC is an important and necessary agent in ensuring nuclear power remains safe.

If the U.S. is to proceed, it will require the support of our Government through regulatory support like that proposed in NEIMA and also through financial support of R&D. It may also benefit from mechanisms like public-private partnerships to foster new generations of nuclear scientists and domestically held intellectual property.

For the U.S. to be a leader in nuclear energy, General Atomics believes our Country must do what it does best, bring the ingenuity

of the people to bear on creating new ways to produce nuclear energy safely, cleanly, and at much lower cost.

So what exactly are nuclear reactors that are advanced? Advanced reactors are those that improve over existing reactors in the following four core objectives: they must produce significantly cheaper and cleaner electricity; be safer; produce significantly less waste; and reduce the risk of proliferation.

These seven improvements identified in NEIMA are consistent with these core objectives. We believe every worthy advanced reactor concept must address these four core objectives jointly. It is not sufficient to address one at the expense of the other three.

My written testimony provides details on how EM2 leverages engineered ceramic materials and leapfrog technologies to meet these four core objectives.

As with any new reactor design, this one will require extensive interactions with the NRC. Ideally, interactions would occur early enough to inform the initial design and produce a safer reactor design. Then, when applying for a license, this early effort would pay off many times over.

Radically new concepts employing new technologies require upfront investments involving some risk. Some 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 more than $40 million in EM2, these commercial realities make it very difficult to justify early costs to engage the NRC.

If the Committee's objectives are to stimulate development of advanced reactors and technologies, then we suggest it would be relatively inexpensive to involve NRC in the early phase of development for potentially high impact. We suggest the Committee authorize the appropriation of $5 million at first, growing to $15 million over 5 years, to provide the NRC services. To trigger funding, a relatively low cost-share of 3 percent could be required.

Thank you for your interest, and I hope that you can all come to San Diego and visit our facilities. There you could see our science in action and understand why we at GA are so optimistic about the future of advanced nuclear reactors. We are at the cusp of some significant scientific discoveries that are within the reach, with a bit of Government support.

I would be pleased to respond to any questions.

[The prepared statement of Ms. Back follows:]

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 "Hearing on S.512
Nuclear Energy Innovation and Modernization Act"
March 8, 2017

Chairman Barrasso and Ranking Member Carper, 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 high technology company that has successfully brought solutions to the defense, aeronautics, space, and energy industries. More specifically, my division has a long history of innovation in nuclear energy, starting with the TRIGA reactor in 1956, High Temperature Gas-Cooled Reactors (HTGRs) including the Peach Bottom 1 and Ft. St Vrain power plants, conversion of test reactor fuel from high to low enriched uranium to meet the Global Threat Initiative goals, and more recently to development of the EM^2 advanced reactor, Accident Tolerant Fuel, and novel production of the medical isotope, Molybdenum 99. Today, we remain committed to developing and implementing clean and safe nuclear energy technologies.

A healthy nuclear power industry is essential to the long-term energy security of the United States and it is indirectly essential to our national defense. Nuclear power has been identified as an essential part of our nation's energy mix and it is the largest source of reliable, clean energy available to our nation. Unfortunately, the principal technology employed by the industry, light water reactors, has remained stagnant since the 1970's with the consequence that it is no longer an economically competitive energy source in this century. Our existing nuclear plants have an average age of around 50 years. Nearly all will be shutdown by mid-century and many plants operating in unregulated markets either have been retired early or risk early retirement due to inability to compete with other advanced energy technologies.

At present, there is no U.S.-owned commercial vendor of nuclear power reactors and the supply chain of nuclear-grade materials and components has either gone off-shore or gone out of business. This is in contrast to vigorous nuclear industries in China, Russia, and Korea which have large internal markets for their products and have ambitious plans for export. Unless the U.S. is able to stimulate its near-dormant nuclear industry, the U.S. will be one of their customers in the future.

On the bright side, there is a strong, nascent effort by private industry to innovate new nuclear plants that can be more cost-effective, safer, use less energy resources and produce less waste. But nuclear development is very expensive. No private industry can justify this investment with such a long payback. If the U.S. is to proceed with the development of new advanced nuclear technologies, it will require the support of our government.

The country will benefit by increasing, not decreasing, the fraction of nuclear energy in the mix of energy sources powering our industries and homes. 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. Moreover, being the technology leader in nuclear energy is critically important to minimize foreign dependence and strengthen national security.

Today's nuclear reactors that use existing technology are 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.

This legislation is timely, and critically relevant, because there are many advanced reactor concepts that need different materials and require different technologies to advance beyond the light water reactors of today, all of which will need approval as they are developed.

As the Vice President of Nuclear Technologies and Materials at General Atomics, I lead a team of scientists working to solve the challenges facing the nuclear energy industry. Specifically, this work focuses on "advanced reactors" and the advanced materials necessary to make these reactor concepts, and the nuclear industry at large, a cost-competitive reality.

In order to be helpful to the Committee, I would like to define the term "advanced reactors," as it has previously been used interchangeably for a number of reactors. Some classify any non-light water reactor, such as a gas-cooled, sodium-cooled, or molten salt-cooled reactor as "advanced." Others use the term to refer to a new light water reactor, such as a Small Modular Reactor (SMR).

Ultimately, nuclear energy involves splitting an atom and using the heat energy released, to turn a generator to produce electricity. What matters most in our discussion of advanced reactors is that electricity is a commodity, and most consumers care about one thing above all else: cost. The source of the energy, whether it is made from nuclear fuels or from burning coal or gas, or from renewables, is of secondary concern.

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

- produce significantly cheaper and clean electricity
- be safer
- produce significantly less waste and
- reduce proliferation risk

These four objectives 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 objective, cost-competitive electricity. Fuel utilization is intertwined with the third objective, less waste. We believe every worthy advanced reactor concept must address these 4-core objectives jointly, it is not sufficient to address one at the expense of the other three, especially cost.

General Atomics is developing a reactor concept, called the Energy Multiplier Module or EM^2, that uses engineered materials and leapfrog technologies, ensuring that the reactor is safer, less waste producing and more proliferation resistant. We kept a laser focus on the commercial

application of the reactor and focused on cost-competitiveness, the most challenging of the four core objectives. While the other three objectives are of importance, if we cannot create cost-competitive advanced reactors, the reactor will not make it into the market.

In EM^2, we take advantage of the unprecedented advances in the understanding of materials over the past three decades to engineer and manipulate materials for our nuclear energy application. Our long-term vision for what nuclear innovation can achieve is embodied in EM^2 and our strategy is to approach that end by delivering nearer-term technologies, such as Accident Tolerant Fuel to demonstrate new materials, and Molybdenum 99 development to exercise new technologies. Modernization of the regulatory process, the intent of this legislation, will clearly be needed to realize the benefits of advanced reactors as well as the nearer-term technology innovations.

Now I will go through each of the objectives to illustrate what is possible with new materials and technologies. 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, as in Accident Tolerant Fuel, 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 have been promising so far. 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 percent of the fuel and produce only 20 percent 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.

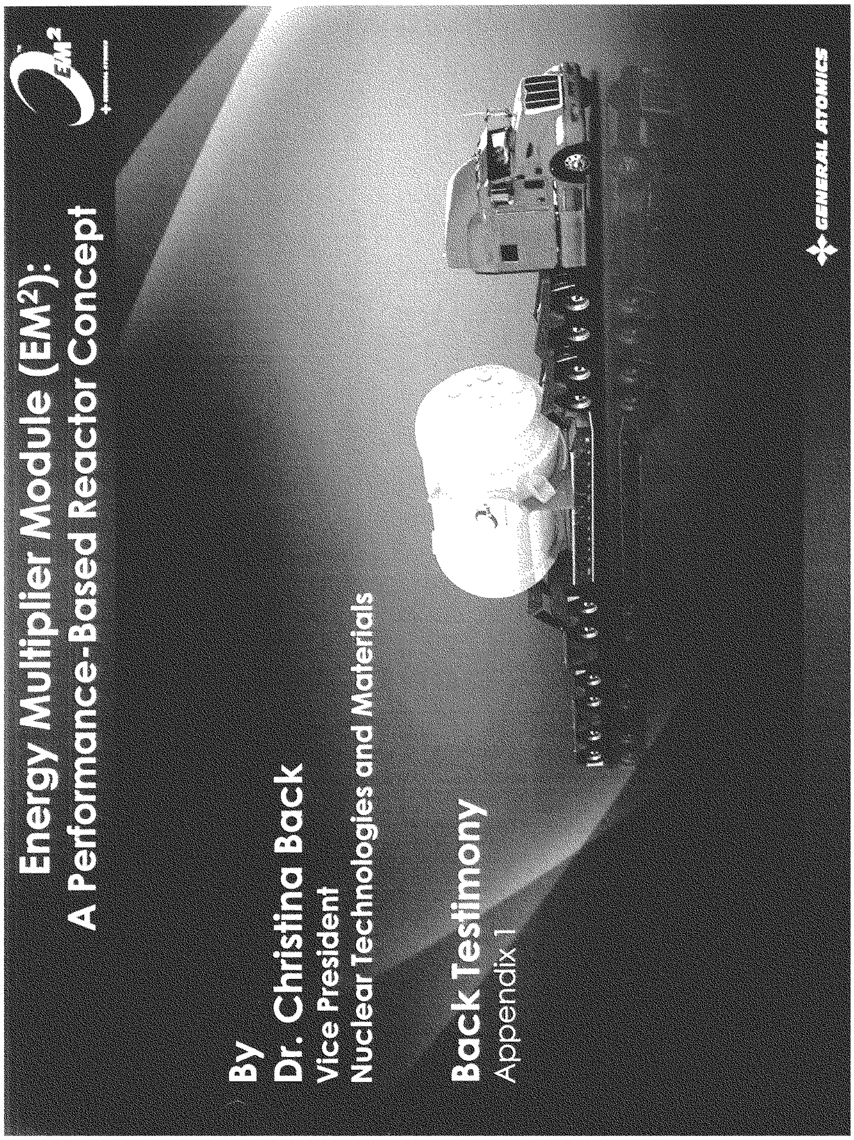
Radically new concepts that employ new technology require upfront investments involving some risk. Some of these investments may not pay off, and even those that are successful could require at least 10 years to produce any revenue. While General Atomics has already invested $40 million in the EM^2 concept,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

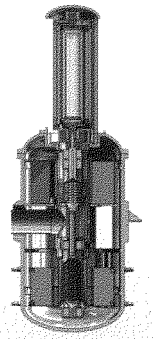
While outside of this Committee's jurisdiction, we also believe that a public-private partnership is necessary to achieve the goal of advanced reactors. The advantages of this approach are noted in the recent Secretary of Energy Advisory Board Task Force Report on the Future of Nuclear Power. Although such an effort would require a significant investment on the part of the federal government, it would yield benefits including: a new generation of nuclear scientists, domestically held intellectual property, and a cost-effective means for producing pollution-free baseload power that increases safety, reduces waste, and is proliferation-resistant.

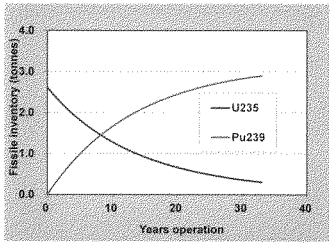
Thank you for your interest in this subject, and this opportunity for me to appear before you. The excitement of discovery in science and the satisfaction of making a safe and more efficient reactor keeps me engaged and eager to continue to push the boundaries of science and harness the energy in the nucleus. The NRC is an important and necessary agent in ensuring nuclear power remains safe. Therefore, it plays a critical role in nuclear power innovation. I would be pleased to respond to any questions you may have.

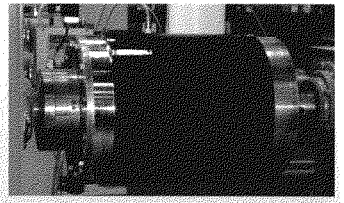

Energy Multiplier Module (EM²):
A Performance-Based Reactor Concept
By
Dr. Christina Back
Vice President
Nuclear Technologies and Materials
Back Testimony
Appendix 1
GENERAL ATOMICS

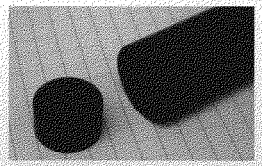
New Technologies at General Atomics Are Key to Competive Nuclear Energy in the United States

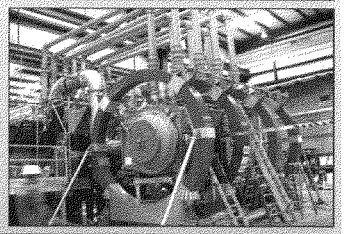
- Convert-and-burn core physics
- Silicon carbide composite structures
- Advanced fuels
- High temperature systems
- Asynchronous, high-speed compact generators
- Proliferation resistant used fuel recycling







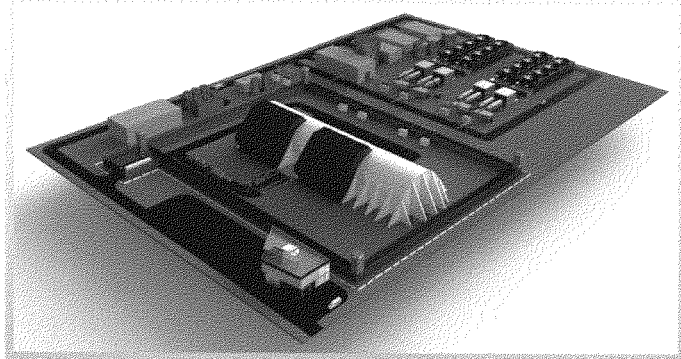




GENERAL ATOMICS

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

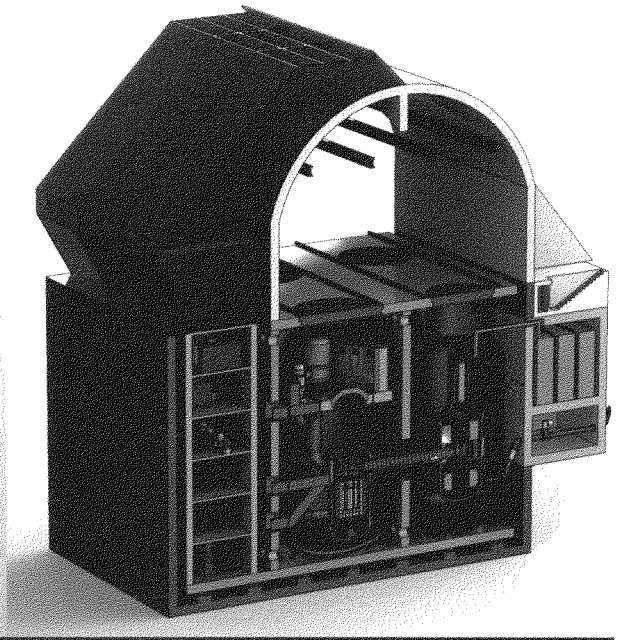


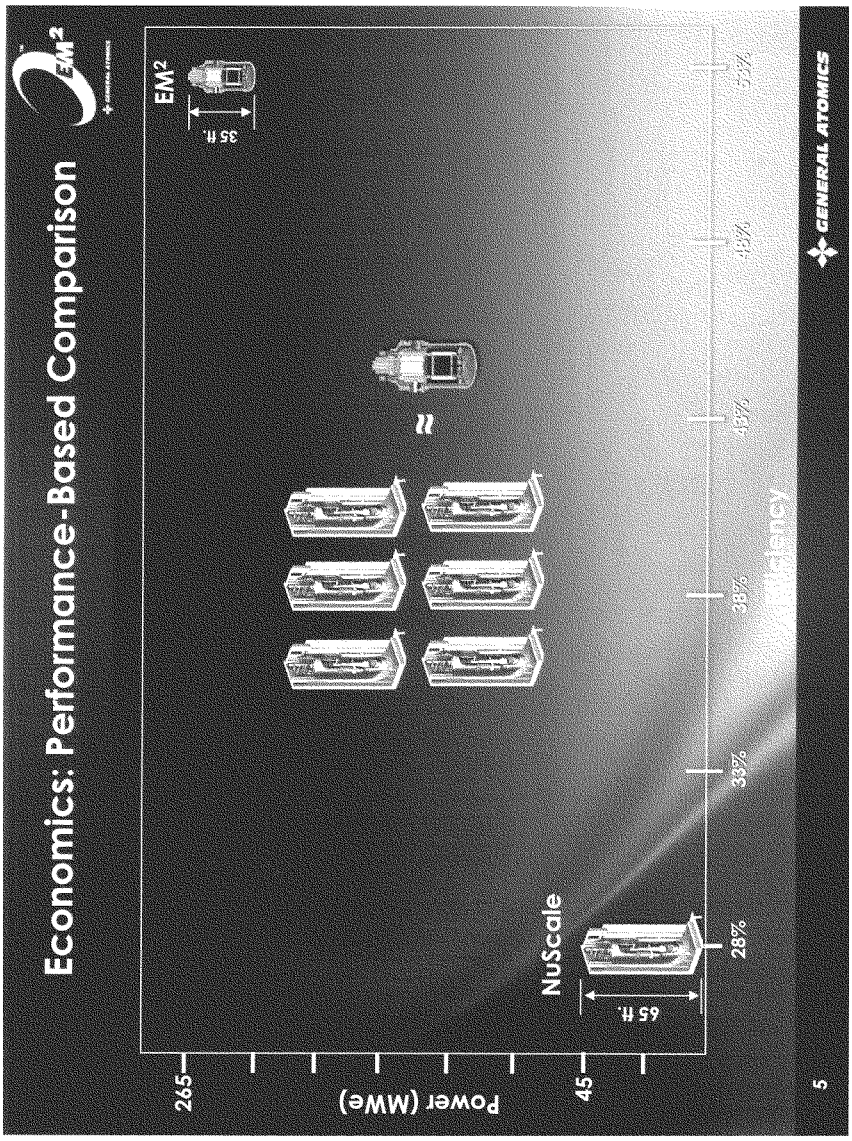
1060 MWe EM^2 plants fits on 9 hectares

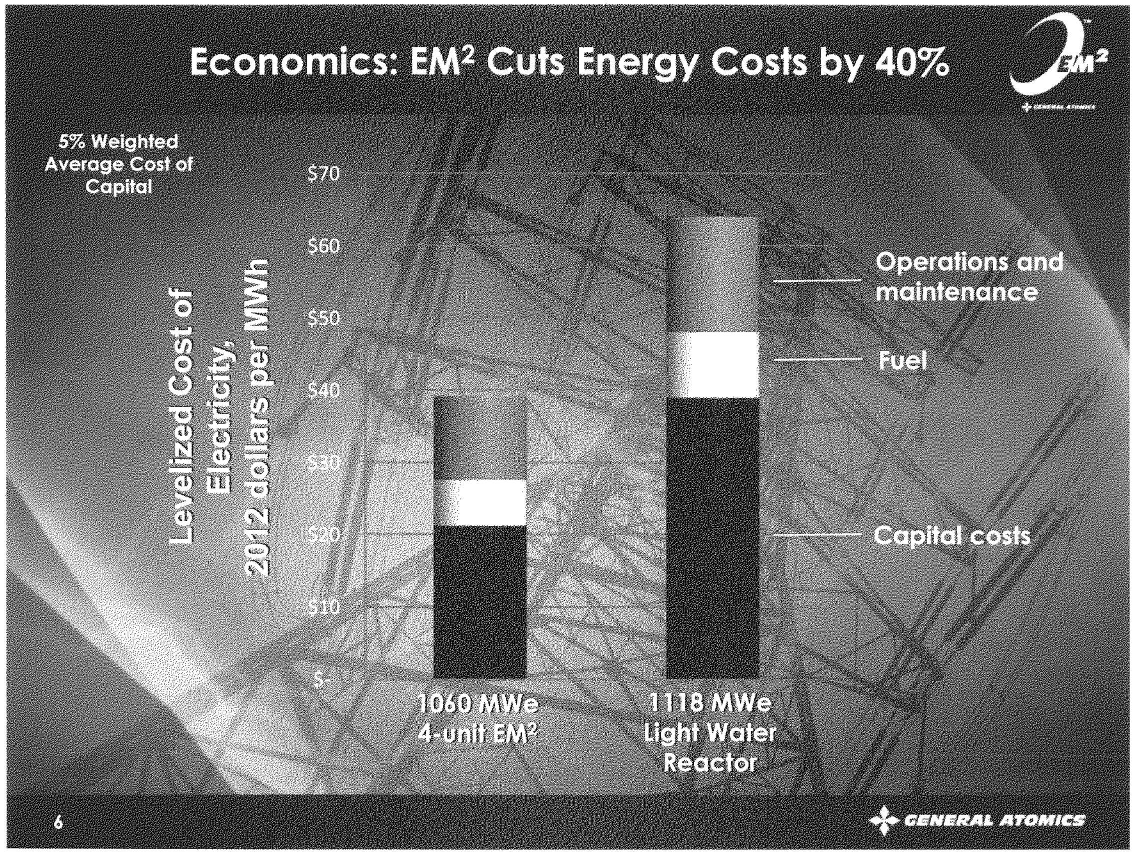
- 30-year fuel life – high burnup
- Multi-fuel capable
- Reduced waste stream
- Cost competitive
- Flexible siting, no need for water cooling
- Rapid load following
- Higher efficiency – 53% net

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**




Economics: Performance-Based Comparison
EM²
Power (MWe)
265
45
NuScale
65 ft.
EM²
35 ft.
28%
38%
38%
48%
48%
53%
Efficiency
GENERAL ATOMICS
5


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
$-
1060 MWe 4-unit EM²
1118 MWe Light Water Reactor
Operations and maintenance
Fuel
Capital costs
6
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)

Molten salt (600°C)

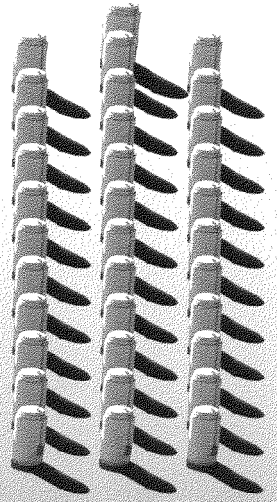
Lead-bismuth (500-600°C)

Sodium (550°C)

Light Water (LWR) (300°C)

Waste Reduction: Benefits from High Temperature and Radiation Resistant Materials

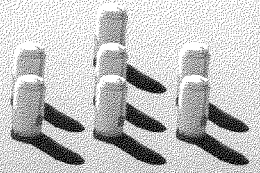
One LWR produces ~600 tonnes of nuclear waste over 30 years



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

- $\frac{1}{1.6}$: 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%

GENERAL ATOMICS

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

Dr. Christina Back has 28 years of experience leading research in private industry and U.S. Department of Energy (DOE) laboratories, including the DOE weapons complex. She is an internationally recognized expert 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, is a Fellow of the American Physical Society and is frequently invited to provide expertise for U.S. Congressional Committees and White House Science and Technology initiatives.

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

Dr. Back has received numerous awards for her many noted contributions to the field, 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 BARRASSO. Well, thank you very much, Dr. Back, for your thoughtful testimony. We appreciate you being here.

I would like to next turn to Dr. Edwin Lyman, who is the Senior Scientist for the Union of Concerned Scientists Global Security System.

Dr. Lyman, thank you for joining us today.

STATEMENT OF DR. EDWIN LYMAN, SENIOR SCIENTIST, UNION OF CONCERNED SCIENTISTS GLOBAL SECURITY SYSTEM

Mr. LYMAN. Thank you. Good morning. On behalf of the Union of Concerned Scientists, I would like to thank Chairman Barrasso, Ranking Member Carper, and the other distinguished members of this panel for the opportunity to testify today on NEIMA and its potential impacts on nuclear safety and security in the future.

UCS puts rigorous, independent science to work to solve our planet's most pressing problems. We are neither pro-nor anti-nuclear. But we do believe that nuclear power must meet high standards of safety and security if it is to be a reliable option in the future.

This Saturday marks the sixth anniversary of March 11, 2011, the day when a massive earthquake and tsunami in Japan triggered the triple core meltdowns at the Fukushima Daiichi nuclear plant. We know when the disaster started, but we cannot predict when it will end, because its legacy will affect the Japanese people for decades to come.

Today, the direct economic impact is estimated at almost $200 billion, approximately 80,000 people remain displaced from their homes, contaminated water continues to flow from the site into the sea every day, and the interiors of the three damaged reactors are so intensively radioactive that even the robots sent in to explore are quickly disabled by the radiation.

The accident had a significant impact on Japan's use of nuclear power. It now only has three operating reactors, and it pays handsomely for imported natural gas to meet its electricity demand. A similar accident in the U.S. would almost certainly compromise the future of nuclear power in this Country.

Fukushima serves as a graphic reminder of the consequences of complacency. The nuclear industry and its regulators seriously underestimated the risk from natural disasters and did not adopt safety measures strong enough to mitigate those risks, so the urgent need to ensure such a nuclear disaster does not happen again provides the context for my remarks today.

UCS testified on an earlier version of this bill last year. The current version of the legislation has some changes that we believe have improved it, and, as a result of those changes, we do not oppose the bill. But neither do we support it, because we still find its basic approach problematic from a safety and security perspective. We also question the need for the legislation. We don't believe it is going to be effective in actually facilitating the deployment of advanced reactors.

One of our main concerns is the promotion of a "risk-informed" licensing strategy. We do not believe that risk-informed licensing is appropriate for new and novel designs. The computer models used to calculate risk need to be thoroughly validated by comparison of

results with actual plant operating experience before you can rely on them to do licensing, and such experience is not available for new reactor concepts.

To focus licensing on new reactor designs is to introduce an unacceptably high degree of uncertainty in the process. So in this light we appreciate that the current version of NEIMA requires that NRC develop strategies for implementing risk-informed licensing only where appropriate. And this phrase effectively provides the NRC with full discretion to confine the use of risk-informed licensing to those areas where it determines it is appropriate, and it is our expectation that there will be few, if any, aspects of advanced reactor licensing where they will make that determination.

There is also a question about which designs may clearly fall under NEIMA's definition of "advanced reactor." I agree with Dr. Back that advanced reactors should improve upon the current generation in a whole variety of different ways, and that there should not be tradeoffs of one improvement for another.

But, in our assessment, none of the advanced reactor designs that are currently under discussion, at least non-light water reactors, actually will achieve that. Liquid metal-cooled fast reactors, high-temperature gas-cooled reactors, and molten salt reactors all introduce new and novel safety and/or security issues relative to light water reactors that may ultimately outweigh any improvements they provide. And this is also true for small modular light water reactors like NuScale.

For example, deployment of any advanced reactor that requires reprocessing and separation of plutonium or other weapon-usable materials will increase the risks of nuclear terrorism and nuclear proliferation, and that includes any reactor that claims they can consume spent fuel for electricity. So I would really recommend the Committee look deeper into what it means to actually consume spent fuel.

The Transatomic Power reactor is an example. The company promoted the idea that its molten salt reactor could consume spent fuel, and actually they had to backtrack recently when it turns out their analysis was wrong.

This isn't to say that TAP is necessarily a failure, but it illustrates the development of advanced reactors cannot be rushed and that early optimism may well be tempered by later results.

It takes a long time and a lot of money to develop advanced nuclear reactors, and a number of studies have demonstrated that. NRC licensing is not the chokepoint or the bottleneck in that process; it is the need to develop the necessary technical basis to convince the regulator that a reactor design is safe. And you can't short-circuit that process, so that is the main reason why we are concerned about the emphasis of this bill in trying to accelerate or bypass the critical safety functions of the agency?

I will conclude there, and I appreciate and welcome your questions. I apologize for exceeding my time. Thank you.

[The prepared statement of Mr. Lyman follows:]

Testimony of Edwin Lyman, PhD

Senior Scientist, Union of Concerned Scientists

On

The Nuclear Energy Innovation and Modernization Act."

Before the

Committee on Environment and Public Works

U.S. Senate

March 8, 2017

Good morning. My name is Edwin Lyman. On behalf of the Union of Concerned Scientists, I would like to thank Chairman Barrasso, Ranking Member Carper, and the other distinguished members of the Senate Environment and Public Works Committee for the opportunity to testify today on the Nuclear Energy Innovation and Modernization Act (NEIMA), and its potential impacts on nuclear safety and security in the future.

The Union of Concerned Scientists (UCS) puts rigorous, independent science to work to solve our planet's most pressing problems. UCS is neither a pro- nor an anti-nuclear organization. However, we believe that nuclear power must meet high standards of safety and security if it is to be a reliable option in the future.

This Saturday marks the sixth anniversary of March 11, 2011, the day when a massive earthquake and tsunami in Japan triggered the triple core meltdowns at the Fukushima Dai-ichi nuclear plant. We know exactly when the disaster started but we cannot predict when it will end: Its legacy will affect the Japanese people for decades to come. Today, the Japanese government's estimate of the direct economic impact of the accident is approaching $200 billion, approximately 80,000 people remain displaced from their homes, contaminated water continues to flow from the site into the sea every day, and the interiors of the three damaged reactors themselves are so intensely radioactive that even robots sent in to explore are quickly disabled.

The accident had a significant impact on Japan's use of nuclear power—it now has only three operating reactors out of a fleet of more than fifty. It pays handsomely for imported natural gas

to help meet its electricity demand. A similar accident in the United States would almost certainly compromise the future of nuclear power in this country.

Fukushima serves as a graphic reminder of the consequences of complacency on the part of the nuclear industry and its regulators, who seriously underestimated the risk to nuclear plants from natural disasters and consequently did not adopt safety measures strong enough to mitigate those risks. The urgent need to ensure that such a nuclear disaster does not happen again provides the context for my remarks today.

UCS first had the opportunity to testify on an earlier version of this bill before the EPW Clean Air and Nuclear Safety Subcommittee in April 2016. At that time, we expressed several concerns with the legislation. I would refer the Committee to our prior testimony for additional details. The current version of the legislation includes a few changes that have by and large improved it. As a result of these changes, we do not oppose the bill. Neither, however, do we support it, as we still find its basic approach problematic from a safety and security perspective. We also question the need for the legislation and are skeptical that it will be effective in facilitating the deployment of advanced reactors.

One of our main concerns with the bill is its promotion of a "risk-informed, performance-based" licensing strategy for advanced nuclear reactors. As discussed in our previous testimony, we do not believe that so-called risk-informed licensing is appropriate for new and novel reactor designs, because the quantitative determination of nuclear plant risk is highly complex and has large uncertainties. The computer models used to calculate risk need to be thoroughly validated

by comparison of results with actual plant operating experience before their accuracy can be confirmed. Such experience is not available for new reactor concepts that have not made it beyond the design stage.

Assessing risk accurately is difficult even for the current generation of nuclear plants, as demonstrated by the Fukushima disaster. State-of-the-art methods are still unable to reliably quantify critical sources of risk, such as fires, the failure of digital instrumentation and control systems, or the massive flooding that was ultimately responsible for the Fukushima accident. And one of the most serious dangers—the risk of terrorist sabotage—cannot be quantified at all.

To focus the licensing of new reactor designs too strongly on these risk analyses is to introduce an unacceptably high degree of uncertainty into the process, which could degrade safety and security by requiring regulators to accept the results of paper studies on faith. For new reactor designs, the licensing process must remain systematic and thorough. Regulatory decisions should be based on high-quality experimental data and conservative assumptions—not on educated guesses or preconceived notions about the performance of reactors that have not been demonstrated at commercial scale.

In that light, we appreciate that the current version of NEIMA requires that the NRC "develop and implement … strategies for the increased use of risk-informed, performance-based licensing evaluation techniques and guidance for commercial advanced nuclear reactors within existing regulatory frameworks …" only *where appropriate*. This phrase effectively provides the NRC with full discretion to confine the use of risk-informed licensing to those areas where it

determines it is appropriate, and per NRC procedures should also allow significant public input into those decisions. It is our expectation that NRC's technical analyses will reveal that there will be few, if any, aspects of advanced reactor licensing where risk-informed approaches will be appropriate.

Our other concern is about "performance-based" licensing. We do not believe that such a concept would be beneficial for new reactor applicants. "Performance-based" regulation requires the use of performance tests to demonstrate compliance. For a new reactor licensee, it will not be possible to carry out many of those tests until a first-of-a-kind unit is operating. If the new reactor fails a performance test, then costly retrofits may be required. In contrast, it would likely be more straightforward and predictable for the applicant to meet prescriptive licensing requirements (for example, the presence of a leak-tight containment).

There is also a question about which designs, if any, may clearly fall under NEIMA's definition of "advanced reactor:" that is, "a nuclear fission or fusion reactor ...with significant improvements compared to commercial nuclear reactors under construction as of the date of enactment of this Act."

In order to determine whether a particular reactor design represents a significant improvement over the commercial fleet, it may be necessary for the design to go through the licensing process first. Thus the number of candidate technologies that clearly demonstrate significant improvements *a priori* and therefore are covered by the advanced reactor provisions in NEIMA may be smaller than the bill's authors had anticipated.

For example, it is not clear that any of the non-light-water reactor "Generation IV" concepts that are currently under development offers unequivocal advantages over the operating reactor fleet or the AP1000 light-water reactors currently under construction. Liquid metal-cooled fast reactors, high-temperature gas-cooled reactors, and molten salt reactors all introduce new safety and or/security issues relative to light-water reactors that may ultimately outweigh any improvements they may provide for uranium utilization or waste management. This is also true for small modular light-water reactors such as NuScale. For example, deployment of any advanced reactor that requires reprocessing and separation of plutonium or other nuclear weapon-usable materials as part of its fuel cycle will increase the risks of nuclear terrorism and nuclear proliferation.

There is also a concern that even if a design is clearly safer, if the NRC ultimately allows regulatory rollbacks in the name of "risk-informed" licensing such as a smaller emergency planning zone or a diminished security force, the end result may be a licensed reactor that is *less safe* than the current fleet.

Some may be surprised to hear this conclusion. But the old adage "if it sounds too good to be true, it probably is" applies here. A case in point is the molten salt reactor being developed by the company Transatomic Power (TAP). For most of the time since it was founded in 2011, the company heavily promoted the idea that its reactor could generate electricity by consuming spent nuclear fuel discharged from operating reactors. TAP even used this aspect as a selling point in radio advertisements. However, recently all references to nuclear waste as a fuel source for the

TAP reactor were scrubbed from the company's website. As it turns out, the TAP reactor can't consume spent fuel after all. According to a February 2017 article in the *MIT Technology Review*, as far back as late 2015, TAP had become aware that the analysis demonstrating the feasibility of using spent fuel as feed for the TAP reactor was incorrect. TAP now makes far more modest claims about the capabilities of its reactor design. One observer attributed the error to "a lack of experience and perhaps an overconfidence in their [TAP's] own ability."

This is not to say that the TAP project itself is necessarily a failure. But the story illustrates that the development of advanced reactors is a painstaking process that cannot be rushed, and that early optimism based on preliminary assessments may well be tempered by later results.

The implication of finding (9) in Section 2 of NEIMA that "the high costs and long durations associated with applying the existing nuclear regulatory framework to advanced nuclear reactors" are impediments to their commercialization is not supported by existing analysis. A September 2016 report by the Secretary of Energy Advisory Board (SEAB) task force estimated it would take 25 years and $11.5 billion, on average, to take an advanced reactor concept from design to operation of a first-of-a-kind commercial-scale unit.

The task force did not identify the NRC licensing process as a major contributor to the substantial time and resources needed to deploy an advanced reactor. Instead, its estimate was largely determined by the time required to carry out the necessary stages of reactor development, from detailed design work to construction. The SEAB task force also stated the licensing cost could "approach $1 billion," which although not insignificant is still only a fraction of the overall

project cost. The task force also concluded that it "does not believe that significant reductions in either time or cost [of licensing] are likely."

The task force also argued that the NRC's current regulatory framework was flexible enough to accommodate many of the modifications needed to facilitate advanced reactor licensing through the development of new guidance, and that changes to the regulatory framework should only be employed if experience demonstrated that such changes were needed.

In this light, UCS believes that it is premature for Congress to require that the NRC complete a rulemaking by the end of 2024 to establish an optional "technology-inclusive" regulatory framework, per Section 103 (a)(4) of NEIMA. Given Presidential Executive Order 13771 and its mandate to offset each new regulation by discarding two existing ones, which the NRC may follow, Congress should be very cautious in requiring new regulations at this time that do not have an important safety or security purpose.

Rather than point fingers at the NRC licensing process, the Committee should seek to uncover the real reasons for the massive delays and cost overruns being experienced at the new nuclear construction projects in the Southeast: the four Westinghouse AP1000 reactors in South Carolina and Georgia and the Mixed-Oxide Fuel Fabrication Facility (MFFF) at the Savannah River Site. In both of these cases, one of the root causes was the initiation of construction before plant designs were finalized: the kind of problem that could be exacerbated if the staged licensing approach that NEIMA encourages is improperly applied. In none of these cases were onerous regulations and overzealous reviews to blame.

In fact, one could argue that more intensive NRC scrutiny of these projects might have uncovered problems sooner so that they could have been corrected at an earlier stage of the construction process, when they would have been cheaper to fix. For example, a scathing internal DOE review of the MFFF contractor's performance concludes that "the contractor's overall cost, schedule and technical performance was unsatisfactory" and that "the contractor lacked the fiduciary will to plan and execute work to fully benefit the project and taxpayer ...".[1] The NRC authorized construction of this project to proceed in 2005, after four years of review, and construction began in 2007. This deterioration in contractor performance did not occur overnight. However, the NRC apparently failed to observe and require correction of the contractor's management problems, which have a material impact on safety.

We raise the issue of the impending failure of the MFFF project for another reason: to point out that commercialization of advanced reactors will also require development, licensing and deployment of commercial-scale fuel fabrication and, in some cases, reprocessing facilities to support the fuel cycles of these reactors. These efforts will be non-trivial, entail additional costs, and introduce the potential for significant delays and cost increases. While NEIMA makes reference to qualification of advanced reactor fuels, it appears not to address the need for facilities that actually make the fuel. In particular, Section 103 only refers to licensing of "advanced nuclear reactors" and not associated advanced fuel cycle facilities. This may be a major oversight.

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[1] Department of Energy, National Nuclear Security Administration, MOX Project Management Office. FY2016 Award Fee Determination. Available at http://www.srswatch.org/uploads/2/7/5/8/27584045/foia_17-00045-m_clements_final_response_mox_award_fee_feb_21_2016.pdf. This document was released under the Freedom of Information Act to the independent group SRS Watch.

Another aspect of the bill that we find problematic is its continued exemption of advanced reactor licensing activities from NRC user fee recovery. In our previous testimony, UCS proposed that the exemption be dropped, given that the bill also authorizes the Energy Department to provide grants to prospective advanced reactor applicants to support licensing activities. Providing funding through DOE would be a better means to ensure that such grants would not be issued on a first-come, first-served basis but would be subject to rigorous peer review and awarded on the basis of merit. However, the user fee recovery exemption was retained in the current version of the bill. This preserves two routes through which taxpayers may provide subsidies to private enterprises. We continue to believe that the DOE program alone is sufficient.

I would like to mention two other additional points. First, UCS strongly supports the additional provisions included in the bill that would address nuclear safety more generally, Sections 105 and 106. In particular, Section 106 requires the NRC to submit to Congress a comprehensive report on evacuation planning. The Fukushima accident demonstrated that emergency evacuations following a large radiation release might be necessary as far as 25 miles from the release site, and Japan has increased its nuclear emergency evacuation zones to 18 miles (30 kilometers). Recent studies from Princeton University indicate that a fire at a spent fuel pool could necessitate the long-term relocation of the public hundreds of miles downwind. Yet even after Fukushima, the NRC has refused to consider the potential need for evacuation planning and potassium iodide distribution beyond 10 miles from nuclear plant sites. Such short-sightedness

puts Americans at undue risk. If the NRC wants to ground its emergency planning rules in sound science, both for operating reactors and for advanced reactors, it needs to address this issue.

Finally, UCS has a concern with regard to the additional provisions in Section 203 that impose annual limits on the amount of uranium that the Energy Department may release from its excess stockpile. To support nuclear nonproliferation and arms control, UCS encourages both the United States and Russia to declare additional quantities of highly enriched uranium (HEU) from their defense stockpiles as excess and to down-blend that material to low-enriched uranium (LEU) as rapidly as practicable. While we understand that the limits specified in NEIMA are consistent with the Energy Department's current schedule for HEU down-blending, we are concerned that these constraints could potentially inhibit an expansion of the down-blending program in the future. This issue also could have an impact on advanced reactor development by the private sector. Many of the advanced reactor concepts currently under consideration would require LEU fuel with enrichments between 10 and just below 20%. The only domestic source of such material currently available in the US is down-blended HEU. It would be prudent for the Committee to consider whether these limits could affect the availability in the near-term of an adequate supply of LEU within this enrichment range for commercial test and demonstration reactors.

This concludes my testimony. Again, I greatly appreciate the opportunity to appear here today and would be happy to answer any questions you have.

Senator BARRASSO. Well, thank you very much for being with us, Dr. Lyman. Thank you for your testimony.

I would like to next turn to Allison Bawden, who is the Acting Director for Natural Resources and Environment with the Government Accountability Office. Thank you very much for joining us.

STATEMENT OF ALLISON BAWDEN, ACTING DIRECTOR FOR NATURAL RESOURCES AND ENVIRONMENT, GOVERNMENT ACCOUNTABILITY OFFICE

Ms. BAWDEN. Chairman Barrasso, Ranking Member Carper, and members of the Committee, thank you for inviting me to discuss GAO's work on the Department of Energy's management of excess uranium.

The Department of Energy regularly undertakes sales and transfers of uranium from its excess inventory. This inventory largely resulted from years of Government enrichment activities prior to 1992 and is considered a national asset.

DOE has a responsibility to effectively manage the excess uranium inventory on behalf of the American people, who paid for it in the first place.

When DOE conducts transactions in uranium, it is legally obligated to ensure these transactions will not result in adverse material impacts to uranium markets and that it receives reasonable compensation for its uranium.

A portion of DOE's excess uranium inventory is in the form of depleted uranium tails, which historically have been considered waste. However, under certain market conditions, tails may have value. For example, tails can be profitably re-enriched when the price of natural uranium is high, because the re-enrichment bypasses the early stages of the nuclear fuel cycle, including mining of uranium ore.

Today I will discuss findings from GAO's prior work on three aspects of DOE's management of its excess uranium inventory. I will also comment on how provisions of the Nuclear Energy Innovation and Modernization Act address legal concerns we have raised.

First, DOE has contracted with a private firm for market impact studies to help it determine whether planned uranium transactions will result in adverse material impacts to uranium markets. The Secretary of Energy is legally required to make these determinations.

In 2014, we found the DOE could not be assured of the quality and reliability of two market impact studies because, despite requirements to do so, DOE did not take steps to address their technical quality and the studies did not include sufficient methodological information to assess the reasonableness of their conclusions. Both studies, however, concluded that DOE's transactions would not have an adverse material impact on domestic uranium markets.

We recommended that DOE take steps to ensure the quality, credibility, and transparency of any future uranium market impact studies, but DOE neither agreed nor disagreed with this recommendation.

Second, even though DOE is legally required to receive reasonable compensation for its material, in May 2014, we found that

DOE did not have guidance for valuing tails. We also found that DOE has inconsistently valued tails when it has sold or transferred them. For example, in 2005, DOE charged a price for tails. But in 2010 DOE transferred tails to a company without charge, despite an estimated value for the transferred material of up to $300 million.

In May 2014, we recommended that DOE develop consistent and transparent valuation methods that maximize the value the Government derives and provides predictability for uranium markets. DOE disagreed with this recommendation.

There continues to be commercial interest in purchasing DOE's tails, which we last valued in June 2014 at about $1 billion.

Third, since 2006, we have concluded that DOE's uranium transactions have, in some cases, violated Federal law. Our legal opinion is that DOE likely does not have authority to sell or transfer tails because of specific prohibitions imposed by amendments to the Atomic Energy Act.

We have suggested that Congress consider clarifying DOE's legal authority to sell or transfer tails. Also, in reporting on certain transactions where DOE has paid for services with uranium, we concluded that DOE's legal authority to conduct barters is unclear and that DOE violated the miscellaneous receipts statute. This statute requires an official or agent of the Government receiving money from any source on the Government's behalf to deposit the money into the Treasury.

We suggested that Congress consider clarifying DOE's authority to conduct barters and to retain the proceeds from such barters.

Provisions included in the Nuclear Energy Innovation Modernization Act would address the legal concerns GAO has raised. The bill clarifies DOE's authority to transact in depleted uranium tails and provides DOE with authority to barter. The bill does not authorize DOE to retain the proceeds from barters.

The bill also addresses concerns we raised about assuring quality for market impact studies by requiring them to undergo peer review.

This concludes my statement, and I look forward to your questions.

[The prepared statement of Ms. Bawden follows:]

United States Government Accountability Office

GAO

Testimony
Before the Committee on Environment and Public Works, U.S. Senate

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DEPARTMENT OF ENERGY

Excess Uranium Transfers

Statement of Allison Bawden, Acting Director,
Natural Resources and Environment

GAO Highlights

Highlights of GAO-17-472T, a testimony before the Committee on Environment and Public Works, U.S. Senate

Why GAO Did This Study

DOE maintains an inventory of uranium, including depleted uranium "tails" resulting from the uranium enrichment process, and periodically sells or transfers excess uranium from its inventory. Under the Atomic Energy Act of 1954, as amended by the USEC Privatization Act, DOE's sales and transfers of uranium are subject to certain conditions. For example, DOE must determine that sales or transfers of uranium will not have an adverse material impact on the domestic uranium market, among other things.

This testimony highlights issues found in nine GAO products from July 2006 through September 2015 related to DOE's transfers of excess uranium. It focuses on (1) steps DOE has taken to assess the technical quality of contracted market impact studies, (2) whether DOE has developed guidance for valuing its uranium resources, and (3) whether DOE's uranium transfers have violated federal law. GAO reviewed relevant laws; documents, including transaction documents and contracts; and interviewed DOE, contractor, uranium industry representatives, and uranium market analysts.

Over nearly a decade, GAO has made numerous recommendations to improve DOE's transfers of excess uranium. DOE has neither agreed nor disagreed on some recommendations and has disagreed with others. GAO will continue to monitor DOE's implementation of these recommendations.

View GAO-17-472T. For more information, contact Allison Bawden at (202) 512-3841 or bawdena@gao.gov.

March 8, 2017

DEPARTMENT OF ENERGY

Excess Uranium Transfers

What GAO Found

GAO has raised several issues related to the Department of Energy's (DOE) excess uranium transfers in five reports, three testimonies, and a legal opinion issued from 2006 to 2015 as follows:

- DOE did not take steps to assess the technical quality of market impact studies conducted in April 2012 and January 2013. In part to ensure that its uranium transfers would not have an adverse material impact on the domestic uranium industry, DOE contracted for studies on the potential market impact of most of its planned uranium transfers. These studies concluded that these transfers would not result in adverse market impacts. In its May 2014 report, GAO reviewed these studies and found issues with their analyses. For example, GAO found that DOE did not take steps outlined in its contracts or in departmental quality assurance guidance to assess the technical quality of these studies. GAO also found that the studies provided only limited detail about their methodology, data sources, and assumptions, although DOE's quality assurance guidance states that DOE information disseminated to the public should contain such information. DOE officials stated that they did not examine the studies' methodology or assess the studies' technical quality because they wanted the studies to be independent, and they trusted the contractor to provide subject matter expertise that did not exist within DOE. GAO recommended that DOE take steps to evaluate the technical quality of the market studies for which it contracts. DOE neither agreed nor disagreed with this recommendation.
- DOE has not developed guidance for valuing its depleted uranium tails—which historically have been considered waste and treated as an environmental liability; however, under certain conditions, some tails may have economic value and therefore be considered an asset. In May 2014, GAO recommended that DOE develop guidance for consistently determining the value of depleted uranium tails when transferring them as an asset. DOE disagreed with this recommendation and stated that it is not required to establish guidance for depleted uranium, and reiterated this position in August 2016. However, since that time, DOE has continued to receive commercial interest in its tails, underscoring that tails can be viewed as an asset. GAO continues to believe that having guidance that provides a consistent and transparent method for determining the value of tails is necessary to ensure that DOE is reasonably compensated for its material.
- DOE's uranium transfers have, in some cases, violated federal law. In May 2014, GAO concluded that DOE likely did not have authority to transfer tails because of prohibitions imposed by the USEC Privatization Act. That law prohibits DOE from selling or transferring "any uranium" to "any person" except in a manner consistent with the act. DOE disagreed with this conclusion, citing its general authority under the Atomic Energy Act to distribute source material. GAO suggested that Congress consider clarifying DOE's authority to manage depleted uranium and provide explicit direction about whether and how DOE may sell or transfer it. Legislation introduced in the 114th Congress would have authorized DOE to transfer tails but it was not passed.

Chairman Barrasso, Ranking Member Carper, and Members of the Committee:

Thank you for the opportunity to discuss our work on the Department of Energy's (DOE) transfers of excess uranium.[1] For more than 50 years, the federal government enriched uranium.[2] These decades of federal uranium enrichment activities, and other sources, generated an extensive uranium inventory that DOE maintains.[3] DOE periodically sells or transfers excess uranium from its inventory—material that has been deemed excess to national security missions—to achieve other DOE missions. For example, DOE sells or transfers its excess uranium to fund environmental cleanup of a shuttered uranium enrichment plant in Portsmouth, Ohio.[4] This activity is also supported using annual appropriations.

Sales or transfers of uranium by DOE have the potential to adversely impact the domestic uranium industry. DOE's sales and transfers of uranium are subject to certain conditions under the Atomic Energy Act of 1954, as amended by the USEC Privatization Act, including a required determination by the Secretary of Energy that the transfer will not have an adverse material impact on the domestic uranium market.[5] To help inform

[1]We define uranium transfers as the exchange of natural, enriched, or depleted uranium "tails," or uranium enrichment services between DOE and another party.

[2]Uranium enrichment involves separating uranium-235—the form, or isotope, that undergoes fission to release enormous amounts of energy in nuclear reactors and weapons—from uranium-238 to increase the concentration of uranium-235. The enrichment process results in two principal products: (1) enriched uranium hexafluoride, which can be further processed for specific uses, such as nuclear weapons or fuel for power plants, and (2) leftover "tails" of uranium hexafluoride, which also are called depleted uranium because the material is depleted in uranium-235 compared with natural uranium.

[3]DOE's inventory of uranium comes from a variety of sources, including the dismantling of some of the nation's nuclear weapons, as well as material remaining from U.S. government enrichment activities before 1993. In 1992, the U.S. government established the United States Enrichment Corporation (USEC) as a government corporation to take over operations of DOE's enrichment facilities and to provide commercial uranium enrichment services for the U.S. government and utilities that operate nuclear power plants. In 1998, USEC was privatized under the USEC Privatization Act. Pub. L. No. 104-134, 110 Stat. 1321, 1321-335 (1996) (codified as amended at 42 U.S.C. §§ 2297h-2297h-13 (2017)).

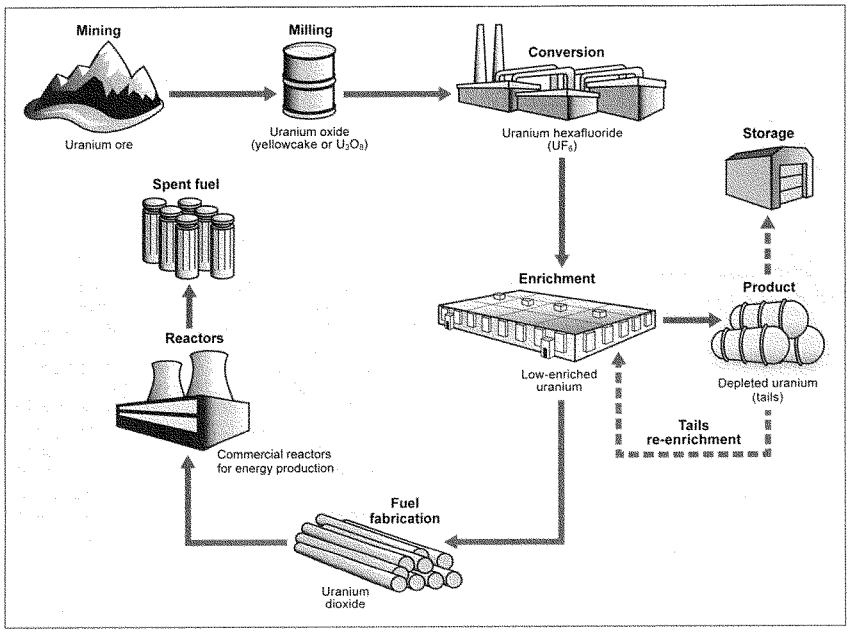
[4]For this activity, DOE transfers uranium from its inventory as payment for cleanup services provided by a contractor at Portsmouth.

[5]See 42 U.S.C. §§ 2073, 2093, § 2297h-10 (2017).

this determination, DOE has contracted with an external consulting firm to assess the market impact of planned uranium transfers.

A portion of DOE's uranium inventory consists of depleted uranium "tails," which have historically been considered waste and treated as an environmental liability; however, under certain economic conditions, some tails may have economic value and therefore be considered an asset. For example, tails can be profitably re-enriched and used in lieu of natural uranium when the price of natural uranium is high or when the cost of enrichment services is low (see fig. 1 for an illustration of the nuclear fuel cycle). When DOE transfers tails for re-enrichment, the mining, milling, and conversion stages of the nuclear fuel cycle are bypassed.

Figure 1: Nuclear Fuel Cycle



Sources: GAO analysis of International Atomic Energy Agency, Nuclear Regulatory Commission, Congressional Research Service, Department of Energy, and Tennessee Valley Authority documents.
GAO-17-472T

In this context, my testimony today highlights our findings from prior work on DOE's management of excess uranium. Specifically, I will address three aspects of DOE's management of uranium about which we have raised issues for nearly a decade: (1) DOE did not take steps to assess the technical quality of contracted market impact studies; (2) DOE has not developed guidance for valuing its uranium resources, particularly tails; and (3) DOE's uranium transfers have in some cases violated federal law.

My testimony is based on our five reports, three testimonies, and a legal opinion issued from July 2006 through September 2015.[6] To conduct our prior work, we reviewed relevant laws; documents, including transaction documents and contracts; and interviewed DOE, contractor, uranium industry representatives, and uranium market analysts. Detailed information about the scope and methodology used to conduct this work can be found in each of our issued products. We conducted the work on which this statement is based in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The Atomic Energy Act of 1954, as amended, gives DOE general authority to transfer uranium related to its nuclear energy functions; to distribute natural uranium under certain conditions to qualified entities; and to sell, lease, grant, distribute, or otherwise make available enriched uranium under certain conditions. In 1996, Congress enacted the USEC Privatization Act to amend the Atomic Energy Act. The USEC Privatization Act restricted DOE's authority to conduct certain transfers of uranium.[7] In particular, Section 3112 prohibits DOE from transferring or selling uranium except as consistent with the act's terms and conditions. For example, DOE is authorized to sell natural uranium and low-enriched

[6]GAO, *Department of Energy: Transactions Involving USEC Inc. Since 1998*, GAO-15-730 (Washington, D.C.: Sept. 10, 2015); GAO, *Department of Energy: Management of Excess Uranium*, GAO-15-475T (Washington, D.C.: Apr. 22, 2015); GAO, *Department of Energy: Enhanced Transparency Could Clarify Costs, Market Impact, Risk, and Legal Authority to Conduct Future Uranium Transactions*, GAO-14-291 (Washington, D.C.: May 9, 2014); GAO, *2012 Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue*, GAO-12-342SP (Washington, D.C.: Feb. 28, 2012); GAO, *Excess Uranium Inventories: Clarifying DOE's Disposition Options Could Help Avoid Further Legal Violations*, GAO-11-846 (Washington, D.C.: Sept. 26, 2011); GAO, *Nuclear Material: DOE's Depleted Uranium Tails Could Be a Source of Revenue for the Government*, GAO-11-752T (Washington, D.C.: June 13, 2011); GAO, *Nuclear Material: Several Potential Options for Dealing with DOE's Depleted Uranium Tails Could Benefit the Government*, GAO-08-613T (Washington, D.C.: Apr. 3, 2008); GAO, *Nuclear Material: DOE Has Several Potential Options for Dealing with Depleted Uranium Tails, Each of Which Could Benefit the Government*, GAO-08-606R (Washington, D.C.: Mar. 31, 2008); and GAO, *Department of Energy: December 2004 Agreement with the United States Enrichment Corporation*, B-307137 (Washington, D.C.: July 12, 2006).

[7]See 42 U.S.C. § 2297h-10 (2017).

uranium from its stockpile if (1) the President determines the material is not necessary for national security needs; (2) the Secretary of Energy determines the sale will not have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries; and (3) the price paid will not be less than the fair market value of the material. DOE has satisfied the second requirement for a secretarial determination with individual determinations of market impact signed by the Secretary of Energy for each transaction or group of transactions. DOE has issued several secretarial determinations over the past few years pertaining to its uranium sales and transfers and the impact on the domestic uranium mining, conversion, and enrichment industries.[8] For example, DOE issued a secretarial determination on May 1, 2015, which covers continued transfers of uranium for, among other activities, cleanup services at the Portsmouth plant at rates of up to the equivalent of 2,500 metric tons of natural uranium per year in 2015 and up to the equivalent of 2,100 metric tons of uranium (MTU) in each year thereafter.[9]

To help inform the Secretary's determinations, DOE has contracted with Energy Resources International, Inc. (ERI), a nuclear fuel consulting firm, to develop studies analyzing the potential impact of planned uranium transfers on the market and has previously made these studies available on its public website. With respect to the third requirement pertaining to fair market value, DOE previously maintained a pricing policy for uranium that at various times specified standard prices or a market value standard for depleted uranium.[10] Such a pricing policy generally informed DOE determinations as to the value of tails until the early 1990s, but DOE has not relied on this policy since the mid-1990s.

[8]The duration of the secretarial determinations is limited to no more than two calendar years subsequent to the determination. Consolidated and Further Continuing Appropriations Act, 2015, Pub. L. No. 113-235, div. D, tit. III, § 306(a), 128 Stat. 2130, 2324 (2014).

[9]Excess Uranium Management: Secretarial Determination of No Adverse Impact on the Domestic Uranium Mining, Conversion, and Enrichment Industries, 80 Fed. Reg. 26,366, 26,366 (May 7, 2015).

[10]See for example, DOE Pricing Policy Change for Sale of Uranium Depleted in Isotope U-235, 47 Fed. Reg. 17,110 (Apr. 21, 1982). See also notices from DOE's predecessors in operating the enrichment facilities, Atomic Energy Commission, Uranium Hexaflouride: Base Charges, Use Charges, Special Charges, Table of Enriching Services; Specifications and Packaging, 32 Fed. Reg. 16,289 (Nov. 29, 1967); Energy Research and Development Administration, Uranium Heraflouride (sic): Base Charges, Use Charges, Special Charges, Table of Enriching Services; Specifications, and Packaging: Revisions, 42 Fed. Reg. 51,635 (Sept. 29, 1977).

In addition, DOE has previously attempted to manage the market impact of its uranium tails transfers by adopting guidance to limit the amount of transfers. For instance, in 2008, DOE adopted a guideline to generally restrict sales and transfers of uranium to no more than 10 percent of the annual U.S. requirements for nuclear fuel, which according to DOE at the time, generally would ensure that such transfers would not have an adverse material impact on the domestic uranium industry. In 2013, DOE announced its decision to discontinue using its 10 percent guideline for limiting uranium sales and transfers and stated that it could meet its statutory and policy objectives without one. In May 2014, we found that DOE officials did not consult with industry representatives before deciding to discontinue using its 10 percent sales and transfer guideline.

The global uranium market entered an extended recession following the Fukushima Daiichi nuclear reactor accident. On March 11, 2011, a magnitude 9.0 earthquake and subsequent tsunami devastated northeastern Japan and severely damaged the Fukushima Daiichi nuclear power plant. The accident led to a review of civilian nuclear power programs worldwide. For example, following the accident, the Japanese government directed that all but 2 of Japan's 50 civilian nuclear power reactors be shut down pending a complete safety review.[11] In addition, Germany accelerated the shutdown of its nuclear power reactors. Specifically, on June 30, 2011, after the Fukushima Daiichi accident, the German parliament voted to permanently shut down its nuclear power plants by the end of 2022. This vote followed the suspension of operations of 8 of Germany's 17 nuclear power plants. The shutdown of nuclear power reactors has reduced the demand for uranium conversion and enrichment services resulting in an oversupply of enriched uranium and a lower market price.

GAO's Prior Work Has Found Issues Related to DOE's Uranium Transfers

In nine products we issued from 2006 to 2015, we have raised several issues related to DOE's excess uranium transfers, including that: (1) DOE did not take steps to assess the technical quality of contracted market impact studies; (2) DOE has not developed guidance for valuing its uranium resources; and (3) DOE's uranium transfers have in some cases violated federal law.

[11]GAO, *Nuclear Safety: Countries' Regulatory Bodies Have Made Changes in Response to the Fukushima Daiichi Accident*, GAO-14-109 (Washington, D.C.: Mar. 6, 2014).

DOE Did Not Take Steps to Assess the Technical Quality of Market Impact Studies for Which It Contracted

In May 2014, we found that DOE did not take steps to assess the technical quality of two market impact studies ERI conducted for DOE in 2012 and 2013.[12] These studies concluded that DOE's planned uranium transfers would not result in adverse market impacts. DOE used these market impact studies, in part, to inform the Secretary's statutorily required determinations about whether DOE sales or transfers of uranium would have an adverse material impact on the domestic uranium mining, conversion, or enrichment industries. However, we found that DOE did not take steps outlined in its contracts or in departmental quality assurance guidance to assess the technical quality of these studies. For example, we found that DOE's contract with ERI included a statement of work providing that, at regular intervals, DOE would formally evaluate the contractor's performance, and that the evaluation could include the technical quality of the contractor's deliverables, among other things. In addition, DOE's *Information Quality Guidelines* set forth quality assurance steps and procedures to ensure the technical quality of information that DOE makes publicly available.[13] The ERI studies were published on DOE's website, but DOE officials told us that they neither conducted an assessment of the technical quality of the studies nor requested any additional information from ERI about the studies. According to DOE officials, they did not examine the studies' methodology or assess the studies' technical quality because they wanted ERI's studies to be independent and did not want to influence their results. DOE officials told us that they contracted with ERI to provide subject matter expertise that did not exist within DOE and trusted ERI to provide that expertise. However, if DOE did not have the internal subject matter expertise to review the studies, another tool available to the department—specifically discussed in DOE's *Information Quality Guidelines*—is peer review, which

[12]The April 2012 study projected the potential market effects during calendar years 2012 through 2033 for three DOE uranium transfers, and the January 2013 study projected the market impact during calendar year 2013 for one transaction. See GAO-14-291 for additional details.

[13]These guidelines—developed by DOE as required by the Information Quality Act and under associated guidelines issued by the Office of Management and Budget—set forth quality assurance steps and procedures to ensure the quality and objectivity of information that DOE makes publicly available. The guidelines state that DOE should seek to ensure that information disseminated to the public meets a basic level of quality, which is measured by the objectivity of the information and whether the information is accurate, clear, complete, and reliable. Consolidated Appropriations Act, 2001, Pub. L. No. 106-554 Title V § 515 (a), 114 Stat. 2763A-153 to 2763A-154 (2000) (commonly referred to as the Information Quality Act).

is generally defined as the process of having independent experts assess the technical and scientific merit of studies. Nonetheless, ERI's principal author told us that the two studies were not peer-reviewed by a third party.

In our May 2014 report, we also found that ERI's studies provided limited detail about their methodology, data sources, and assumptions, even though DOE's *Information Quality Guidelines* direct such information to be included in publicly disseminated documents.[14] For example, ERI did not provide information about the sources of data it used to develop its market supply curves, which were fundamental to its market analysis. We also identified shortcomings in the studies that raise questions about their conclusions, which DOE used to inform the Secretary of Energy's statutory determinations that its uranium transfers would not have an adverse material impact on the domestic uranium market. For example, we identified concerns about ERI's assumption that DOE's planned uranium transfers would not have a cumulative effect on the term market.[15] Similarly, in September 2011, we also identified concerns with the results of two market impact analyses ERI conducted for DOE in November 2009 and December 2010 because of issues related to the economic model developed by ERI.[16]

To ensure the quality, credibility, and transparency of any future uranium market impact studies, in our May 2014 report we recommended that DOE (1) conduct assessments of the quality of its future market impact studies consistent with DOE's *Information Quality Guidelines* or have an independent third party conduct a peer review and (2) require that the studies include information on the methods, data sources, and assumptions used consistent with DOE's *Information Quality Guidelines*.[17] DOE neither agreed nor disagreed with the first part of this

[14]See GAO-14-291.

[15]Specifically, we identified several concerns with the certainty of ERI's conclusions regarding the effect of DOE's uranium transfers on the term and spot markets, including (1) the completeness of the data ERI used to develop the market supply curves, which were fundamental to its term market analysis; (2) ERI's assumption that DOE's planned uranium transfers would not have a cumulative effect on the term market; and (3) ERI's model that it developed for its analysis of the spot market, which accounts for some, but not all, factors that can affect spot market prices. See GAO-14-291 for our analysis of ERI's market impact studies and discussion of these concerns.

[16]See GAO-11-846.

[17]See GAO-14-291.

recommendation and stated that it would continue to consider the applicability of its *Information Quality Guidelines* to independent analyses of the potential market impact of the proposed transactions and take appropriate steps if applicable. DOE did not comment on the second part of our recommendation to include information on the methods, data sources, and assumptions in its studies. We continue to believe that DOE should require that its future studies contain such information to ensure their quality, credibility, and transparency.[18] However, DOE has taken some steps that are consistent with the intent of these recommendations. For example, in notices published in the *Federal Register* in December 2014 and July 2016, in anticipation of new secretarial determinations covering future transfers of uranium, DOE solicited public input on the potential effects of DOE transfers of excess uranium on the domestic uranium mining, conversion, and enrichment industries.[19]

DOE Does Not Have Guidance for Valuing Its Uranium Tails

In our May 2014 report, we found that DOE did not have guidance for valuing depleted uranium tails.[20] Specifically, we found that DOE did not have guidance for determining the value of tails when they are treated as an asset in a transaction and, as a result, DOE estimated the tails it transferred for re-enrichment in a 2012 transfer had a potential value ranging from $0 to $300 million. For this 2012 transaction, DOE decided that the tails it transferred had no value because tails are typically considered to be an environmental liability and, therefore, the transaction had no cost to the department. However, because the tails were re-enriched and used in lieu of natural uranium, we found that the tails were an asset in the context of this transaction and, therefore, should have had some value. Moreover, in other cases, DOE has determined that tails do have value. For example, in a DOE 2005 transfer of tails, DOE charged a

[18]In April 2014, ERI released a report assessing additional proposed DOE transfers. In that assessment, ERI does not make any conclusion about whether or not the release of DOE inventories into the commercial markets will result in an adverse material impact. Instead, ERI notes that, in accordance with the USEC Privatization Act, any determination of adverse material impact is made by the Secretary of Energy.

[19]Excess Uranium Management: Effects of DOE Transfers of Excess Uranium on Domestic Uranium Mining, Conversion, and Enrichment Industries; Request for Information, 79 Fed. Reg. 72,661 (Dec. 8, 2014); Excess Uranium Management: Effects of DOE Transfers of Excess Uranium on Domestic Uranium Mining, Conversion, and Enrichment Industries; Request for Information, 81 Fed. Reg. 46,917 (July 19, 2016).

[20]See GAO-14-291. As will be discussed in more detail below, DOE likely does not have authority to sell depleted uranium tails, but if DOE does sell it, DOE policy requires DOE to ensure that the department receives reasonable value in return for transferred uranium.

price for its tails. We concluded that without guidance for how to value its tails in the context of transactions that treat them as an asset, DOE cannot ensure the government is reasonably compensated for its uranium transfers.

Having guidance that provides a consistent and transparent method for determining the value of tails is particularly important because—as we reported in March 2008—uranium prices are very volatile, and a sharp rise or fall in prices could greatly affect the value of DOE's tails inventory depending on when transfers occur.[21] At the time of that report, we concluded that the dramatic increases in uranium prices in 2008 had presented the U.S. government with an opportunity to gain potentially billions of dollars from depleted uranium tails material that was once considered a liability.[22] In June 2011, GAO reported that DOE's depleted uranium tails inventory had a net value of $4.2 billion. However, since 2011, the market prices for uranium have decreased, and the composition of DOE's tails inventory has changed in part because of transfers, thereby lowering the value of DOE's remaining inventory. In 2014, as part of technical assistance provided to Congress, GAO calculated the June 2014 value of DOE's inventory at then-current uranium prices using a model developed by uranium experts at a DOE site and found that the estimated value of DOE's tails inventory was about $1 billion.

In May 2014, we recommended that DOE develop guidance for consistently determining the value of depleted uranium tails when transferring them as an asset. DOE disagreed with this recommendation and stated that it was not required to establish guidance or a pricing policy for depleted uranium and to do so would hinder DOE's ability to maximize the value received by the government in a given transaction. In August 2016, DOE reiterated this position and stated that the department's response is unchanged and no actions have been taken that are specific to this recommendation. Since that time, DOE has continued to receive commercial interest in its uranium tails, underscoring that the tails can be viewed as an asset. For example, in November 2016, DOE announced that it had agreed with GE-Hitachi's Global Laser Enrichment (GLE) to sell depleted uranium for re-enrichment over a 40-

[21]See GAO-08-606R.

[22]While we concluded that DOE's authority to sell depleted uranium tails was doubtful, we found that DOE generally has authority to re-enrich and then sell the tails.

year period.[23] According to the licensor of the GLE technology, the agreement facilitates the sale of approximately 300,000 tons of depleted uranium. The tails would be enriched at a proposed facility to be built in the early 2020s in Paducah, Kentucky, next to the shuttered Paducah uranium enrichment plant.[24] Therefore, we continue to believe that having guidance that provides a consistent and transparent method for determining the value of tails in the context of a transaction is necessary.

DOE's Uranium Transfers Have, in Some Cases, Violated Federal Law

Since 2006, we have reported on legal concerns with a number of transfers or potential transfers of uranium.[25] In May 2014, we identified legal concerns with four DOE uranium transactions conducted from 2012 through 2013.[26] In a March 2013 transaction, for example, we found that DOE transferred ownership of uranium previously obtained for national security purposes without obtaining the required presidential determination that the uranium material was no longer necessary for national security purposes.[27] For another transaction, in May 2012, we found that DOE likely did not have authority to transfer tails because of specific prohibitions imposed by the USEC Privatization Act.[28] As we explained in our May 2014 report—and had explained in our 2008 report when we addressed the same legal issue[29]—section 3112 of the USEC Privatization Act prohibits DOE from selling or transferring "any uranium" to "any person" except in a manner consistent with the act. Because the act specifies no conditions for the sale or transfer of depleted uranium tails, in contrast to the act's conditions for other types of uranium, statutory construction rules indicate DOE likely does not have authority to

[23]According to DOE officials, as of June 2014, DOE maintained approximately 525,000 metric tons of uranium in the form of depleted uranium tails.

[24]The 2016 announcement followed a Request for Offers in July 2013 regarding its remaining inventories of tails. The Request for Offers specified that natural uranium created from the tails could not enter the market before 2019 and would have to be limited to 2,000 MTU natural uranium equivalent per year. See DOE Portsmouth/Paducah Project Office, Request for Offers for the Sale of Depleted and Off-Specification Uranium Hexafluoride Inventories, Request for Offers Number: DE-SOL0005845, July 3, 2013.

[25]See GAO-14-291, GAO-11-846, GAO-08-606R, and B-307137.

[26]See GAO-14-291.

[27]See GAO-14-291.

[28]42 U.S.C. § 2297h-10 (2017).

[29]See GAO-08-606R.

sell or transfer depleted uranium. DOE disagreed with this conclusion, citing its general authority under the Atomic Energy Act to distribute source material.[30] Even if that general authority applied to the transfer of depleted uranium, however, we found that DOE did not meet the Atomic Energy Act's requirement to charge a price for the tails because it transferred them without charging any price at all.

To ensure the same type of scrutiny that Congress has required for the sale or transfer of DOE's other valuable federal uranium assets—such as price, protection of the domestic uranium industry, and safeguarding the national security—in March 2008 and September 2011, we suggested that Congress consider clarifying DOE's authority to manage depleted uranium and provide explicit direction about whether and how DOE may sell or transfer it.[31] Legislation introduced in the 114th Congress would have authorized DOE to sell or transfer depleted uranium tails subject to certain conditions but was not passed.[32]

In our May 2014 report, we recommended that for each uranium transaction it conducts, DOE should publicly identify the legal authority it relies on and explain how the transaction meets the requirements of that authority. DOE disagreed with this recommendation and stated that it would not publicly report the authorities it relies on because it is not legally required to do this and because citing the law would disclose information "traditionally...protected as attorney work product or privileged pre-decisional documents." Reporting DOE's final decision on which law it has relied on for its transactions would breach no privilege, however, and we maintain that reporting this to Congress and the public would improve transparency. After we issued our report, Congress took action in the Consolidated and Further Continuing Appropriations Act,

[30]DOE stated that its position is "consistent with" section 3112's broad prohibition because Congress included no conditions authorizing the sale or transfer of depleted uranium. This only reinforces GAO's interpretation. Congress imposed conditions on DOE's sale of all valuable uranium; because depleted uranium was not valuable in 1996, Congress did not need to address its sale or transfer and instead addressed its disposal in section 3113. When depleted uranium later became valuable, its sale or transfer remained prohibited unless and until Congress sets conditions to ensure appropriate management of this federal asset. See GAO-14-291 and GAO-08-606R.

[31]See GAO-11-846 and GAO-08-606R.

[32]SAVE Act, H.R. 614, 114th Cong. § 114 (2015); Excess Uranium Transparency and Accountability Act, H.R. 2544, 114th Cong. (2015); Excess Uranium Transparency and Accountability Act, S. 1428, 114th Cong. (2015).

2015, to require what we had recommended: that DOE report to the Committees on Appropriations the provisions of law under which it conducts uranium transactions not less than 30 days prior to conducting the transaction.[33]

In July 2006[34] and September 2011,[35] we reported on a different legal concern, finding that certain DOE uranium transfers were sales authorized by the USEC Privatization Act but that DOE violated federal fiscal law in how it handled proceeds from these transfers. Specifically, the miscellaneous receipts statute requires an official or agent of the government receiving money from any source on the government's behalf to deposit the money into the Treasury.[36] We found that DOE provided uranium to a company for sale to a third party and allowed the company to keep the proceeds of the sales as payment for services rendered to DOE, but DOE did not deposit the value of the net proceeds from these uranium sales into the Treasury. Even with no money changing hands, we concluded that an amount equivalent to the value that went to the company should have gone to the Treasury. While our 2011 report noted that the transactions we analyzed in 2011 differed in some superficial respects from the transactions we analyzed in 2006, we found the core substance was the same and, as DOE officials told us in 2011, the department intentionally structured the disposition of federal assets to avoid payment of the proceeds for those assets into the Treasury. Our September 2011 report suggested that Congress consider providing DOE with explicit authority to barter excess uranium and to retain the proceeds from bartering, transferring, and selling uranium. Legislation introduced in the 114th Congress would have authorized DOE to barter uranium but it was not passed.[37]

[33]Pub. L. No. 113-235, div. D tit. III, § 306(b) (2014).

[34]See B-307137.

[35]See GAO-11-846.

[36]Miscellaneous receipts statute, 31 U.S.C. § 3302(b) (2017).

[37]Excess Uranium Transparency and Accountability Act, H.R. 2544, 114th Cong. (2015); Excess Uranium Transparency and Accountability Act, S. 1428, 114th Cong. (2015).

Chairman Barrasso, Ranking Member Carper, and Members of the Committee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

GAO Contact and Staff Acknowledgments

If you or your staff members have any questions about this testimony, please contact me at (202) 512-3841 or bawdena@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. GAO staff who made key contributions to this testimony are William Hoehn, Assistant Director; Eric Bachhuber, Antoinette Capaccio, Julia Coulter, Amanda K. Kolling, Katrina Pekar-Carpenter, and Steven Putansu.

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Senate Environment and Public Works Committee
Hearing entitled, "Legislative hearing on S.512, the Nuclear Energy Innovation and Modernization Act"
March 8, 2017
Questions for the Record
Allison Bawden

Chairman Barrasso:

On December 2, 2016, Secretary of Energy, Ernest Moniz, signed a Secretarial Determination that the National Nuclear Security Administration's barters of low-enriched uranium (LEU) for highly enriched uranium (HEU) downblending services are no longer subject to section 3112(d)(2) of the USEC Privatization Act. I understand the Department of Energy did not provide any notice of the December 2, 2016 Secretarial Determination until referencing it in a Notice published in the Federal Register on March 7, 2017 – the day before this hearing.

1) **Was the Government Accountability Office (GAO) aware of the December 2, 2016 Secretarial Determination before my staff shared the Secretarial Determination with you on March 7, 2017?**

   No. Before receiving a copy of the Determination from committee staff on March 7, 2017, GAO was previously unaware of the document.

2) **Was the Department required to provide public notice of the December 2, 2016 Secretarial Determination?**

   GAO is unaware of any requirement on the Department to provide public notice of its secretarial determinations.

3) **Does GAO see any problems with or have any concerns about the December 2, 2016 Secretarial Determination? If so, please explain in detail.**

   We have several concerns with DOE's December 2016 Secretarial Determination in which DOE argues that both downblending highly enriched uranium (HEU) and exchanging low-enriched eranium (LEU) for downblending serves a national security purpose. If the national security exemption applies to both downblending and payment for downblending as DOE suggests, we question whether such transactions should be exempt from the conditions that generally apply to transfers and sales of DOE uranium. Specifically, the USEC Privatization Act generally applies three conditions to such transfers and sales. It requires 1) a presidential determination that the material is not necessary for national security needs, 2) a secretarial determination that the sale will not have an adverse material impact on the uranium industry, and 3) that the price paid will not be less than fair market value. If DOE's proposed downblending transactions do constitute a "national security purpose" then they are not subject to these conditions. However, we note that allowing a contractor to retain as payment a portion of the derived LEU for downblending services would certainly have a market impact. In addition, we have concerns about DOE labelling the portion of transactions involving the exchange of LEU as serving "a national security purpose," as presumably the value of this LEU to its recipient is in its subsequent sale, and the sale could thus be conducted without having to obtain a presidential determination that the assets are no longer necessary for

national security needs. GAO has previously reported on an instance where DOE did not obtain a required presidential determination for the transfer of LEU to a private corporation that DOE had previously obtained for a national security purpose.

In addition, DOE released a new Secretarial Determination on April 26, 2017, in which DOE authorized transfers of natural uranium hexafluoride to contractors for cleanup services at the Portsmouth Gaseous Diffusion Plant at lower levels than had been established in a May 1, 2015 Secretarial Determination. DOE stated that this action was taken in response to the Department's interest in maintaining healthy domestic nuclear industries. The 2017 Secretarial Determination does not address the December 2016 Secretarial Determination.[1] However, the analysis accompanying the 2017 determination reiterates DOE's conclusion that downblending HEU serves a national security purpose and assumes for analysis purposes that DOE will transfer 500 metric tons of LEU from 2017 through 2019, in addition to the authorized transfers of natural uranium hexafluoride and other uranium transfers. We have not assessed the analysis accompanying the 2017 Secretarial Determination.

4) **In GAO's view, do the Department's barters of LEU for HEU downblending services violate the miscellaneous receipts statute (31 U.S.C. § 3302(b))? If so, please explain.**

5) **In GAO's view, is an officer or employee who carries out the Department's barters of LEU for HEU downblending services in violation of the Anti-Deficiency Act (31 U.S.C. § 1342)?**

6) **In GAO's view, is an officer or employee who carries out the Department's barters of LEU for HEU downblending services subject to discipline or removal from office under 31 U.S.C. § 1349?**

7) **In GAO's view, may an official or agent who carries out the Department's barters of LEU for HEU downblending services be removed from office (or required to pay to the Treasury the value of the LEU or HEU downblending services) under 31 U.S.C. § 3302(d)?**

Questions 4 through 7. As we discussed with your staff, GAO will issue a legal opinion concerning whether DOE's transfers of LEU were consistent with the miscellaneous receipts statute and the Antideficiency Act. We look forward to receiving your letter requesting this opinion. 31 U.S.C. § 1349 provides that an officer or employee who violates 31 U.S.C. § 1341(a) of the Antideficiency Act "shall be subject to appropriate administrative discipline including, when circumstances warrant, suspension from duty without pay or removal from office." Ultimately the agency must determine the appropriate administrative action to take against any employees involved in the violation. In addition, if an officer or employee violates the Antideficiency Act, the agency "shall report immediately to the President and Congress all relevant facts and a statement of actions taken." 31 U.S.C. § 1351. Under section 145 of Office of Management and Budget Circular A-11, this report should include a "statement of the administrative

[1]In response to a comment from the Uranium Producers of America seeking withdrawal of DOE's 2016 Secretarial Determination, in the accompanying analysis DOE stated that the 2016 national security determination was outside the scope of the 2017 Secretarial Determination, which only considered future transfers of uranium hexafluoride for Portsmouth cleanup services.

discipline imposed and any further action(s) taken with respect to the officer(s) or employee(s) involved in the violation."

The miscellaneous receipts statute, 31 U.S.C. § 3302(d), provides that an official or agent who does not comply with 31 U.S.C. § 3302(b) may be removed from office and may be required to forfeit appropriate amounts. GAO's legal opinion will address whether the LEU transfers violated 31 U.S.C. § 1341(a) and 31 U.S.C. § 3302(b). As with violations of the Antideficiency Act, ultimately the agency concerned must determine the appropriate administrative action to take against any employees involved in a violation of the miscellaneous receipts statute.

8) **In GAO's view, would the Department's barters of LEU for HEU downblending services be subject to the annual caps proposed in section 203 of S. 512? If not, what changes to section 203 are necessary to ensure that the LEU bartered for HEU downblending services is subject to the caps?**

Whether the provision of LEU for HEU downblending services is subject to the annual caps proposed in section 203 of S. 512 depends on whether the transactions are for "national security purposes." If such transactions are conducted under what is currently subsection 3112(d) of the USEC Privatization Act (subsection (f) as it would be redesignated by S. 512), they would be subject to the caps. However, the December 2, 2016 Secretarial Determination asserts that such transactions would be conducted not under subsection (d), but under subsection (e) (subsection (g) as it would be redesignated by S. 512), for which no caps are proposed. Subsection (e) allows the Department to transfer or sell enriched uranium for national security purposes. While we do not dispute that downblending HEU constitutes a national security purpose, we question whether transferring LEU for downblending services constitutes a national security purpose. To the extent that the committee wants to ensure that such transactions are subject to the proposed caps, it may want to consider making the capping provision its own subsection applicable to both inventory sales and government transfers; including caps for subsection (e); or defining what constitutes a "national security purpose." Furthermore, as discussed in our response to Question # 3 above, we note that transactions conducted under subsection (e) are not subject to any of the other conditions applicable to transactions conducted under subsection (d), including: 1) a presidential determination that the material is not necessary for national security needs, 2) a secretarial determination that the sale will not have an adverse material impact on the uranium industry, and 3) that the price paid will not be less than fair market value. Clearly defining "national security purpose" could also prevent the Department from using subsection (e) to avoid the conditions imposed by subsection (d) by taking an overly broad view of what may constitute a "national security purpose."

9) **In the hearing, you responded to a question from Sen. Rounds regarding the size of the Department's excess uranium transfers/barters by stating:**

"Well, there have been several of those transactions. We looked at the first in a legal opinion we issued in 2006 and then there were others that we looked at in a report in 2011. I don't know the current value of that, but we would be happy to look into that for the record."

Would you please provide information on both size and value of the Department's excess uranium transfers/barters for the record?

In two separate GAO reports, we reported on then-values of certain uranium transactions conducted between December 2009 and December 2013.[2] GAO's work did not cover all of DOE's uranium transactions undertaken during this time, but rather covered two subsets: (1) uranium transactions between December 2009 and June 2011 where uranium was used to pay for environmental cleanup services; and (2) uranium transactions involving USEC Inc.—a private company now known as Centrus Energy Corp.—in 2012 and 2013.

In 2011, we reported on seven separate transactions where DOE used natural uranium to pay for cleanup services. Table 1 provides the quantity of uranium DOE provided for each transaction, the transaction's value as we reported it in 2011, and the present value of each transaction in 2017. The present value represents the inflation adjusted value of the transaction, and not a recalculation of the value of the transaction if conducted under current market conditions.

Table 1: Amount and Value of Natural Uranium DOE Used to Pay for Cleanup, December 2009 through June 2011, in 2011 and 2017 dollars

Date	Recipient	Metric tons of uranium	Value (in 2011 dollars)	Present Value (in 2017 dollars)
December 2009	USEC	201.90	$22,740,662	$29,006,572
March 2010	USEC	201.52	$22,020,735	$27,691,536
May 2010	USEC	226.32	$25,246,385	$30,423,010
July 2010	USEC	250.82	$27,970,088	$32,647,366
October 2010	USEC	242.74	$32,256,667	$36,454,545
March 2011	USEC	349.99	$64,030,962	$74,750,516
June 2011	Flour-B&W Portsmouth	400.20	$61,763,235	$69,794,204
Total		**1,873.49**	**$256,028,734**	**$300,767,749**

Sources: GAO-11-846 and GAO analysis.

In 2014, we reported on four separate transactions that involved DOE and USEC. Three of these transactions involved direct uranium transfers with USEC while the fourth transaction involved a uranium transfer with a third party that then transferred the uranium to USEC for enrichment. Table 2 provides the quantity of uranium transferred between DOE and either USEC or the third party (Energy Northwest), the transaction's value as we reported it in 2014, and the present value of each transaction in 2017. The transactions are as follows.

[2]*Excess Uranium Inventories: Clarifying DOE's Disposition Options Could Help Avoid Further Legal Violations*, GAO-11-846 (Washington, D.C.: Sept. 26, 2011) and *Department of Energy: Enhanced Transparency Could Clarify Costs, Market Impact, Risk, and Legal Authority to Conduct Future Uranium Transactions*, GAO-14-291 (Washington, D.C.: May 9, 2014).

1. **March 13, 2012 separative work units (SWU) procurement**. In March 2012, DOE exchanged 409 metric tons of uranium (MTU) of Russian-origin natural uranium for an equivalent amount (48 metric tons) of already enriched unobligated LEU. Unobligated uranium can be used for national security purposes, while Russian-origin uranium cannot. DOE compensated USEC for the value of the work to enrich the natural uranium—estimated at $44 million—by accepting a $44.4 million disposal liability from USEC in the form of depleted uranium tails. This transaction was essentially cost neutral.

2. **May 15, 2012 tails transfer.** This was a complex, multi-step transaction which resulted in benefits to several parties, including DOE. The value of the precipitating transaction, in which DOE transferred 9,092 MTU of high-assay depleted uranium tails to Energy Northwest, was determined by DOE to range anywhere from $0 to $300 million.

3. **June 12, 2012 tails acceptance.** In June 2012, DOE accepted $87.7 million in disposal liability from USEC for up to 39,200 MTU of depleted uranium tails. USEC credited this $87.7 million as DOE's first installment payment on its financial commitment to the American Centrifuge Research, Development, and Demonstration program. DOE did not transfer any uranium in this transaction, but rather received it.

4. **March 15, 2013 SWU transfer.** In March 2013, DOE and USEC agreed to largely reverse their March 13, 2012 transaction. The value of the SWU, which DOE and USEC continued to value at $44.4 million, was credited as payment to fulfill another part of DOE's financial commitment to the American Centrifuge Research, Development, and Demonstration program.

Table 2: Amount and Value of Certain Uranium Transactions Involving the Department of Energy (DOE) and USEC Inc.[a] in 2012 and 2013[b]

	Steps	Description of Transaction	Amount of Uranium Transacted, and Services, As Applicable	Value (in 2011 dollars)[c]	Present Value (in 2017 dollars)
1. March 2012 separative work units (SWU) procurement	1	USEC transferred tails[d] to DOE	13,073 metric tons (MTU) tails	This transaction was essentially cost neutral, in that DOE accepted an estimated $44 million in tails liability in exchange for $44.4 million worth of enrichment services. These would be worth $47.5 million and $48 million in 2017 dollars, respectively.	
	2	DOE transferred Russian-origin natural uranium to USEC	409 MTU natural uranium[e] as uranium hexafluoride		
	3	USEC transferred domestic low-enriched uranium (LEU) to DOE	48 MTU of LEU (equivalent to 409 MTU natural uranium) Enrichment services (SWU)		
2. May 2012 tails transfer		DOE transferred high-assay tails to Energy Northwest	9,092 MTU of high-assay tails	$0-300 million[f]	$0- 318.3 million
3. June 2012 tails acceptance		USEC transferred uranium tails to DOE	Up to 39,200 MTU of depleted uranium hexafluoride[g]	$87.7 million	$92.6
4. March 2013 SWU transfer	1	USEC transferred Russian-origin natural uranium to DOE	409 MTU natural uranium as uranium hexafluoride	The exchange of natural uranium and LEU conducted in the March 2012 transaction was essentially reversed. The value of the SWU enrichment services transferred from DOE back to USEC were worth $44.4 million, which is $46.9 million in 2017 dollars.	
	2	DOE transferred LEU to USEC	48 MTU LEU (equivalent to 409 MTU natural uranium) Enrichment services (SWU)		

Source: GAO-14-291 and GAO analysis.

[a]In September 2014, USEC Inc. changed its name to Centrus Energy Corp.

[b]This table is a summary of information presented more fully in GAO-14-291.

[c]Because these transactions involve uranium transfers, uranium sales that are ongoing, and uranium services, we cannot total the value of all these transactions.

[d]The enrichment process results in two principal products: (1) enriched uranium hexafluoride, which can be further processed for specific uses, such as nuclear weapons or fuel for nuclear power plants; and (2) leftover "tails" of uranium hexafluoride. These tails are also known as depleted uranium because the material is depleted in uranium-235 compared with natural uranium.

[e]Uranium is categorized by concentration of uranium-235, expressed as a percentage "assay." Natural uranium has an assay of about 0.7 percent uranium-235. For use in a nuclear power reactor or weapon, natural uranium must be enriched to increase its assay to a level required for its ultimate use. For example, LEU, which is used in commercial nuclear power reactors, typically, has an assay of between 3 and 5 percent uranium-235.

[f]DOE did value the collective benefit to the department of this transaction at about $759 million. DOE identified this amount in cost savings primarily from avoiding the costs of an alternative to using tails to obtain LEU.

[g]Conflicting amounts of uranium were reported in the documents supporting the June 2012 tails acceptance transaction.

10) In GAO's view, are the Department's uranium transfers/barters taxable events? If so, how should these transfers/barters be treated under the tax code?

To the extent that DOE is compensating contractors for services in either cash or uranium or other property, that compensation may be taxable income. Under section 61 of the Internal

Revenue Code, 26 U.S.C. § 61, compensation for services is taxable income, and if services are paid for in property, the fair market value of the property taken in payment must be included in income as compensation.

Senator BARRASSO. Well, thank you very much. I appreciate all of you being here. We are going to proceed with questions at this time, and I would like to start with you, Ms. Bawden, if you would.

First, I wanted to commend you and commend your team for the good work that you have done in bringing to light the Department of Energy's mismanagement of the public stockpile of excess uranium. I want to thank you also for the technical help that you and your team have provided to me and to Senator Markey as we drafted these provisions.

In your testimony, you explain that Federal law requires the Department of Energy to assess whether its forthcoming sales and transfers of excess uranium would impact the uranium market.

For years, the Department has relied on a contractor to assess whether the Department's sales and transfers of excess uranium would impact the market, but your team has found that the Department has not taken steps to ensure that the contractor performs quality analysis of that market.

In the process, the Department has ignored the terms of its own contract and its own information quality guidelines, and I think this is critically important.

On Monday, the Casper Star Tribune in Casper, Wyoming ran a front-page story entitled State Uranium Operators Are Facing a Global Glut. The State uranium operators facing a global glut.

We need to know whether and to what extent the Department's proposed sale or transfer of excess uranium will hurt America's uranium producers. So my question to you is what should the Department do to assess the quality of its contractor's work?

Ms. BAWDEN. There are many actions DOE could take to ensure that it fully understands the basis for its conclusions included in its secretarial determinations that uranium transactions will not have an adverse material impact on the market. First and foremost, we have recommended that DOE take steps to technically evaluate the studies for which it contracts to ensure the reliability of the conclusions of those studies.

We have also recommended that another way the Department could evaluate the quality of those studies is to put them through peer review.

We have also recommended that the studies should include sufficient information on their methodology and their assumptions so that others can assess the veracity of those studies' conclusions.

Senator BARRASSO. Could I just followup? How would this bill improve the quality of the market impact analysis that the Department prepares for itself or contracts others to prepare for it?

Ms. BAWDEN. The bill includes provisions that require the studies to be subject to peer review, and that is consistent with our recommendation to the Department.

Senator BARRASSO. Thank you. Thank you very much.

Ms. Korsnick, in 2018, my home State of Wyoming is going to become an NRC agreement State, which, as you know, allows Wyoming to assume responsibility for regulating uranium recovery. When that happens, the total number of uranium facilities that the NRC oversees is going to shrink from 11 to 3. So that means that there are only going to be 3 facilities left to shoulder all the costs of the NRC Uranium Recovery Office.

You noted in your testimony how the decline in the number of NRC licenses increases the fee burden on those licensees who are remaining. Do you believe this problem is a result of a faulty fee recovery system?

Ms. KORSNICK. Yes, that is a concern for us. It is very similar to when plants decommission, as an example, the same burden is raised on the other plants that continue to operate. So that is why, in this bill, there is a cap structure that is established, which we think directly applies to this concern and would help ameliorate that effect.

Senator BARRASSO. Terrific. The performance in the report and reporting provision in our legislation directs the NRC to expressly budget for the funding necessary to complete license reviews requested by the applicants and licensees. The bill also directs the NRC to establish transparent schedules to complete each requested review along the way.

So would you please describe the benefits of these provisions toward improving the timeliness and the predictability of the reviews?

Ms. KORSNICK. We think that is very important. Right now, the process is much less predictable from a licensee perspective in terms of the amount of time that the NRC would need to review products, etcetera. So we think that this helps improve that transparency and the predictability from a licensee perspective. It is a step in the right direction.

Senator BARRASSO. Thank you very much for your comments.

Senator CARPER.

Senator CARPER. Mr. Chairman, I notice a number of the guys up here on the dais are wearing red ties and some of the folks in the audience are wearing red as well, and today is a day where we specially recognize the contributions that women continue to make in even greater ways.

I think Senator Inhofe mentioned earlier today that about 20 years ago he was the chairman of the subcommittee on Clean Air and Nuclear Safety, and held the first oversight hearing, I think, for NRC that had been done in maybe 10 years. It has been interesting to see the lineup of the witnesses 20 years ago. My guess is it looked a little different then.

We are happy to see all of you, and thank you for your contributions and those who you represent in a very important way.

I want to start off and ask my first question. There are a lot of things in the legislation that we are here talking about that I think commend it to all of us, but what might be one thing that each of you would change in the bill? What would be maybe one thing you would like to see changed in the legislation?

We will just start right here. Thank you.

Ms. KORSNICK. One thing that we would like to see changed from what is?

Senator CARPER. Everything I do I know I can do better. I have not written the perfect bill yet, and my guess is this one probably is not perfect either. Maybe one thing that you would like to see changed as we go forward.

Ms. KORSNICK. I think there are some provisions in the bill relative to baffle bolts and some emergency planning zone issues that

we feel have been addressed and were not necessarily needed for the current bill. That would be one example that we think that would be something that could be removed.

Senator CARPER. All right, thank you.

Dr. Finan? Do you pronounce your name Finan?

Ms. FINAN. Finan, yes.

Senator CARPER. Good. Thanks.

Ms. FINAN. Thank you.

Senator CARPER. I never want to get to the end of the hearing and find out we have been mispronouncing your name for the last 2 hours.

Ms. FINAN. OK.

I think something could be added to make the bill stronger. One thing that would be helpful is if the research and test reactors were able to recover more than 50 percent of their operating costs through providing services like irradiation and tests and power and electricity or heat. That would potentially make the case for private funding of demonstration projects stronger and reduce the amount of Government matching funds that might be needed there. So I would suggest that as a possible addition.

Senator CARPER. All right, thank you.

Dr. Back? Not Back. It looks like Back, but is pronounced Back.

Ms. BACK. Thank you very much. Yes.

You know, I would like to stress the fact that innovation actually brings advantages that you can't always foresee, but one of them in the case of advanced nuclear reactors is to reduce the cost and to actually foster innovation. So I would like to see, in this bill, maybe a strengthening of the ability to look at cost-share from an industry point of view. As I pointed out, it takes 10 years or more, potentially, for technologies to give some kind of payoff. That is much longer than any private company will take on, and so we are not asking for a free ride, but a fair look at the cost-share and the contribution, especially early in the phase for the NRC regulations, would be a huge help to all of the companies that are working on advanced reactors.

Senator CARPER. All right, thanks, Dr. Back.

Dr. Lyman, if you have an idea you would like to share with us, please do. One improvement you would like to see made in the legislation.

Mr. LYMAN. Thank you for your question. UCS believes that the NRC does need regulatory reform, but it would be in the direction of strengthening safety and security, rather than weakening it. In particular, the post-Fukushima reforms that the NRC has enacted do not go as far as we would like. In particular, the Commission rejected a recommendation of its own task force to reform the regulatory structure to increase the defense in depth, that is, extra layers of protection in regulations. So, you know, as part of the larger package, we would like to see an enhancement of NRC's regulatory framework to account for defense in depth in its regulatory decisions in a more formal way.

Senator CARPER. All right. Thanks, Dr. Lyman.

Allison Bawden.

Ms. BAWDEN. Thank you.

Senator CARPER. Let me say we so apricate the work that you and your colleagues at GAO do for us and applaud your efforts on behalf of our Country. Thank you. But go right ahead.

Ms. BAWDEN. We appreciate it. Thank you.

I don't know that I would characterize this as something GAO would like to see changed, but we have suggested that the Committee could consider using a percentage-based cap in the bill for the amount of uranium the Department of Energy is authorized to transfer, rather than a hard cap. We have suggested that to the Committee. It may provide additional flexibility.

Senator CARPER. All right, thanks.

One last question for Dr. Back. It has been, I think, about a year since the Obama administration announced efforts to assist the research development and deployment of advanced nuclear reactors. Could you just give us a quick update on how things are going, please?

Ms. BACK. Sure. I would be happy to do that.

We have been very appreciative, industry has been very appreciative of opportunities that now are available to get some grant funding. Those have not been large, but there have been some that we have been able to take advantage of, and that has helped us develop some of these critical technologies that are allowing much higher temperature resistance, superior neutron irradiation tolerance; and those kinds of efforts have led to beginnings of standards that are being developed to treat accident-tolerant fuel, as well as future materials that are able to withstand much greater temperatures and much greater conditions, harsh conditions in the reactor.

So those areas we would like to see more of, but we are very appreciative of what exists. It has helped in the crosscutting, looking across all the reactors. But those opportunities are few and far between.

Senator CARPER. All right, thanks.

I am going to slips out right now. I will be back. We have another simultaneous hearing going on in Homeland Security, but very much appreciate you being here, your thoughtful testimony, and your responses.

Senator INHOFE.

[Presiding.] Thank you, Senator Carper.

Ms. Korsnick, we are in kind of a situation now, and you have heard me talk about this before, that the last 10, 15 years we have seen the workload or proposed workload in anticipation of growth in nuclear energy go up and down and up and down. Now, it was Reagan that said there is nothing closer to life eternal on the face of this earth than a government agency once formed. Well, the same thing is true with the expansion of an agency. When the workload of this agency looked like it was going to be going up, we prepared for that and then it didn't happen. And there are a lot of political reasons why it didn't happen. I am thankful that I think we have overcome those now.

In the year 2000, the NRC got its work done with 2,800 people and $470 million. Now, with 3,300 people and twice the amount of money, $905 million, it oversees six fewer reactors, half as many as the materials, licenses and reviews anticipated. The GAO commented on this. They said by 2011, however, it had become clear

that the projected growth had not materialized. NRC's budget and its regulatory fees, however, have not declined since that time.

So what is your thought on that? I know a lot of people on this side of the table are thinking, well, the stakeholders are going to be paying for this more than just Government. But, nonetheless, that is a fact that we have anticipated, growth. And, of course, it didn't happen and yet Government just grew. What are your thoughts about that?

Ms. KORSNICK. Well, I agree with your sentiments, Senator. We do understand why the NRC staffed-up. They did staff-up significantly, as you suggest, and if you look at the details for the bill, the cap is capping it at a 2015 level, which we think is a high watermark, if you will, so more than sufficient for the agency.

Senator INHOFE. Well, I wasn't really referring just to this bill. I am just saying that this is history now. This has happened. We didn't shrink any when our workload was considerably reduced in the past.

Now, I am concerned about the caps, and that was addressed by the Chairman in his questions. And I think it is a good idea to go ahead and get on record where we are going to be at that time, where we anticipate. Do you think that under 512, that the caps are realistic? I want to get on record now and say that we are going to be able to do it within those caps?

Ms. KORSNICK. Absolutely. I think that there is clearly room for the agency to be more efficient than it is today. They have done some work in their Project Aim. I would say this bill institutionalizes some of the thinking that they are doing under Project Aim, and I think the caps within the bill are clearly achievable.

Senator INHOFE. OK. That is good to hear, and we will get that on the record.

You know, as we watch, I mentioned in my opening statement the concern I have over the fact that we are not operating in a vacuum, there are other countries that are maybe even passing us up. I would like to have any one of the witnesses respond to where do you think we are right now with China and Russia.

Why don't we start with you?

Ms. KORSNICK. I guess I will start with that. I would tell you that there are 60 reactors being built around the world today, and two-thirds of those reactors are being built by Chinese and Russian design, and I think that is a significant concern that we, in the United States, need to take a look at the leadership level that we want to play in a world conversation relative to nuclear. It is not only that we have the technology and the best designs; we have the best standards on how to operate these reactors. And when you get engaged in the conversation about these reactors being operated in other countries, those standards and those nonproliferation requirements go with it, and that is something that is significant, should be very significant to us.

Senator INHOFE. Yes.

Anyone else want to comment on that, as to where we are with our competition? Yes, ma'am.

Ms. BACK. I would just like to add, also, that in, for instance, China, they are pursuing every kind of advanced reactor in R&D and hopefully, from their point of view, to a demonstration plant,

and the challenge with this is that the governments, for instance, Japan also, are sponsoring the research that is being done. So it is very difficult to compete at a fair level.

Senator INHOFE. Yes, that is a good comment.

Any other comments?

Mr. LYMAN. Yes, I appreciate the opportunity. I do agree with Ms. Korsnick that domestic U.S. standards, including NRC regulations, are the gold standard, and that is why we believe it is very important to maintain those standards and not engage in a race to the bottom. So of Russia and China, you know, Russia is the country that brought us Chernobyl, and my understanding is that China's own regulatory process, including the process for qualifying fuel, is not nearly as rigorous as the United States. So I think we need to maintain those standards, and that is the best selling point we would have.

Senator INHOFE. I think that is good. I don't want to race to the bottom, either, but I think it is important for us to talk about the fact that there is competition out there and other countries are doing things more aggressively than we are. So I think we are all in agreement on that.

Senator Whitehouse.

Senator WHITEHOUSE. Thank you, Chairman.

First, can I say I am delighted that we have been joined by Senator Booker, who is my co-lead sponsor on our side.

Let me ask, first, Ms. Korsnick, is there value to the carbon emissions-free nature of nuclear generated power? And, if so, are nuclear power plants compensated for that value?

Ms. KORSNICK. There is absolutely value, and, no, they are not compensated for it.

Senator WHITEHOUSE. I consider that to be kind of a market deformation. How does that market deformation work out in practice in the nuclear market?

Ms. KORSNICK. So the challenge we have today is that the marketplace just values electricity. It values the capacity and it values the product, but it doesn't value whether or not you have a carbon-free nature or if you have any other impact to the environment. And as you know, from a clean air energy, as we look at nuclear, you know, there are asthmas, issues in terms of health for people and there are also impacts on the environment, things like acid rain. So nuclear power is very environmentally friendly; doesn't produce any of those. In the marketplace we have today, that is just simply not something that is valued. So many of the States are using individual solutions and out-of-market solutions right now that they are using to value that, and that is becoming a challenge for the marketplace, and I know that is something right now that we are working with our members to see what it is that we can do to, in effect, come up with a more holistic solution.

Senator WHITEHOUSE. Well, I look forward to working with you. I think Chairman Alexander has a similar concern. And if there are ways we can find to compensate safely operating nuclear plants for the carbon-free nature of their power, that creates, I think, a level playing field for nuclear power, which is now disadvantaged by the fact that it gets no benefit for that.

My other question is similarly an accounting question. Very often accounting is policy. As I understand it, we don't have a liability on the books of the United States for the out-year cost of dealing with our stockpiles of nuclear waste. If we were a company and we had that liability, we would have to report it to our shareholders, and management would take a look at that liability and say, oh my gosh, that is a real drag on earnings, that is a real out-year risk for our shareholders. We better pay attention to that; we have to figure out what to do. We might even pay somebody to figure out how to reduce that liability, because there would be value in reducing the liability.

When we don't adequately account for the liability we have of all the nuclear waste we have stockpiled, then there is no economic rationale for spending money to try to move to the point we talked about earlier, which is is there a technology out there, or is there the potential for a technology out there, that could rid us of the liability for our nuclear waste stockpile by actually figuring out, through innovation, how to turn it from a liability into an asset, and find a way to turn it into a safe nuclear fuel.

Would you comment on the liability accounting of all of this and how that acts out in your world?

Ms. KORSNICK. Yes. I guess I would just frame it by saying that all of the used fuel is being safely stored today. It is not a technology problem; it is a political problem that we need to appreciate and make decisions on where we want to ultimately store this fuel. And as you heard earlier today, what we consider a challenge today, or trash today, or used fuel today, in the future I am sure we will look at it as a resource. So what you consider a liability today, depending on new technology, can quickly become an asset for the future.

Senator WHITEHOUSE. And last question to Drs. Finan and Back, who are technical experts here. Is that a prospect worth pursuing?

Ms. FINAN. Absolutely. And many of the innovative companies today are pursuing that. So I think we need to be supportive of them so that they can achieve that goal.

Senator WHITEHOUSE. Dr. Back.

Ms. BACK. Yes, I agree. Many people do consider the waste at the back end. When we were looking at EM2 and designing the reactor, we took that into consideration to be able to use the spent nuclear fuel in light water reactors regenerated and reformed into a fuel that the EM2 reactor could use. And in doing that you are gaining back all of the energy that would usually just put stored in waste and just sit there and not be reused, so we are not putting more effort into taking new natural resources, but we are actually using the waste as fuel.

Senator WHITEHOUSE. Thank you, Chairman. My time has expired.

Senator INHOFE. Thank you, Senator Whitehouse.

Senator ROUNDS. Thank you, Mr. Chairman.

Ms. Bawden, I would like to followup on what Senator Whitehouse was just talking about. In your GAO report you actually identify the fact that there are tailings and so forth that are the property of the U.S. Government today, and that there appears to be a commercially viable alternative to simply storing them and

that there has been an interest in purchasing those tailings. Could you share a little bit about your report and what you are finding actually in today's marketplace with regard to those tailings?

Ms. BAWDEN. Thank you for your correct. The last time we valued the Department of Energy's inventory of tails was in June 2014, and we put that value at about $1 billion. We have reported over the years that sometimes certain types of tails may be able to be re-enriched, and when that occurs basically the tails are used as the feedstock for enrichment, rather than natural uranium that has been converted. That has occurred on several occasions, re-enrichment has occurred, and most recently the Department of Energy issued a press release stating that there is commercial interest in purchasing a significant amount of the Department's inventory.

Senator ROUNDS. So there has been a private entity which has made an inquiry to our Department requesting the opportunity to purchase tailings, correct?

Ms. BAWDEN. That is correct.

Senator ROUNDS. And at the same time we don't have a process in place in which we can facilitate the negotiation of the sale of that in any type of a regulated manner, is that a fair way to put it?

Ms. BAWDEN. So we have had a legal opinion in the past that says we do not believe the Department of Energy has authority to transact in tails. The Department has disagreed with that legal opinion, and the bill before us today does address that issue.

Senator ROUNDS. Thank you. Let me ask another question. In your May 2014 report you recommended that for each uranium transaction that it conducts, that DOE should publicly identify the legal authority that it relies on for that transaction. You went on to indicate that there were times in which there had been transfers of uranium, a product owned by the Federal Government, that had been delivered to a third party that we apparently had a contract with and we owed money to. And instead of paying the bill with cash, we bartered it out by giving them uranium instead, and that they were then allowed to sell the uranium and that was our way of completing the transaction through DOE.

Can you talk a little bit about what that does to the accounting process and keeping track of where the money goes in an asset of the Federal Government that has been converted at this point?

Ms. BAWDEN. It is confusing. So what we have said in the cases of those transactions that we reviewed that we believe there was a miscellaneous receipt statute violation, and that the Department of Energy should have deposited in the Treasury the net proceeds of the sale of that uranium. It did not, and that continues to be a legal disagreement between GAO and DOE.

Senator ROUNDS. Do you have any idea as to the size of that transaction in terms, if we converted it to cash like we would normally do if we were going to have a transaction that could be followed, what size was that transaction?

Ms. BAWDEN. Well, there have been several of those transactions. We looked at the first in a legal opinion we issued in 2006 and then there were others that we looked at in a report in 2011. I

don't know the current value of that, but we would be happy to look into that for the record.

Senator ROUNDS. Would it be fair to say that if a department such as DOE wanted additional resources that they could utilize, they can sell an asset of the U.S. Government, basically fuel, they can sell it to a third party or transact it to a third party, rather than paying cash, which would be part of their budget, and they then have additional excess cash available to do what they want with or to cover other expenses as they see fit?

Ms. BAWDEN. The Atomic Energy Act and amendments to it does authorize DOE to transact in certain types of uranium. But what we believe is not allowed is DOE's authority to retain the proceeds from those transactions. And in these cases that is what we believe DOE has done, and that is why we included an opinion that said there was a miscellaneous receipts statute violation.

Senator ROUNDS. In other words, what they should have done is deposited it back with the United States Treasury.

Ms. BAWDEN. That is correct. And not having done so, they would have supplemented their appropriation.

Senator ROUNDS. Are you aware of any other department that transacts business like this that is currently allowed to keep the resources that we could follow? I know in your recommendation you suggested actually that rather than simply slapping their hands for doing it, you suggested that we amend the laws in place today so that they could do that in the future.

Ms. BAWDEN. We suggested that the lobby clarified one way or the other. There are examples across the Government where Federal agencies are allowed to retain proceeds from various things, but I personally don't know of any Federal agencies that transact in this way.

Senator ROUNDS. Thank you.

Thank you, Mr. Chairman.

Senator INHOFE. Thank you, Senator.

Senator MARKEY.

Senator MARKEY. Thank you, Mr. Chairman.

Ms. Korsnick, before we discuss next generation reactors, I have a question about how we can ensure that the current nuclear fleet is secure against terrorism. The 2005 Energy Policy Act includes a provision which I authored that mandates that the Nuclear Regulatory Commission conducts security inspections at U.S. nuclear power plants. The reason I built that in, obviously, is the terrorist attack on 9/11, where two planes were hijacked from Logan Airport that flew into the World Trade Center. So my goal was to make nuclear power plants more secure.

The inspections must include force-on-force exercises where a mock adversary terrorist force conducts a simulated attack on a power plant to probe potential gaps in the plant's security. These exercises allow the NRC to ensure that nuclear power plants are adequately protected against terrorists or other bad actors.

The alternative, having plant operators run their own exercises, would not only violate the law, but it would create a clear conflict of interest and undermine public safety.

In the past, the Nuclear Energy Institute lobbied the Nuclear Regulatory Commission to get rid of its force-on-force exercises in

favor of exercises conducted by the owners of the power plant. In effect, this would have nuclear power plant operators inspecting themselves.

In December I wrote to the NRC to explain that implementing such a proposal would not only be dangerous, but also illegal. In response to my letter, the Nuclear Energy Institute stated publicly that it did not support getting rid of the NRC's force-on-force exercises.

But at a recent public meeting, the Nuclear Energy Institute appears to have shifted its position yet again and now says that it might support getting rid of NRC-run security evaluations in favor, instead, of letting the owners of the plant do their own inspections.

Could you clear this up? Which side of that issue is the Nuclear Energy Institute on?

Ms. KORSNICK. I can share that we are currently conducting these force-on-force exercises. I am familiar with those. I know that there has been some work with the industry working with the NRC to see if we could do these in a more efficient way, rather than the way that they had been conducted.

Senator MARKEY. Do you support that the Government ensure that it is done independent of the owner of the plant, or do you support letting the plant operator do it? Which position do you take? There are two different positions here just in the last couple of months.

Ms. KORSNICK. What I am familiar with is that it is done independently. I will let you know that——

Senator MARKEY. Independently of?

Ms. KORSNICK. That there is an independent force that conducts these, that the NRC observes this independent force on this force-on-force exercise. That is how it is done today. I do know that there are folks that are looking at our security right now.

Senator MARKEY. So you support the continuation of NRC-run force-on-force exercises, is that correct?

Ms. KORSNICK. That is correct. That is what we do today. I do know that there are people looking——

Senator MARKEY. Do you support that position being continued?

Ms. KORSNICK. I do support that, but there are folks that are looking at it. If, in the future, they come up with a recommendation, we will evaluate it, but that is how it is currently being done today.

Senator MARKEY. Well, the reason that we have the goal of having the plant operator not inspect itself is the same reason that you don't have take-home exams in school, that not only do you take it at home, but then you give yourself your own grade. There would be a disproportionate number of A-plusses that students would give to themselves for the work which they were doing. So you need an independent way of looking at the safety issues, especially post-9/11, post-Tsarnaev brothers in Boston, as well, on Marathon Monday.

So I urge you very strongly, Ms. Korsnick, to have the Nuclear Energy Institute adopt the position which you did at the end of last year, that there should be independent inspections to make sure that these plants can withstand a terrorist attack, and it is not just done by the plant owners themselves, who will want to have, nec-

essarily, a stake in lowering the cost that they would have for trying to protect these plants.

So I can't urge you strongly enough that we learn this lesson in Boston, on 9/11, and then with the Tsarnaev brothers. They are coming; they have plans. Nuclear is at the top of their list; nuclear weapons coming in from overseas, nuclear power plants in the United States. If they don't have the kind of security that protects against a successful terrorist attack, then we are going to see them try to penetrate the loose standards that some of these power plant owners will put in place.

So I thank you, Mr. Chairman, and I yield back the balance.

Senator INHOFE. Thank you, Senator Markey.

Senator FISCHER.

Senator FISCHER. Thank you, Mr. Chairman.

Ms. Bawden, I would like to followup a little bit on Senator Rounds' questioning that he had with you. In your testimony, you mention the miscellaneous receipts statute. Can you please expand on the purpose of the statute and how it protects Congress's power of the purse under the Constitution and why the American public should care whether the Department of energy violates that law?

Ms. BAWDEN. Essentially, the miscellaneous receipts statute requires that any money the Government receives be deposited in the Treasury. When that doesn't happen, an agency has essentially augmented its appropriation or used money that Congress didn't give it, and this circumvents Congress's power of the purse, which, as you stated, is its constitutional responsibility.

In the cases that we have looked at with respect to uranium transactions the Department of Energy has carried out, DOE paid for certain services in uranium rather than paying for them with appropriated funds, and in our legal opinion did so without authority.

Senator FISCHER. So what are the consequences if the Department has violated that statute?

Ms. BAWDEN. It is difficult to determine the consequences. Miscellaneous Receipts Act violations can be resolved if Congress were, for example, to retroactively approve what the Department did or for the Department of Energy to adjust its books to reflect the uranium that it essentially provided as an obligation against its budget authority. It has not done either of those things. So it is possible, if the Department of Energy obligated more money than it was appropriated, that it could be viewed as having an Anti-Deficiency Act violation, which does carry with it penalties, civil and criminal penalties.

But we believe that Congress could ask DOE for more information about this issue to really try to understand its scope. For example, Congress could ask DOE to provide the total value of the uranium it has traded and look at that with respect to its obligational authority. There are also appropriations levers that could be used.

Senator FISCHER. So Congress does have some tools to be able to address this.

Ms. BAWDEN. Yes.

Senator FISCHER. And do you think they are appropriate at this time or do we need to look at augmenting them?

Ms. BAWDEN. I haven't looked at that issue.

Senator FISCHER. OK. Thank you.

Dr. Finan, I understand that there are several advanced reactor technologies that need uranium enriched up to 20 percent, and this is higher than the standard 5 percent enrichment currently used in operating reactors. Can you tell me more about the situation?

Ms. FINAN. Sure. Thank you for the question, Senator.

There are many of the advanced reactor companies who will need to use enriched uranium that is low enriched, but is between 5 and 20 percent, and currently we don't have a domestic supply chain for that fuel because there hasn't been a demand. So that is essentially the situation. It is possible that they could obtain the materials internationally, but that is not the preferred option.

Senator FISCHER. So it is not available right now in the commercial market?

Ms. FINAN. It is not.

Senator FISCHER. And is the Department of Energy's uranium surplus, is that the only source that we have?

Ms. FINAN. It is the only domestic source currently.

Senator FISCHER. Domestic. Which is the preferred method that we should be looking at, right?

Ms. FINAN. Right, right. So it would be a very promising way to provide a bridge for those early movers to have the fuel that they need to do their development work before commercial enrichment capacity is established in the U.S.

Senator FISCHER. Thank you very much.

Ms. Korsnick, to followup on the line of questioning we just had here, how long would it take to establish a commercial fuel supply with the enrichment necessary to meet the needs of the advanced reactors that we are looking at?

Ms. KORSNICK. For that higher enrichment, very much what Dr. Finan just said, we would look to the down-blending of the highly enriched uranium as sort of a stopgap measure, and we would need that until enough of a market develops that there would be a commercial opportunity. Once there is investment at a commercial level, we are estimating probably in the neighborhood of 7 to 10 years, but that is after the decision has made to pursue it. So I want to be careful there. It is not 7 to 10 years after people start needing it; it is after somebody has made a commercial commitment to actually pursue it. And in the meantime we think down-blending the HEU is the best approach.

Senator FISCHER. And it is appropriate that the Department would be able to supply that, do you think?

Ms. KORSNICK. It would. I think we need to look at this current bill and some caps that were put in place. We would think that the caps would not apply to the down-blending.

Senator FISCHER. And in the bill before us, S. 512, it directs the NRC to examine the feasibility of extending the duration of uranium recovery licenses, and your testimony states that you believe 40 years would be appropriate. Can you explain why?

Ms. KORSNICK. Yes. It is very commensurate with other facilities, we think, the 40-year timeframe. For example, when you license a reactor, that comes in a 40-year license. And the risk associated is much less with the facilities that we are talking about. So we think

it is very commensurate with the risk that a 40-year license would be very appropriate.

Senator FISCHER. Thank you very much.

Thank you, Mr. Chairman.

Senator BARRASSO.

[Presiding.] Thank you, Senator Fischer.

Senator BOOKER.

Senator BOOKER. Thank you very much, Mr. Chairman. And let me just say, to begin with and echoing the comments of Senator Whitehouse, how grateful I am that we have a tremendous bipartisan bill together. It really is a testimony to this Committee and our ability to work together, and I just want to thank Senators Inhofe, as he walks out, and thank you, sir, always for your leadership, and Barrasso, Capito, Fischer, as well as Senator Duckworth and Manchin, who are now all cosponsoring what I think is a very strong bill. In fact, I think it is an urgent bill.

Nuclear energy, right now, is critical, if not vital when you look at the larger energy picture in the United States of America. Not only is it from the perspective especially from us Democrats here, about the challenges, crises we are facing from the bleaching of coral reefs to, as was mentioned already, the extraordinary high asthma rates in communities like mine. But it is also urgent when it comes to the global security perspective and the competition we are seeing in nuclear energy, and what is happening with those scientists who are many ways being developed more so in China or Russia than here in the United States.

Right now we all know that nuclear energy provides a very, very critical aspect of our non-carbon-producing power. We did the right thing in a very important negotiation in 2015, when we extended tax credits for wind energy and solar energy and, as a result of having 7 years of predictability, we saw a boom in investment in this area, literally creating thousands and thousands of more American jobs. And it was the right thing to do, especially if you look at, as Senator Whitehouse was saying, the impact of carbon and the cost of carbon. But we did not include nuclear energy as a result.

Now, the crisis we have is the fact that if you look at wind and solar, we still have nuclear power, baseload, critical baseload power, which now compromises about 20 percent of the total U.S. electricity generation and more than 60 percent of our Nation's carbon-free electricity. It is a powerful component. And to have these plants closing down and having us move, as a Nation, away from nuclear energy really threatens our ability to do carbon-free, to reduce our carbon-producing, polluting-producing energy sources.

So right now in the United States, though, the good news is that there are dozens of private sector companies that are moving forward and making billions of dollars in investments in advanced nuclear designs that could lead to the next generation of reactors. I confess, when I first read about advanced nuclear, I thought I was reading science fiction and not science fact, because these reactors are far more safe to not have a lot of the challenges or problems; actually eat the spent nuclear fuel of current generation reactors.

So we really need long-term policies that are going to support the existing fleet, but also support the development and upscale of ad-

vanced nuclear technologies. So that is what the urgency is right now.

I think some of the issues that Senator Markey was bringing up are critical. We need to always be doing everything safely. But if we are going to move forward and embrace a carbon-free future, we are not going to get there quick enough relying on solar or wind; nuclear has to be a critical part of it. And, again, looking at the critical global security issues and competition issues, this is a space that we don't want to give the advantage to other nations.

So I want to thank everyone who joined together on trying to design a bipartisan bill. It creates a regulatory regime that still focuses on safety, but also focuses on creating a regulatory environment for us to lead. And my hope is, I think what Senator Whitehouse was hinting at, is we start looking at valuing the carbon contributions or, I should say, the non-carbon contributions of nuclear as well as thinking of ways to create tax policy in the way we did with solar and wind in this space.

But very quickly I would like to just put a question to Dr. Finan on a concern I have about the first-of-the-kind technologies, people that are moving in this advanced nuclear space that is really, I think, critical right now and exciting. There is an issue for the first-of-the-kind technologies that there is a significant design review costs in this space, both pre-application and post-application. These costs can be higher and less predictable than for subsequent projects. So I want to know, Dr. Finan, do you see this as a problem and can you talk about how the DOE matching grant program in this bill could really help solve that problem?

Ms. FINAN. Yes. Thank you for the question. Many of the advanced nuclear companies have cited these review costs as a major challenge to their commercialization. I think that the grant program will help to address that, as similar programs have for the AP 1000 and for the NuScale project.

Senator BOOKER. So this is a first step. But looking at the future, this really exciting technology in the nuclear space, are there things that we can do to expand on the DOE grant program in this bill and make it actually more effective, if you were sort of advising us?

Ms. FINAN. I think that there are. The current language authorizes that that grant program can be used to defray NRC fees. You could expand that to allow it to be used for applicant costs in preparing and pursuing the applications, as has been done in the SMR program; and that might be more effective.

Senator BOOKER. Thank you very much. And then there are clearly these economic reasons, which I have discussed, why we want to develop these next generation nuclear technologies, or safety reasons why we want to embrace these next generation nuclear reactors here in the United States, but can you talk about some of the other reasons why this is so critical and what risks we face if we don't allow these technologies? What is exciting you about it and what are the risks for not moving forward?

Again, I feel like a nerd now when I go around sort of talking about the exciting next generation nuclear technologies, so I am hoping that you can confirm me so I can clip this part right here and my friends don't think I am weird for talking about it so much.

[Laughter.]

Ms. FINAN. Absolutely. Well, the U.S. has been a leader in nuclear energy since the dawn of technology, and we are actually starting to cede that leadership, as has come up a couple times today. Many would argue we have ceded it to Russia and to China and others, but we have an opportunity here with this future before us to seize that role back and to really regain that leadership role so that we have influence on non-proliferation discussions and on best practices and safety and environmental issues globally. And I think that is a key thing that we will lose if we don't maintain leadership here.

Just one other point is that if we don't support our domestic innovators, some of these technologies might not be developed at all, or they could be supplanted by designs developed elsewhere, where they don't necessarily prioritize safety the way that we do here.

Senator BOOKER. And if you could just clarify for me, in terms of, again, Senator Whitehouse is one of the leaders on this issue of trying to create a carbon-free future in energy. To get there quickly, what is the role that nuclear must play if we are going to get there in 10, 15, 20 years?

Ms. FINAN. Nuclear needs to play an enormous role. We have a huge increase in energy demand globally that we are going to see, and we can't keep those people from having energy. We need to have everyone have energy abundance for human health and economic growth, and nuclear really is available and ready to play a role in providing that energy globally, without any carbon emissions or criteria pollutants.

Senator BOOKER. And so from India, which is still embracing coal power plants left and right, China still starting new coal power plants left and right, if we get this technology right, if America leads on it in this space, we can really be the leaders in proliferating and really helping to stop this continued reliance on dirty fuel.

Ms. FINAN. Right. We can bring great opportunity to developing countries so that they can have clean, abundant power, but also help our economy here at home with abundant exports of our technology.

Senator BOOKER. And is the safety of advance nuclear excite you as much as me? Does it?

Ms. FINAN. Absolutely. I think that one of the biggest amazing things about advanced nuclear is the prospect of being able to have a plant that does not have impacts outside the site boundary in an accident. I think that is a critical characteristic for advanced nuclear plants to meet.

Senator BOOKER. Thank you very much. Please, more caffeine in your next hearing so you can be as jazzed as I am about this.

[Laughter.]

Senator BOOKER. And, Dr. Back, really quick, I am excited about the work that you and your team are doing over at General Atomics. In your testimony, you touched on advanced reactors can be safer than existing technologies. Could you just elaborate on that safety as the last point? Thank you.

Ms. BACK. Yes. This gets to your excitement about new technologies. I mean, we start with a fiber that is a silicon carbide fiber. We make it into a weave and then we solidify that by depositing silicon carbide in between. That makes something that is called a silicon carbide composite that is much more resistant to the neutron radiation and also can go to more than two times the temperature of metal zircaloy, for instance.

So that fundamentally changes the game for safety because you cannot only avoid accidents in areas where you had meltdown in Fukushima of the fuel and the fuel rod, but also you reduce the generation in hydrogen so you don't have explosions like at Fukushima. Also, that allows you to burn the fuel more efficiently; you can go to higher temperature. That allows you to generate more electricity from the same amount of heat. So, for instance, for EM2, we can generate 60 percent more energy from the same amount of heat.

And there are simple things with technology where you can borrow and build on other technologies, for instance, moving from a steam generator to a gas turbine also jumps you enormously from light water reactor plant is sort of bounded by 33 percent efficiency. When you use gas turbines, you can jump up to 53 percent for our particular design. There are other designs that use gas turbines, but also make other advantages in technologies that allows you to burn fuel more or, in the case of safety, which I shouldn't forget, we started EM2 before Fukushima happened, but it turns out the silicon carbide material that we use is exactly used. It is important for light water reactors for the same reasons it is for EM2, which is that it is more resistant at temperature and you can avoid these problems that happen at Three Mile Island and Fukushima. These would not have been problems where you would have to walk away from the reactors.

Senator BOOKER. Thank you very much.

Thank you, Mr. Chairman.

Senator BARRASSO. Thank you, Senator Booker.

Senator CAPITO.

Senator CAPITO. Thank you, Mr. Chairman.

And thank all the witnesses.

I would like to address both my questions, really, to Ms. Korsnick. In the GAO report on the NRC's fee recovery process, one industry stakeholder indicated a lack of understanding as to how the fees actually relate to the NRC's budget. You talked a lot about this in your written statement. Another noticed a mismatch between the activities in the NRC budget and the activities the staff actually performs.

So are the structural problems with the NRC's fee recovery a recent development or has the industry had longstanding concerns about the fee structures?

Ms. KORSNICK. We have actually had longstanding concerns, and I know we have had conversations that date back, I don't know, to the early 1990's, I believe, talking about the concerns that we expressed. We do think that this bill is a step in the right direction in terms of creating more transparency and making it much more clear in terms of where money is being spent. You mentioned a report. There was also an Ernst & Young report that was done in

terms of the amount of money that the NRC spends on their corporate costs, so through the provisions in this bill I think there is more clarity in terms of how much money would actually be spent on those corporate costs, which is something that is of much interest to the industry.

Senator CAPITO. I guess a very simple question, when I was reading some of the background on this issue, in terms of corporate costs, is that another name for administrative fees? Do you know what those corporate costs are that they are devoting, what is it, 32, 33 percent of their budget to?

Ms. KORSNICK. It is a wide range of things; human resources, administrative costs, building fees, for example, where the offices are located. There are information systems costs, etcetera. So it is a variety.

Senator CAPITO. It is a variety. OK.

So you just mentioned that you think that S. 512 would go a long ways toward the transparency. I have the GAO report here, which recommends greater transparency. So you are satisfied that this is necessary to get that transparency and equity that you think would make this fee structure much more fair and transparent?

Ms. KORSNICK. Absolutely. Step in the right direction.

Senator CAPITO. Well, thank you. S. 512 also directs the NRC to expressly identify the funds necessary to work on reviews requested by licensees and applicants, and I understand that one of the issues is, as plants decommission, it then gets the last man standing, fees go up. Could you talk about that a little bit?

Ms. KORSNICK. Yes. And that is why the provision in the bill relative to the cap is important to us, because, as we spoke earlier to your point, as plants decommission, it raises the price, if you will, on the plants that remain, so the cap structure that is put in in this provision in this bill would help ameliorate that effect.

Senator CAPITO. Could you say affirmatively that this wouldn't compromise any safety or security issues around any of the plants?

Ms. KORSNICK. Absolutely. And the reason I would give you for that, first of all, the level that it is capped at is the 2015 level, which is a high watermark in terms of the amount of money; and in the same token, if there is some, I will say, unforeseen event that for some reason the NRC would feel the need to go higher than the cap, there is a provision in the bill for them to make that appeal in that case. I would find that, obviously, very remote, but there is a provision in the bill should that be necessary.

Senator CAPITO. Right. Thank you very much.

Senator BARRASSO. Thank you, Senator Capito.

Senator HARRIS.

Senator HARRIS. Thank you.

To Ms. Bawden, as you know, the San Onofre Nuclear Generating Station in San Diego, California was nationally scrutinized, beginning in 2012, for concerns over the radioactive leaks and potential fire concerns, and I can tell you, living close to that community, many families, many children very concerned about the health consequences of what happened there. And the Nuclear Regulatory Commission then began its investigation, which ultimately led to the decommissioning, as you probably know, in 2013, of the station. Still, there are concerns that of the almost 3.6 million

pounds of radioactive nuclear waste that was left behind, that there could be significant risk to the 65,000 residents of the San Clemente area and its surrounding communities.

So from the GAO's perspective, has the Nuclear Regulatory Commission sufficiently overseen what is going on in that area and in particular the work of Southern California Edison and its process for handling the nuclear waste?

Ms. BAWDEN. I appreciate that question. Unfortunately, I am not GAO's expert on NRC regulation. I came today——

Senator HARRIS. What have you heard around the office?

[Laughter.]

Ms. BAWDEN. That is a great question. No, I would be happy to provide the details on GAO's work for that for the record.

Senator HARRIS. OK, I would appreciate that. And as soon as possible, because, obviously, it is a big issue for the folks who are there.

Ms. BAWDEN. Absolutely.

Senator HARRIS. In addition, GAO issued four reports between 2003 and 2011 which cited the Commission's regulations were "too weak" in their ability to ensure safety and security for the nuclear power plants, and also the concern about their ability to monitor the underground pipe leaks and their ability to enforce fire protections, all issues that apply to many places but, in particular, San Onofre, from my perspective.

Do you think that there are existing regulations that the Commission should strengthen or others that the Commission should consider before we start having a discussion about expediting licenses to advanced nuclear energy projects?

Ms. BAWDEN. Again, I very much appreciate your question and I will provide a full response to it for the record.

Senator HARRIS. OK. And thank you.

Ms. Back, one of my general concerns about how nuclear waste is disposed of is that even if there is some of it that remains, it presents a serious challenge and harm to the health of the people in that community. Last year, in an interview with the San Diego Tribune, you stated that General Atomics' new Energy Multiple Module, which you have mentioned, EM2, could decrease the amount of nuclear waste by 97 percent, which is laudable, compared to a traditional nuclear reactor. So although, of course, that is encouraging, what will completely eliminate the nuclear waste that is produced?

Ms. BACK. That is a tough challenge, but the way that we reduce the amount of waste is we I don't want to say burn, because you are not really making a flame, but you are using up the fuel, you are consuming the fuel when you start to generate heat which then turns into electricity. If you generate at higher temperatures and you generate or you run the fuel for a longer time—in EM2 we use the fuel for 30 years—then you can burn up, if you will, the radioactive elements that are having long life radioactive decay, also short life. But if you then use that fuel and reconstitute it and then take it through the reactor again, then you can burn more. After multiple cycles is how you get to a 97 percent decrease.

Senator HARRIS. So what about that remaining 3 percent? Let's talk about that.

Ms. BACK. So that remaining 3 percent, there is still some part you will have to put into a geological disposal. That will be much, much smaller volume. If you look at the amount of volume from reducing it to 97 percent less, it is hardly comparable.

Senator HARRIS. So what do you imagine the future will look like in terms of our ability, based on the research and the science that we are engaged in, what could it possibly look like that we would be able to completely eliminate that remaining 3 percent? What would need to happen?

Ms. BACK. I think in the end you still have to dispose of it as a geological waste. So there will be some small amount that you will still have to dispose of.

Senator HARRIS. Do you foresee that incrementally we will get to the point that we will at some point reduce that number to 2 percent and 1 percent, or have you determined that 3 percent is pretty much the end? Pardon the pun.

Ms. BACK. No, I am never going to second-guess science; there are too many discoveries that have happened.

Senator HARRIS. Of course.

Ms. BACK. And new technologies that maybe are able to do something in the future that we can't imagine now. But today I would say that that 3 percent is going to have to go into a geological waste. But I think that should be kept in contrast with the huge amount of waste that you see generated for other power sources. So this is an extremely efficient use, where you are taking a large atom, uranium, it is splitting, you are getting out energy.

You know, the footprint of a nuclear reactor, for instance, compared to a solar array, which basically we can't get States that will give us a large enough amount of surface area because it is just not possible; the technology is not able to compensate. So replacing that 20 percent of nuclear energy that is going to be retired, I personally can't see a way to do that right now. So, to me, nuclear has to be a part of the diverse mix of energy sources. I think it is also good for the Nation, for national security, and this is, I think, something that we, as a Country, have to make a decision to invest the money and the technology to really be able to make these hurdles.

I mean, if you look at the comparison of, I have used this before, but it is just too simple to see. If you look at your telephone from the 1950's and you look at your iPhone today, I mean, you could never have imagined that it could grow by leaps and bounds there. Nuclear technology has not really fundamentally changed since the 1940's and 1950's, when it was developed, so I think probably there is not a person in this room that couldn't imagine that you could make improvements and make them safely. I mean, we value the NRC. We believe that they should exist and we believe they should be regulated, and we think that advanced reactors can fit within that envelope easily. We have to be given a chance and it takes time to prove these things out, but that doesn't mean that we shouldn't start now.

Senator HARRIS. Thank you.

Senator BARRASSO. Thank you very much, Senator Harris.

Senator Duckworth, thank you for being a cosponsor. If you would like to have some additional time to make an opening statement as well as the questioning, please feel free.

Senator DUCKWORTH. Thank you, Mr. Chairman.

Well, I would like to thank the Chair and Ranking Member for convening today's hearing. I also want to commend Chairman Barrasso for your leadership in developing this legislation in a transparent and bipartisan fashion. I am very proud to cosponsor this bill that seeks to modernize how we regulate the nuclear industry.

My constituents get a significant amount of energy from nuclear sources. Illinois's 11 reactors, the most of any State, generate half of the State's electricity. We also have 3-D activated reactors.

But that is only half of the story. These facilities are major job creators in my State. Illinois's nuclear energy facilities employ nearly 6,000 high skilled workers and, on average, each reactor has an annual payroll of $40 million a year, and Illinois facilities pay almost $300 million in State and local taxes. These are good jobs, and my mission in the Senate is to protect them and the communities that they support. So I thank the Chairman for this bill.

I would like to begin my questioning by just saying a lesser known fact, but one that we take special pride in, is that Illinois is home to Argon National Laboratory, one of our Nation's crown jewels of scientific research and a leader in developing nuclear technology. In fact, our current nuclear technology is a product of the hard work performed by Argon researchers in Illinois.

The folks there, about 3,300 researchers and scientists, are leading the Nation's development of fast reactor and fuel recycled technologies, and if Congress fulfills our commitment to fund this program, Argon will fulfill its promise to improve the affordability of nuclear power, enhance safety and security, and minimize radioactive waste, as we have been discussing already.

Dr. Finan, you mentioned in your testimony that startup companies are pioneering nuclear designs that offer safer and more affordable nuclear technology options. In your view, what are the top nuclear innovation benefits of our investment in DOE national laboratories, such as those made at Argon, particularly when it comes to materials development, advanced chemistries, reduced nuclear wastes, and super-computing capabilities? Can you talk about some of the things that are exciting that are happening right now that really depend on the DOE laboratories?

Ms. FINAN. Absolutely. The national labs are really invaluable and irreplaceable partners to these nuclear innovators. Not only, as you said, do they develop many of the technologies that this work is based on now, but these innovators are working hand-in-hand with experts at the national labs, including Argon and Oak Ridge in Idaho, all of those places, to do their materials work and to do their super-computing. They are using the experimental facilities at those labs that aren't available elsewhere, and, really, it is enabling them to move forward in a way that the private sector couldn't do alone. So the labs play a critical role in all of those areas.

Senator DUCKWORTH. Is there any particular technology that is being developed that you find especially exciting that is a partnership with private organizations?

Ms. FINAN. I think one of the key technologies being developed or worked on and furthered is fast reactor fuels, which are really being developed in partnership with the labs and the private companies, and that is an important synergy, where the fuels really couldn't be developed on their own in the private sector.

Senator DUCKWORTH. Thank you.

I believe deeply in scientific research and remain committed to advance in innovation. I also know that R&D on its own will not make the lives of Illinoisans or Americans better by itself. In order to fully capitalize on our investments in next generation nuclear technology, we have to make sure that those jobs associated with them stay at home. So could you speak a little bit as to how you think we could ensure that U.S. components manufacturers and manufacturing workers, what kind of a role do they plan in the development of manufacturing of SMRs and other advanced nuclear technologies, the folks who are the subs and who are making the components?

Ms. FINAN. Sure. You know, I think it is important to note that several U.S. companies are already turning to other countries to be their main partners in licensing and demonstrating their technologies. And when they do that and go that route, they are much more likely to use manufacturing in those countries where they are looking for their demonstrations to be built. So I think the best way that we can support more manufacturing here in the States is to really support the innovators' ability to be licensed and to demonstrate their technologies here in the U.S., and I think that S. 512 goes a long way toward assisting that. We also need to support the supply chain here to make sure that the manufacturing is available for those technologies.

Senator DUCKWORTH. Thank you.

Ms. Korsnick, how can advanced reactors and innovation contribute to overcoming the economic challenges that current nuclear power plants are facing in States like Illinois?

Ms. KORSNICK. Well, if we were to look ahead in the future, you know, 30 or 40 years, I see a grid that is supported by advanced nuclear in strong partnership with, say, wind and solar for a clean energy future. And by doing that, these advanced reactors, they produce more than just the electricity that we are all interested in; they are partnering with other systems, say, high temperature, steam that maybe another technology might need to use. So you can imagine these reactors of the future supporting desalinization plants or supporting, again, other technologies that are in need of this high pressure steam, for example.

So I see the design very different than just reactors that are there and supporting of just an electric grid. It will be more of an integrated view.

And, also, as you look at these advanced reactors, they are not all the large reactors that we think of today and benefit today from; they are reactors that are a 1 or 2 megawatt size, a 50 megawatt size, as well as the large size. So you can then see a variety of deployments, right? Think of some remote locations out in the

middle of the desert or out in the middle of, say, Alaska, that maybe you only need a couple of megawatts or maybe you want a couple of megawatts that you put together that you are now able to have in this remote location. Maybe it only needs fuel every 10 to 15 years. Well, that is very helpful in some of these remote locations.

We talked about the fact that the world needs energy. But some places in the world are relatively remote. So being able to provide this technology in a case where you don't have to refuel it very often, also very significant. So we really look ahead to see a very dynamic future. Our challenge is what can we do today to spur that future to a reality.

Senator DUCKWORTH. I really see nuclear as a consistent source of fuel in that coalition with wind and solar and all of the other sources, because it is always there.

Ms. KORSNICK. Absolutely.

Senator DUCKWORTH. Thank you.

I yield back, Mr. Chairman.

Senator BARRASSO. Thank you very much.

At this time I would like to ask unanimous consent to submit for the hearing record three letters in support of the bill, one from Mr. Ed Wallace of GNBC Associates, Mr. Jay Faison of ClearPath Action, and Mr. Josh Freed of the Third Way.

[The referenced information follows:]

GNBC ASSOCIATES

8121 E. 6th Ave
Denver, CO 80230
423-902-5330

March 6, 2017

Senator John Barrasso (R-WY) Chairman,
Senator Tom Carper (D-DE) Ranking Member
Senate Committee on Environment and Public Works

Re: S512 Nuclear Energy Innovation and Modernization Act (NEIMA)

Dear Honorable Chairman and Ranking Member:

I am writing in support of the timely passage of Senate bill S512. I am a 47 year veteran of the power industry who has been involved in development, design, construction, licensing and operations of multiple generations of nuclear and non-nuclear power plants. This is a very important moment in American history, one where the opportunity to become energy independent, with a well-crafted mix of reliable, secure, carbon free and affordable energy can drive a renewed, reinvigorated economy capable of supporting the needs of American citizens. Nuclear power is an important part of that mix and must remain so for generations to come. Renewables are not a singular answer. The true cost of renewable energy is hidden since backup power, currently in the form of nuclear, natural gas and some coal plants is needed to take up the slack at times wind and solar power are not available. Economic growth and reliable, affordable electricity remain intimately and inextricably tied. Without a new generation of advanced reactors, some envisioned as far back as the Atoms for Peace Program, nuclear energy will wither and die exactly at the time the nation needs it most.

The vision and purpose demonstrated in S512 is essential to have the next generation of nuclear designs ready to fill the gaps caused by retirements of existing generation and to supply the needed new capacity that fuels America's prosperity and security. One key to delivering on time is to make the nuclear regulatory process far more efficient and timely. The first decade of reactors still operating safely and reliably today were designed, licensed and constructed in less than ten years. That should be the goal today. Simpler, safer and more economical reactors are on the drawing boards of small and large companies anxious to fill the energy gap. Yet the single impediment most often heard in boardrooms, financial institutions and energy planning agencies, is can we count on them being delivered in time? To be sure, there are any number of events, natural and man-made that can slow or stop a major project like a nuclear power plant. However, modernizing the regulatory practices and requirements to achieve a predictable, practical and timely end is at the top of the list. This bill recognizes the essential features well. It deserves prompt and bipartisan support for what it can enable if done right. It can open the path to advanced nuclear energy delivery in the early 2030's, just when the country needs it most.

Thank you for your vision and support for this critical legislation.

Edward G. Wallace
President, GNBC Associates, Inc.
ed.wallace@gnbcassociates.com

8121 E. 6th Ave
Denver, CO 80230
423-902-5330

CC: The Honorable Senators Sheldon Whitehouse (D-RI), Jim Inhofe (R-OK), Cory Booker (D-NJ), Mike Crapo (R-ID), Deb Fischer (R-NE), Shelley Moore Capito (R-WV), Joe Manchin (D-WV) and Michael F.Bennet, (D-CO), Cory Gardner (R–CO), Lamar Alexander (R-TN)

March 7, 2017

Chairman John Barrasso
U.S. Senate Environment & Public Works Committee
Washington, DC 20510

Ranking Member Tom Carper
U.S. Senate Environment & Public Works Committee
Washington, DC 20510

Dear Chairman Barrasso and Ranking Member Carper,

On behalf of ClearPath Action, a 501(c)4 organization working to accelerate conservative clean energy solutions, I want to let you know of our support for the proposed Nuclear Energy Innovation and Modernization Act.

Nuclear power is one of the most important energy resources of the United States, representing a triumph of American ingenuity and engineering. Nuclear energy is highly reliable, clean and affordable, and is a vital part of our electricity mix.

Nuclear plants built decades ago still safely provide 20% of our electricity. But as these plants near retirement, a new generation of advanced nuclear technology is being developed by dozens of companies and universities across the nation. Advanced nuclear reactors promise benefits from increased safety and affordability, resistance to proliferation, and the ability to run on old nuclear waste.

Several of these advanced nuclear companies will begin applying for design certifications within the next 5 years, and one company called NuScale Power recently submitted the first Design Certification Application for a Small Modular Reactor. However, expensive and arduous regulations at the NRC are encouraging some others to consider building abroad for initial deployment.

Instead of driving our engineers overseas, we should be promoting a regulatory environment that is safe, innovative and efficient. The Nuclear Energy Innovation and Modernization Act does just that – directing the NRC to develop a technology-inclusive licensing plan that promotes safety without being prescriptive, while modifying the cost recovery mechanism so utilities aren't on the hook for other companies' technologies.

Updating our regulatory system for advanced reactors is an important part of the broader need to "rightsize" the NRC to match its workload. To that end, this legislation also wisely prevents the NRC from allowing its annual fees and administrative costs to overwhelm the broader nuclear industry.

The NRC is second to none for safety, but it has unfortunately also become second to none for cost, delays, and complex rulemaking. This legislation preserves our record of safety while preserving an abundant clean energy future for our children.

Sincerely,

Jay Faison
President

ClearPath Action Fund for Conservative Clean Energy, Inc.
300 New Jersey St, NW, #907
Washington, DC 20001

cc: Senators Jim inhofe, Mike Crapo, Cory Booker, Sheldon Whitehouse, Deb Fischer, Shelley Capito, Joe Manchin

third way
fresh thinking

THE CLEAN ENERGY PROGRAM

March 6, 2017

Chairman John Barrasso
307 Dirksen Senate Office Building
Washington, D.C. 20510

Ranking Member Tom Carper
513 Hart Senate Office Building
Washington, D.C. 20510

Dear Chairman Barrasso and Ranking Member Carper:

I am writing to voice strong support for the recently-introduced bill, S. 512, the Nuclear Energy Innovation and Modernization Act. Protecting the continued safe operation of the existing fleet of nuclear reactors and enabling the development and deployment of advanced reactors can play a major role in meeting both domestic and global targets for emissions reductions. It can also allow U.S. industry to compete for a growing global market, create domestic job growth, and enhance America's international influence. To reap these rewards, U.S. policy must encourage continued production from our existing nuclear fleet while also providing a viable path to commercialization for advanced nuclear. The current structure of certain processes at the Nuclear Regulatory Commission (NRC), however, may actually act as a deterrent to safe and economical operation and advancement of nuclear technology.

Innovation in the private sector has grown rapidly over the past several years, but regulatory uncertainty at the NRC is hampering long-term investment. The current licensing process was developed for a previous generation of technology and is ill-equipped for advanced reactors. This bipartisan bill would require the NRC to provide a pathway for advanced reactor licensing that would better guarantee their safety and encourage continued investment in innovation. It would also provide much-needed transparency and fee reform to address concerns about increasing regulatory costs for our existing nuclear fleet.

We applaud the introduction of S. 512 and hope that your Committee quickly approves it. The United States government plays a vital role in the future of the advanced nuclear sector and this bill establishes the regulatory certainty the industry needs to succeed. We look forward to continuing to support it as it moves through the House and Senate.

Sincerely,

Josh Freed
Vice President for the Clean Energy Program
Third Way

cc:
Senator Mike Crapo
Senator Sheldon Whitehouse
Senator Cory Booker
Senator Jim Inhofe

Senator BARRASSO. Senator Carper.

Senator CARPER. Thanks, Mr. Chairman.

Thanks again to all of you for joining us today and for your testimony. I think we feel encouraged on much of what has been said.

Dr. Lyman, in his comments when he was speaking earlier today, reminded us of Fukushima and the horror and havoc that it has created for a place in Miyagi Prefecture, a place which is a sister State of the State of Delaware. I have been there before and have a great affection for Miyagi and the people who live there.

I am going to ask a question for the record, but I am going to tell you what it is now and we will ask it for the record. There are a number of lessons we needed to learn; the Japanese needed to learn from Fukushima: What went wrong? Maybe what went right, but mostly what went wrong. I am not going to ask you to respond right now, but I am going to be asking for the record. In terms of what went wrong, what have we learned? What are we doing differently hear in this Country? Maybe what more do we need to do in order to fully realize and gain from the lessons of something very bad that happened?

I would like to say sometimes out of something bad something good comes, and my hope is that certainly is the case here.

The other thing I want to ask, one of our witnesses before this Committee once talked about if you could take all the spent fuel from nuclear power plants in this Country and stack them up on a football field, Mr. Chairman, it would fill up a football field and go up into the sky not a couple of miles, but it would go up into the sky for some distance. And some of you probably know the answer to that question. Does anybody know how high it would be today? Anybody know? I don't know.

Ms. KORSNICK. I think the estimate is 20 yards. It is not very tall.

Senator CARPER. It is not that far.

Ms. KORSNICK. No. If you used all of your energy personally that you got for your entire lifetime, and you got it from nuclear power, that waste would fill a 12 ounce can of soda.

Senator CARPER. Thank you.

Ms. KORSNICK. So the volume is not very large.

Senator CARPER. I am encouraged by what Dr. Back told us about 97 percent spent fuel being really burned up or consumed.

Whether it is 20 yards or however high that pile of spent fuel rods goes in that football field, do we have the ability to derive additional energy from that spent fuel? I know a lot of it is in casks and so forth, but is it gone forever and just has to sit around for tens of thousands of years, or is there some potential to derive energy from it going forward?

Ms. KORSNICK. Oh, we can absolutely. There is about 95 percent of the energy left in that spent fuel; it has just been transitioned to a different isotope, if you will. There is technology available around the world today in reprocessing. As you may know, France reprocesses fuel.

Senator CARPER. I have been there.

Ms. KORSNICK. And that is how they tap into that additional energy, because you then make that available, if you will, for a different source. And some of the technologies that these folks here

are talking about are other ways that they can tap into the use of that energy?

Senator CARPER. All right.

Do you have any closing statement, any briefly closing thought that comes to mind before we conclude that might be helpful for us? Anybody? Please. Just very brief.

Mr. LYMAN. Yes. I would just like to go back to this issue that keeps coming up about consuming spent fuel, about reprocessing. You know, I appreciate Senator Booker's enthusiasm for these technologies, but I do believe that many of them still are in the science fiction stage, and it is not clear that throwing a lot more money and time after them is going to realize their promise.

Reprocessing is dangerous, it is dirty, and it is expensive. Other countries have had terrible experience with it and they are dealing with the legacy. The French company AREVA, is practically bankrupt, or it is bankrupt, and a large part of that has to do with its reprocessing activity. So reprocessing is not a solution for nuclear waste.

And my concern is that a focus on the pipe dream of trying to burn up or consume spent fuel is distracting from developing systems where you increase uranium utilization on a once-through basis, and one example of that was the original TerraPower reactor that was being developed by the company Bill Gates sponsored. The promise of that type of system is that you can achieve the goals that people who claim are for reprocessing without having to actually process the spent fuel, extract plutonium, and securing the safety liabilities associated with that process.

So our recommendation as the main direction for innovation should be to pursue once-through cycles where you can get some of the purported benefits of reprocessing without separating plutonium, which is a proliferation and terrorism risk. And I would really hope that you would look into those issues in your reconsideration of whether it is really feasible or practical to burn up spent fuel.

Senator CARPER. My time is about over.

I am going to ask, for the record, I will ask our other witnesses to respond to what Dr. Lyman has said. And we appreciate you raising those points.

I will close with this thought. We know climate change is real. We only have to look at what has happened this winter on the east coast and California, where they got more rain in a couple of weeks than they have gotten in years, and stuff like that. So it is apparent that it is real.

The question is what do we do about it. About two-thirds of the carbon-free electricity being produced in this Country comes from nuclear, and that is a good thing, and we need to figure out how to come up with more carbon-free energy. But we need, at the same time, to keep in mind that nuclear has a lot to offer, and hopefully in the future even more.

Thanks so much.

Senator BARRASSO. Well, thank you, Senator Carper.

Thanks, Senator Booker, for staying with us all the time.

Thank you all for your testimony. It was, I think, very beneficial to all of the members of the Committee. Some members who

weren't able to be here for the whole time may submit written questions. I hope you will try to get those answers back to us.

The hearing record will remain open for 2 weeks. Thank you for being here. The hearing is adjourned.

[Whereupon, at 12:05 p.m. the committee was adjourned.]

[Additional material submitted for the record follows.]

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STATEMENT OF WILLIAM PAUL GORANSON
EXECUTIVE VICE PRESIDENT, ENERGY FUELS RESOURCES (USA) INC. ON
BEHALF OF THE URANIUM PRODUCERS OF AMERICA

ON

THE NUCLEAR ENERGY INNOVATION AND MODERNIZATION ACT (S. 512)

SENATE ENVIRONMENT AND PUBLIC WORKS COMMITTEE

MARCH 8, 2017

My name is William Paul Goranson, and I am the Executive Vice President of ISR Operations for Energy Fuels Resources (USA) Inc., with offices in Casper, Wyoming. On behalf of Energy Fuels Resources (USA) Inc. and the Uranium Producers of America (UPA), I am pleased to offer testimony in support of the Nuclear Energy Innovation and Modernization Act, S. 512. We greatly appreciate the leadership of Chairman John Barrasso and Senators Sheldon Whitehouse, Jim Inhofe, Cory Booker, Mike Crapo, Deb Fischer, Shelly Moore Capito, and Joe Manchin for introducing this important legislation. While we support many aspects of this bill, including nuclear industry innovation and advancement, we want to call attention to provisions in Title 3 that are particularly important to the uranium mining and conversion industries. It is imperative that the United States maintain a domestic uranium industry for national security reasons, and the actions of the federal government must encourage the industry and not undermine it. Without a viable long-term domestic uranium industry, the reliability of one-fifth of the U.S. electricity supply could be jeopardized.

SEC. 201 – URANIUM RECOVERY REPORT

We are supportive of this section of the Act. The current license renewal process is unnecessarily burdensome and lengthy. The uranium industry can provide several examples of licensees that have been in "timely" renewal of their licenses for years due to the lengthy administrative review process and the fact that these reviews are not a high priority for the NRC because of the low risk nature of these projects. As directed under this Act, a review of extending the duration of licenses from 10 years to 20 years will be consistent with what is already known - a uranium recovery license is low risk. The extension of the license duration will not elevate risks associated with these licensed activities. Additionally, extending the duration of the licenses will significantly reduce the regulatory agency's burdens caused by the frequency of current renewal periods. This will allow the agency to better utilize and allocate its review resources.

SEC. 202 – PILOT PROGRAM FOR URANIUM RECOVERY FEES

We strongly support this pilot program. Several licensing actions performed by the Commission are ripe for consideration of fee recovery using a flat fee structure. Several Agreement States successfully use a similar approach for all licensing activities, and this provides an efficient regulatory review process. As a licensee, we see several specific activities that would fit the expectations of this program. 1.) The annual review of financial assurance under 10 CFR § 40 Appendix A Criterion 9; 2.) Routine inspection activities; 3.) License renewal applications for source material licensees that are on standby; and 4.) Licenses for facilities that fit within the scope of environmental impacts that were analyzed in the General Environmental Impact Study and supplemental environmental impact studies already issued for Uranium Mills and In Situ Uranium recovery source material licensees.

SEC. 203 – URANIUM TRANSFERS AND SALES

We are pleased the Nuclear Energy Innovation and Modernization Act includes a bipartisan

proposal to bring greater accountability and transparency to Department of Energy's (DOE) management of the excess uranium inventory, and we want to thank Senators Barrasso and Markey for their leadership on similar legislation introduced last Congress. Since 2009, the DOE has sold (or bartered) inventory to pay for agency priorities, particularly the cleanup of legacy federal nuclear sites. We recognize the importance of cleaning up these legacy sites and understand DOE's desire to monetize excess uranium, but DOE's actions have caused great harm to our industry. [1]

We recognize DOE's transfers are not fully responsible for the current adverse market conditions; however, they have made the situation decidedly worse. At the same time our industry is reducing production, shutting in mines, making workforce reductions, and cancelling new projects, the federal government has continued to transfer significant amounts of uranium into an oversupplied market, competing with domestic producers. For context, in 2016, DOE sold more than twice as much uranium as the entire domestic industry produced. DOE sales have accounted for more than 100 percent of the global uncommitted utility demand, meaning there is no room for the domestic producers to compete.

Under the USEC Privatization Act (P.L. 104-134), before making any uranium transfers, the Department must certify the proposed transfers will not have "an adverse material impact on the domestic uranium mining, conversion, or enrichment industry." In our view, DOE has violated this obligation. It is hard for any reasonable person to conclude DOE transfers that exceed twice our domestic uranium production, with prices well below our cost of production, are not having an adverse material impact.

Last year UPA called on DOE to temporarily suspend transfers until market conditions recover. In our view, DOE should not make any transfer when the spot market price is below the average cost of producing uranium in the United States. According to the U.S. Energy Information Administration (EIA), the average total cost for U.S. uranium production was $66.86 per pound in 2015. The average total cost includes exploration, production, restoration, land, plant capital, wellfield capital, regulatory permitting, etc. EIA estimates average production ("cash") costs at $35.44 per pound. With the current uranium spot price near $25, DOE should halt any additional transfers in 2017 and postpone all future transfers until the market recovers.

If DOE continues transfers at the current rate and market conditions do not recover, the domestic industry may not survive. According to EIA, only 2.9 million pounds of uranium were produced in the U.S. during 2016. The United States now imports more than 93 percent of the uranium needed to fuel our nuclear reactors, putting 20 percent of our electricity supply at risk to foreign supply disruptions. Rather than compete with our industry and drive down prices, DOE should be looking at what steps it can take to support our industry and ensure we have a stable, domestic uranium supply.

Before DOE transfers any more of their inventory, UPA encourages DOE to conduct a full review

[1] The Department's position that its barter transfers are not the "driver" of market conditions to justify its increased disposition of excess uranium inventories was rejected by Judge Reggie Walton in Converdyn v. Moniz 68 F Supp. 3rd (2014). Whether the Department's transfers are "the driver" of market conditions is not the inquiry set forth in Section 2297h-10(d).

of the barter program. This should include identifying ways to minimize the impact of any future transfers on the domestic industry and examining whether prior DOE transfers have violated the miscellaneous receipts statute (31 U.S.C. § 3302(b)). According to the Government Accountability Office, DOE's barter program is in violation of the miscellaneous receipts statute because the value of uranium DOE transfers is not deposited into the Treasury. We encourage the DOE to investigate the application of the statute to these barter transfers.

The UPA has also encouraged DOE and the National Nuclear Security Agency (NNSA) to consider revising the current practice of downblending High Enriched Uranium (HEU) to commercial grade Low Enriched Uranium (LEU) below 5 percent U-235. Instead, DOE-NNSA should be downblending HEU to levels between 5-19.75 percent LEU for research and advanced reactor fuel. This would be supportive of U.S. non-proliferation policy as well as eliminate the adverse material impact the uranium, conversion and enrichment components contained in the DOE LEU below 5 percent are having on the commercial market.

The UPA strongly supports the inclusion of Section 203 dealing with DOE uranium transfers and sales. Section 203 will help bring greater accountability and transparency to the management of DOE inventory and will place limits on the amount of material DOE may transfer in a given year.

The legislation will require DOE to issue a new 10-year management plan for the federal excess uranium inventory, including steps the Secretary will take to minimize the impact on the domestic industry and maximize taxpayer value for this asset. Importantly, the legislation would require the DOE to issue a proposed management plan for public review and comment similar to the regular rulemaking process. In the past, DOE issued management plans with minimal public input, and in 2013, DOE determined it would manage the inventory without any public input. Requiring DOE to develop a new management plan is an important step to reforming this program and one the UPA strongly supports.

Despite our concerns about the DOE inventory and legitimate questions about whether DOE's current program is legal, the industry has always been willing to engage in a collaborative dialogue with DOE and other stakeholders. In fact, in 2008, the industry, utilities, and DOE developed a consensus-based approach to cap annual transfers to no more than 10 percent of domestic reactor requirements – about 5 million pounds per year. Unfortunately, DOE exceeded the cap in 2009 and never looked back. The UPA strongly supports the provisions in Section 203 to place a statutory cap on the amount of material DOE can transfer in any given year, subject to a Secretarial Determination that the proposed transfers would not have an adverse material impact on the domestic uranium, conversion, or enrichment industry.

The legislation will also ensure the Secretarial Determination process is more rigorous and subject to a public process. Although DOE issued a request for information in advance of its most recent Determination, DOE only solicited comments on the factors the agency should consider in its pending determination, rather than take comment on a draft Determination. Under the legislation, DOE would be required to release a draft Secretarial Determination for public review and comment before it could be finalized. This additional step will help ensure there is more meaningful public input and will allow stakeholders to better evaluate the impact of a specific proposal.

DEFINING STANDARDS OF GENERAL APPLICATION

As this legislation moves forward, we encourage the Committee to consider adding a provision to clarify the regulatory responsibilities of the Nuclear Regulatory Commission (NRC) and the Environmental Protection Agency (EPA) for uranium recovery. Under the current framework, EPA sets generally applicable standards and the NRC is charged with developing the specific implementation standards. Yet, there is no definition in the Atomic Energy Act (43 U.S.C. 2014) of generally applicable standards, which has created confusion and conflict between the EPA and NRC. This is evidenced by EPA's recent proposed rulemaking revising 40 CFR § Part 192, and the concerns expressed by the NRC General Counsel that EPA's proposal went well beyond setting general standards. Clearly defining standards of general application, without reducing any oversight of the industry, would help clarify the roles and responsibilities of EPA and NRC, reduce regulatory conflict, and provide for a more effective regulatory framework.

Respectfully submitted,

William Paul Goranson

Senate Environment and Public Works Committee
Hearing entitled, "Legislative Hearing on S.512, the Nuclear Energy Innovation and Modernization Act"
March 8, 2017
Questions for the Record
Paul Goranson

Chairman Barrasso:

1. Your written testimony states: "Several licensing actions performed by the Commission are ripe for consideration of fee recovery using a flat fee structure. Several Agreement States successfully use a similar approach for all licensing activities, and this provides an efficient regulatory review process." Would you please describe several examples that you believe are effective?

Response:

Our company, Energy Fuels Resources (USA) Inc. operates uranium recovery operations in several jurisdictions, including Wyoming, Texas and Utah. The first jurisdiction being a Non-Agreement State where the State and the Commission both regulate uranium recovery activities, and the latter two are Agreement State that regulate uranium recovery activities solely through their own statutory programs. This provides a unique ability to compare fee recovery programs in these jurisdictions regarding their effectiveness and their relevance to uranium recovery programs.

Utah's fee recovery program is described in Utah Administrative Rules §R313-70-7, License Categories for Types of Fees for Radioactive Materials Licenses. §R313-70-7(2)(b)(1), a monthly fee of $8,540.00 is assessed for Licenses for possession and use of source material such as conventional milling. Included in this fixed fee is all activities related to the regulation and oversight of an active conventional uranium mill, such as our White Mesa Mill located in Southeast Utah. Most license activities, including the license renewal and amendments are included in this fee. Only pass through costs are added to the fixed fee if the State engages 3rd party contractors, and that is infrequent.

Texas' fee recovery program is described in title 30 of the Texas Administrative Code Chapter 336.105, and uranium recovery operations are described as Subchapter L facilities from the same chapter. §336.105(a)(4) assess a fixed fee for new license applications for Subchapter L facilities, and this fee covers all review costs, unless the application is not determined to be administratively complete, where supplemental costs may be applied. §336.105(b)(4) establishes annual fees for operating Subchapter L facilities. §336.105(b)(5-8) provides annual fees for other activities described for Subchapter L facilities. §336.105(b)(9)(A-E) describe one-time for specific types of license amendments and the related environment assessments.

In summary, I have focused the response to two specific Agreement State fee recovery programs because they are related to active uranium recovery regulatory programs. There are other Agreement States with similar fee recovery approaches, but are less relevant to the overall uranium mining industry. These fee recovery programs assure that the regulation of these facilities remain robust and demonstrate compliance with the Agreement State programs described in the Atomic Energy Act of 1958 (as amended). They provide the licensee the financial accountability and certainty when engaging in licensed activities and licensing actions.

This subset of Agreement State fee recovery programs demonstrate that regulatory programs can remain effective, even with a fixed fee. As I provided in my March 8, 2017 written statement, there are specific minor licensing actions performed by the Commission that would provide an opportunity to test the effectiveness of fixed fees.

2. Would you please provide information on the extent of DOE's transfers and the market price for uranium? Please provide in a graph, if possible.

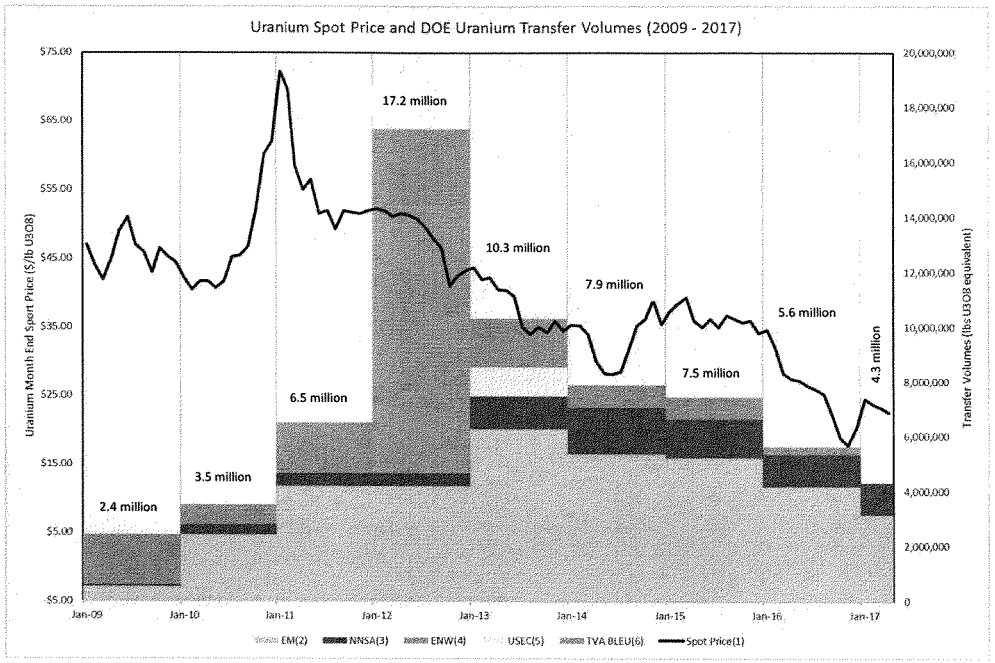
Response:

Figure 1 (attached) provides a graphical representation of the annual volumes of uranium transfers from 2009 to 2017, and the monthly spot price is superimposed onto the graph. The annual volumes associated with the barter transfers are derived from a combination of amounts described in Secretarial Determinations dating from 2009 to 2017 and the Excess Uranium Inventory Management Plans from 2008 and 2013.

On Figure 1, the annual volumes are labeled as below:

- "EM" represents transfers to U.S. Enrichment Corporation (USEC) and Flour B&W Portsmouth (FBP) related to the accelerated cleanup work being performed at the Portsmouth Gaseous Diffusion Plant managed by DOE's Office of Environmental Management (EM). Total transfers for the period 2009 - 2016 is 32.37 million lbs U_3O_8 equivalent.
- "NNSA" represents the uranium bartered to WestDyne International LLC by NNSA for the downblending of HEU. Total transfers for the period 2009 – 2016 is 6.83 million lbs U_3O_8 equivalent.
- "ENW" represents 9,075 MTU of high assay UF_6 tails transferred to Energy Northwest (ENW) for re-enrichment at the Paducah GDP by USEC with the excess to ENW needs being purchased by Tennessee Valley Authority (TVA). Total transfers for 2012 are 9.8 million lbs U_3O_8 equivalent.
- "USEC" represents a transfer of up to 48 MT of LEU (equivalent to 409 MTU) for DOE's cost share under the 2012 Cooperative Agreement between DOE, USEC, and the American Centrifuge Demonstration, LLC. Total transfer for 2013 is 1.07 million lbs U_3O_8 equivalent.
- "TVA BLEU" represents blending of off-spec HEU from the NNSA under the BLEU program. Total transfers for 2009 – 2016 are 9.09 million lbs U_3O_8 equivalent.

Figure 1: Annual Cumulative Uranium Transfers by DOE from Excess Uranium Inventories



Notes:

(1) Source: Tradetech LLC (www.uranium.info).

(2) Secretarial Determinations dated: November 9, 2009; March 1, 2011; May 15, 2012; May 15, 2014; May 1, 2015; and April 26, 2017.

(3) For Periods 2009 – 2011: Excess Uranium Inventory Management Plan December 16, 2008; and Excess Uranium Inventory Management Plan July, 2013; For Periods 2012 – 2017: Secretarial Determinations dated: May 15, 2012; May 15, 2014; May 1, 2015; and April 26, 2017.

(4) Secretarial Determination dated May 15, 2012

(5) Secretarial Determination dated March 15, 2013

(6) Source: Excess Uranium Inventory Management Plans dated December 2008 and May 2013

HEARING STATEMENT FOR THE RECORD
MR. VICTOR M. McCREE, EXECUTIVE DIRECTOR FOR OPERATIONS
UNITED STATES NUCLEAR REGULATORY COMMISSION

FOR THE
SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

March 8, 2017

INTRODUCTION

On behalf of the staff of the U.S. Nuclear Regulatory Commission (NRC), I appreciate the opportunity to provide written comments on the bill entitled the "Nuclear Energy Innovation and Modernization Act" (S. 512), and to offer some highlights of NRC activities regarding uranium recovery licensing.

S. 512, THE "NUCLEAR ENERGY INNOVATION AND MODERNIZATION ACT"

On April 21, 2016, I testified before the Clean Air and Nuclear Safety Subcommittee on a predecessor to the current bill, S. 2795, which was introduced in the last Congress. As I indicated at that time, my comments represented the NRC staff's assessment of factual issues associated with the bill, consistent with my role as the NRC's Executive Director for Operations. This characterization also applies to the comments on the current bill that I am providing today.

The current bill contains provisions on advanced nuclear reactors, NRC fees, uranium recovery, and several other matters. While there are many similarities between S. 512 and S. 2795, a number of modifications and clarifications have been made since I testified on the bill last year. The current bill incorporates "to the maximum extent practicable" or "where appropriate" language in a number of provisions, allows the NRC to waive the cap on annual fees for operating reactor licensees if the cap may compromise the NRC's safety and security mission, and presents other changes that provide additional flexibilities not included in the prior bill.

The current bill continues to require the NRC to undertake a number of activities related to advanced reactors and to report on those activities to Congress. As I testified last year, the NRC currently has significant ongoing and planned activities in the areas of advanced reactor licensing infrastructure, technical preparation, and stakeholder outreach. There are many similarities between the requirements in S. 512 and the NRC's ongoing activities, although the bill would require the NRC to undertake these activities on an accelerated schedule and would require development of additional reports to Congress. The fundamental requirements related to advanced reactors in the bill are complementary in concept to the NRC's ongoing activities, but significant time and resources would be required over several years to implement the full range of additional activities on the schedules described in the bill, particularly with regard to rulemaking.

Another area addressed in both the earlier bill and the current bill is performance and reporting. S. 512 continues to require the NRC to develop performance metrics and milestone schedules for any activity requested by a licensee or applicant and to report certain delays to Congress. In particular, subsections 4(11) and 102(c) of the bill, when read together, could be read as potentially requiring the NRC to develop performance metrics and milestone schedules for many activities beyond those for which such metrics and milestones are currently prepared, including many routine interactions with licensees and applicants. We believe we currently have appropriate, challenging, and outcome-oriented performance metrics that are consistent with the NRC Strategic Plan, Congressional Budget Justification, and the GPRA Modernization Act of 2010. These measures recognize that schedule performance can be affected by applicant, licensee, or NRC performance, and that the NRC may need flexibility to account for emerging safety or security issues, changes in licensee plans, and other circumstances.

URANIUM RECOVERY

In addition, the bill contains a requirement to submit a report to Congress describing the "safety and feasibility of extending the duration of uranium recovery licenses from 10 to 20 years, including any potential benefits of the extension." The NRC staff is in the process of analyzing the possibility of changing the current 10-year licensing term to a longer period, such as 20 years. The staff is developing a paper with options and recommendations that will be submitted to the Commission by August 31, 2017.

The bill also includes a provision for a pilot for uranium recovery flat fees. As directed by the Commission, the NRC is undertaking a flat fee pilot program for uranium recovery licensees. As described in the staff paper SECY-16-0097, "Fee Setting Improvements and Fiscal Year 2017 Proposed Fee Rule," this pilot will involve evaluation of data to collect a representative sample of the costs for various licensing reviews. While the agency has identified initial estimates of the current range of costs for major uranium recovery licensing actions on our public website, the NRC does not have sufficient data in a standardized form that would support completing the pilot by July 31, 2018. The agency is in the process of developing the new data recording structure and is scheduled to complete that activity this fiscal year. Subsequently, we will train our staff to record the data using the new data structure. After a period of recording data using the new data structure, the staff will analyze the data and develop recommendations. These recommendations will continue to address our requirements under the Omnibus Budget Reconciliation Act of 1990 (OBRA-90) to collect approximately 90 percent of the NRC's annual budget through fees and under the Independent Offices Appropriation Act, 1952 (IOAA) to assess user fees that are fair and based on the costs to the government and certain other factors. We are scheduled to submit our recommendations to the Commission for approval in FY 2019, and implement the Commission's direction in FY 2020.

In July, the NRC expects to receive Wyoming's final application to become an Agreement State. The NRC staff has been working with Wyoming on its transition to Agreement State status since 2014. On August 3, 2016, the Commission approved the proposed approach for a "limited" Agreement, which would allow Wyoming to assume regulatory authority over the subcategory of source material involved in the extraction and concentration of uranium and thorium milling and the management and disposal of byproduct material as defined in section 11e.(2) of the Atomic Energy Act. Wyoming's subsequent draft application differed from the Commission-approved subcategory

approach in that it proposes that the NRC retain regulatory authority for six Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II sites (i.e., six uranium recovery sites in decommissioning). The NRC staff met with Wyoming staff in December 2016 to provide preliminary comments on the draft application and plans to complete its review of the draft application next month. Currently, the NRC staff is developing a paper for Commission review to address the handling of the six UMTRCA Title II sites.

The NRC staff continues to look for opportunities to improve our processes and engage further with stakeholders. The NRC staff sponsors and participates in workshops with industry and members of the public to enhance communication on topics such as licensing and acceptable approaches to meeting NRC requirements for radiation protection. These efforts are expected to increase the predictability of the licensing process and risk-inform our approaches by facilitating discussion on NRC expectations to meet regulatory requirements and focusing attention on issues commensurate with their importance to public health and safety.

To build on these accomplishments, the NRC staff is finalizing an assessment of current licensing processes and practices. Preliminary recommendations include further augmenting pre-application activities, developing or updating key guidance documents, improving coordination and reducing unnecessary duplication with State and other Federal agencies, and establishing additional internal processes for the oversight of the uranium recovery licensing activities.

CLOSING

I appreciate the Committee's interest in enhancing the NRC's performance to accomplish our safety and security mission in an effective and efficient manner.

Senate Committee on Environment and Public Works
Hearing entitled, "Legislative Hearing on S. 512,
the Nuclear Energy Innovation and Modernization Act"
March 8, 2017
Questions for the Record for Mr. Victor McCree

QUESTION 1. **S. 512 directs the NRC to complete a pilot program regarding flat fees for routine uranium recovery licensing actions. Your written testimony states: "...the NRC does not have sufficient data in a standardized form that would support completing the pilot by July, 2018." Please describe why the past two years of data are sufficient to serve as a basis for recovering fees from licensees, but not sufficient to serve as a basis for the pilot program.**

ANSWER.

Our existing data are sufficient for recovering fees from licensees for work performed, but they may not include sufficient granularity to allow the NRC to determine whether potential subtasks are amenable to flat fees. Using the existing data may result in the flat fees developed being less accurate for this small class of licensees. Accordingly, as part of its pilot project, NRC staff plans to ensure sufficient data are available for its analysis and develop recommendations for the Commission.

QUESTION 2. **Written testimony provided by the Uranium Producers of America states: "Several licensing actions performed by the Commission are ripe for consideration of fee recovery using a flat fee structure. Several Agreement States successfully use a similar approach for all licensing activities, and this provides an efficient regulatory**

review process." If Agreement States already use this process, why does the NRC need four years to implement it?

ANSWER.

The schedule for implementing a flat fee structure in fiscal year 2020 must allow sufficient time for the NRC to implement an effective voluntary pilot initiative. This includes time to develop a new data recording structure, to train staff to use the new structure, to analyze the new data collected, to develop recommendations, and to engage a licensee volunteer to participate in the pilot. Accelerating the timeline would limit our ability to collect and utilize the new data and to have thoughtful interaction with the licensee community. As part of this process, we will reach out to the Agreement States to understand their methodologies.

QUESTION 3. **Any nuclear material in DOE's possession that is transferred to a private entity would be logged by DOE into the Nuclear Materials Management and Safeguards System (NMMSS) database. Please provide copies of the DOE/NRC 741 Forms for all transfers of uranium, in any form, from the Department of Energy to NRC license holders for the last ten years.**

ANSWER.

Please note our response to Question 3 is "Official Use Only - Business Proprietary Information" and will be transmitted under a separate cover. We respectfully ask that the handling instructions accompanying the letter be honored.

QUESTION 4. **As an example, please provide a copy of a report generated from NMMSS database resulting from a transfer of uranium from DOE to a NRC licensee.**

ANSWER.

Attached is a sample NMMSS report. The report identifies two transactions that occurred on September 26, 2016, from Babcock & Wilcox Conversion Services (BWCS) Paducah (referenced as "GBB"), to Honeywell International, Inc. (referenced as "YSP"). The transactions involved government-owned natural uranium. The document is Official Use Only and contains business proprietary information. We respectfully request that you honor these markings.

QUESTION 5. **How does the NRC determine that a permanently defueled reactor may modify security and emergency preparedness to reflect the reduction in risk that occurs when an operating reactor enters the decommissioning phase? Is there opportunity for public involvement in the process? On what basis does the NRC approve exemptions? Are site-specific analyses considered?**

ANSWER.

The emergency preparedness (EP) requirements are based upon an anticipated prompt response to a wide range of events for an operating power reactor. Following the permanent removal of all spent fuel from the reactor vessel, the range of events that can have significant offsite consequences is greatly reduced. The physical protection programs at operating reactors and permanently defueled reactors are required to protect against the design basis

threat for radiological sabotage, meaning that licensees must protect against significant core damage and spent fuel sabotage. However, physical security protective strategies shift to focus principally on protection of the spent fuel at a permanently defueled reactor site.

Licensees may seek regulatory relief through the exemption processes described in NRC regulations (10 CFR 50.12, "Specific exemptions," and 10 CFR 73.5). Licensees have requested exemptions to revise or reduce EP and security requirements to reflect the lower risk and reduced security focus associated with a power reactor being permanently shut down and all spent fuel being permanently moved from the reactor vessel to a spent fuel pool (SFP) or dry cask storage installation. Licensees also submit amendments for revised emergency plans to reflect the permanently shut down condition of the reactor and the EP requirements that would be applicable if the requested EP exemptions were granted.

Exemption requests are not subject to a hearing opportunity under section 189a of the Atomic Energy Act of 1954, as amended. For license amendment submittals, the NRC publishes in the *Federal Register* a notice and opportunity for a hearing on the amendment. In addition, the NRC may hold public meetings, such as pre-submittal meetings related to decommissioning licensing actions, which the public can attend to get information and ask questions of NRC staff.

The NRC reviews requested EP and security exemptions on a case-by-case basis, and will only grant an exemption if a licensee's request demonstrates that the applicable regulatory criteria are met.

- The NRC staff review must conclude that granting the exemption to EP requirements is authorized by law, will not present an undue risk to the public health and safety, is consistent with the common defense and security, and that at least one of the special

circumstances provided in 10 CFR 50.12(a)(2) is present. The NRC staff reviews site-specific analyses submitted by the licensee. A detailed description of the NRC's process for the evaluation of EP exemption requests and associated emergency plan changes for decommissioning power reactors is provided in NSIR/DPR-ISG-02, "Emergency Planning Exemption Requests for Decommissioning Nuclear Power Plants."

- The NRC review must conclude that granting the exemptions to security requirements is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. A licensee is required to ensure that its physical protection program will continue to protect against the design basis threat given the change in security focus to the spent fuel and spent fuel pool. The NRC's review of 10 CFR 73.5 exemptions and site-specific security plan revisions is outlined in NSIR ISG-03, "Interim Staff Guidance on Review of Security Exemptions/License Amendment Requests for Decommissioning Nuclear Power Plants."

Because the development of regulations for operating nuclear power plants often did not consider decommissioning, the requirements imposed on decommissioning power reactors may be inappropriate, may not be applicable, or may not align with safety significance. Given the number of exemptions the NRC has received for decommissioning facilities, the Commission has directed the NRC staff to proceed with rulemaking on decommissioning to address whether the NRC regulations imposed on operating nuclear power plants are appropriately imposed on decommissioning power reactors. Staff plans to provide the draft final rule for Commission review and approval in October 2019.

Among other things, the rulemaking seeks to make the decommissioning process more efficient, open, and predictable by reducing the reliance on licensing actions, including license

amendments and exemptions, to achieve a long-term regulatory framework. The rulemaking provides opportunities for public participation that can help the NRC revise the security and emergency planning requirements applicable to decommissioning power reactors. To date, the NRC has provided four opportunities for public participation in this rulemaking process. The first was an opportunity to comment on the Advance Notice of Proposed Rulemaking (ANPR) (80 FR 72358; November 19, 2015); the second was a December 9, 2015, public meeting to discuss the ANPR; the third was the draft regulatory basis for a proposed rulemaking, entitled "Regulatory Improvements for Power Reactors Transitioning to Decommissioning," which was published on March 15, 2017, for a 90-day comment period; the fourth was a public meeting on May 8-10, 2017, to discuss the draft regulatory basis as well as the preliminary draft regulatory analysis. An additional opportunity for public participation will be provided upon publication of the proposed rulemaking for comment.

QUESTION 6. **When considering exemptions for shutdown and defueled reactors, does the NRC take into account initiating events that could result in offsite radiological releases, including beyond design basis threats?**

ANSWER.

Yes. For exemptions requested by decommissioning power reactor licensees that relate to protection from offsite radiological releases, such as requests for relief from EP requirements, the NRC's review has included consideration of initiating events that can result in offsite releases, including beyond design basis events. However, for exemption requests that do not relate to protection from offsite radiological releases, such as requests for relief from financial based requirements, the NRC's review does not include consideration of initiating events that can result in offsite releases.

QUESTION 7. **After exemptions are approved, what emergency planning capabilities must be maintained by the licensee?**

ANSWER.

Exemption requests from permanently shut down power reactor licensees have included exemptions from EP regulations that reduced the requirements to those consistent with the following EP standards: (1) 10 CFR 50.47(d), which addresses the requirements for a license authorizing fuel loading and low power testing only; and (2) 10 CFR 72.32(a), which establishes the information required in an emergency plan for an independent spent fuel storage installation (ISFSI) licensee. If these exemptions are granted, licensees must continue to maintain an onsite emergency plan addressing the declaration of an emergency up to the second-lowest classification level ("Alert"), capability to notify licensee personnel and offsite authorities of emergencies, onsite exercises with the opportunity for offsite response organization participation, arrangements for offsite response organizations (i.e., law enforcement, fire and medical services) that could respond to onsite emergencies, and coordination with designated offsite government officials following an event declaration so that, if needed, offsite authorities can implement appropriate response actions.

QUESTION 8. **Why is it beneficial for licensees to maintain the option to seek exemptions and license amendments related to reducing emergency planning and security requirements once the reactor has been permanently defueled?**

ANSWER.

The practice of considering exemptions is a well-established part of the NRC's regulatory process that allows licensees to address site-specific situations or implement alternative

approaches for circumstances not necessarily contemplated in the regulations for operating reactors.

The opportunity to seek regulatory relief from existing requirements allows a licensee to address special circumstances, such as when application of the regulation in the particular circumstances is not necessary to achieve the underlying purpose of the rule or to avoid undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted. This allows a decommissioning power reactor licensee to develop programs and focus resources on decommissioning, while continuing to maintain adequate measures to protect the health and safety of the public and not endanger common defense and security. These measures take into account the lower risk and reduced security focus associated with a power reactor being permanently shut down and all spent fuel being permanently moved from the reactor vessel to a spent fuel pool or dry cask storage installation.

QUESTION 9. **Why is it important that the NRC maintain flexibility in addressing certain emerging safety and security issues associated with decommissioning nuclear power plants?**

ANSWER.

Flexibility allows the NRC to adjust our licensing and oversight programs and resources, as appropriate and on a case-by-case basis, for decommissioning power reactors to be commensurate with the reduced risk after permanent shutdown and the change in focus to decommissioning activities. Should any specific circumstances of concern arise, the NRC must also maintain the authority and capability to modify requirements as necessary to address emergent safety and security issues. Exercise of this authority may be accomplished by various regulatory actions, up to and including the issuance of orders to modify, suspend, or revoke a

license. In addition, exemptions and amendments are important mechanisms for NRC and licensees to revise the authorities and requirements conveyed to licensees to reflect changes in their specific circumstances, including those that were not considered when a regulation or other requirement was established.

QUESTION 10. **Some have advocated the use of a process similar to the Vendor Design Review conducted by the Canadian Nuclear Safety Commission to inform the vendor of the overall acceptability of the reactor design and provide early identification of regulatory and technological issues. Does the NRC consider this process to be contrary to public health and safety? If not, please describe the benefits and drawbacks of implementing such a process for advanced reactors.**

ANSWER.

The NRC sees significant benefit in pre-application interactions to provide early feedback to advanced reactor designers. The Canadian Nuclear Safety Commission (CNSC) Vendor Design Review is one example of pre-application interactions by which early feedback can be provided to designers on the ability of their designs to meet the requirements necessary for licensing.

The NRC does not consider the CNSC Vendor Design Review process to be contrary to public health and safety. In fact, the NRC encourages pre-application interactions as discussed in its Advanced Reactor Policy Statement which states:

> To provide for more timely and effective regulation of advanced reactors, the Commission encourages the earliest possible interaction of applicants, vendors, other government agencies, and the NRC to provide for early identification of regulatory requirements for advanced reactors and to provide all interested parties, including the public, with a timely, independent assessment of the safety and security characteristics of advanced reactor designs. Such licensing interaction and guidance early in the design process will contribute towards minimizing complexity and adding stability and predictability in the licensing and regulation of advanced reactors.

The NRC has engaged in pre-application discussions with reactor designers and the Department of Energy (DOE) on several advanced reactor designs and has provided feedback on designs and testing programs related to the development of these designs. An example of NRC feedback similar to that which would be provided by the CNSC during a Vendor Design Review is the NRC staff's review and issuance of pre-application safety evaluation reports such as: NUREG-1368, "Pre-application Safety Evaluation Report for the Power Reactor Innovative Small Module (PRISM) Liquid-Metal Reactor," NUREG-1369, "Pre-application Safety Evaluation Report for the Sodium Advanced Fast Reactor (SAFR) Liquid Metal Reactor," and NUREG-1338, "Draft Pre-application Safety Evaluation Report for the Modular High-Temperature Gas-Cooled Reactor."

In response to increasing interest in advanced reactor designers in a staged licensing process, on October 19, 2016, the NRC published a draft Regulatory Review Roadmap for Non-Light Water Reactors, which describes the spectrum of regulatory interactions available from the conceptual through the final design processes. NRC staff has confirmed that our existing regulations and processes provide the means for early and incremental feedback to designers

on the ability of their designs to meet the NRC's licensing requirements, in a manner similar to the CNSC vendor design review.

Attachment to Question 4

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FOR
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NA-532

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