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PRESERVING AND EXPANDING CLEAN, RELIABLE NUCLEAR POWER: U.S.
COMMERCIAL NUCLEAR REACTOR PERFORMANCE TRENDS AND SAFETY
INITIATIVES

Wednesday, November 13, 2019

United States Senate

Committee on Environment and Public Works

Washington, D.C.

The committee met, pursuant to notice, at 10:05 a.m. in room 406, Dirksen Senate Office Building, the Honorable John Barrasso [chairman of the committee] presiding.

Present: Senators Barrasso, Carper, Inhofe, Braun, Boozman, Ernst, Cardin, Gillibrand, Markey, Duckworth, Van Hollen.

STATEMENT OF THE HONORABLE JOHN BARRASSO, A UNITED STATES
SENATOR FROM THE STATE OF WYOMING

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

This morning, we will review the performance and safety of our Nation's commercial nuclear power plants. Nuclear power provides clean, reliable, carbon-free energy to basically one in all five American homes and business. It should be a central, growing share of our Nation's energy mix if we are going to be serious about addressing our changing climate.

Nuclear power generated a record amount of electricity this last year. We trace today's use of nuclear power to the Shippingport Atomic Power Station, the Nation's first commercial nuclear power plant. In 1958, the Pennsylvania site first generated electricity for civilian use. The Shippingport operation also established a founding principle of nuclear regulation.

The company licensed to operate the reactor holds the primary responsibility for nuclear safety. Government regulators remained onsite to make sure the operators met all the safety requirements. This model remains in place for the 96 nuclear reactors that are in operation today.

The number of operating nuclear reactors actually peaked at 112 in 1990. The number of U.S. reactors has shrunk since then.

In the last seven years, nine nuclear reactors have been shut down. Those nine reactors generated enough clean, carbon-free energy to power over 11 million homes.

Another eight reactors are scheduled to close over the next five years. Together, the carbon-free energy generated from those eight reactors is roughly equal to all the energy produced by solar panels last year in the United States.

It is time to reverse this trend. We need to preserve and expand our use of nuclear energy. To achieve that goal, the American public must have confidence in the safe use of nuclear material.

The Nuclear Regulatory Commission staff reports that safety has improved over the last 20 years. Today, nuclear power plants are performing at historically high levels of safety and efficiency. Improved safety leads to more efficient reactor operation. Reactors have fewer unplanned shutdowns and have increased safety margins.

Nuclear utilities should continually strive for safety excellence. The industry does so through the Institute for Nuclear Power Operations. The Institute's mission is to build on their core values. Those are engagement, nuclear safety, broad industry support, accountability, independence, and confidentiality. These values can allow our Nation to transition to advanced nuclear technologies.

Navigating the regulatory approval process for new nuclear technologies requires substantial financial commitment. Rigid, costly regulations will stunt the growth of nuclear innovation. American businesses that invest in advanced technologies must have confidence in future safety rules. The rules must be based on the performance and risk of their reactor designs, not in terms of the inflexible legacy of previous technologies.

Last Congress, this committee led the effort to get the Nuclear Energy Innovation and Modernization Act signed into law. The law requires predictable and efficient safety regulations for advanced nuclear technologies. The law will help stimulate the development and deployment of advanced nuclear technologies.

Nuclear power plants are just one piece of preserving and expanding our nuclear industry. The entire nuclear fuel cycle, starting with America's uranium producers, must be valued.

Wyoming is our nation's largest uranium producer. Russia's strategic decision to flood the market with subsidized uranium has put Wyoming's uranium mining at risk. President Trump recognized that preserving domestic uranium production, instead of relying on foreign imports, is a national security issue. He established a Nuclear Fuel Working Group to recommend actions to help America's nuclear fuel cycle. I look forward to the Working Group's report and urge President Trump to take swift action to support our Nation's uranium producers.

We must also address what we do with the nuclear fuel after it is used. Washington is long overdue to fulfill our legal obligation to permanently dispose of nuclear waste. That includes advancing a nuclear waste policy centered on completing the scientific review of the Yucca Mountain site. So I put forth draft legislation to do so.

If we are serious about addressing climate change, we must be serious about increasing nuclear power. That means advancing performance-based safety rules, deploying advanced nuclear technologies, ensuring we maintain U.S. uranium production, and permanently disposing of nuclear waste. This committee can play an important role in accomplishing all of these goals.

I would now like to turn to my Ranking Member, Senator Carper, for his opening comments.

[The prepared statement of Senator Barrasso follows:]

STATEMENT OF THE HONORABLE THOMAS R. CARPER, A UNITED STATES
SENATOR FROM THE STATE OF DELAWARE

Senator Carper. Thanks, Mr. Chairman. It is a pleasure to see each of you. Thank you. Some of you have been here before. How many of you have been here before? A couple of you guys I am afraid we will have to put on the payroll. Bless you for coming and sharing your expertise with us many, many times.

Mr. Willard, welcome. Admiral, right?

Admiral Willard. Admiral, retired.

Senator Carper. Captain, retired, sir. Navy salutes Navy. Thank you.

Two days after Veteran's Day, every day is Veteran's Day in Delaware. We thank you. Are either of you veterans as well? Okay. Would you like to be?

[Laughter.]

Senator Carper. As it turns out, Admiral, just last Friday I had the honor and privilege to deliver the keynote address at a change of command ceremony in Norfolk, Virginia, for the USS Delaware, SSN-791, fast attack nuclear submarine. Construction is almost completed. And I had a chance to speak at their change of command for captain, newly promoted Captain Brian Hogan is headed off to join the folks at the Pentagon and to work. It was an honor to be there with him.

As it turns out, our Country has been building nuclear

powered vessels like the USS Delaware for a long time. In fact, the Navy began to explore the potential of building nuclear powered vessels I think right at the end of World War II, when my dad was coming home from overseas, and about all my uncles as well.

First ever nuclear-powered submarine was the USS Nautilus, as some of us will remember. It was commissioned in 1954 and sent to sea the next year, 1955. By the 1960s, the U.S. Navy had dozens of nuclear-powered submarines, either underway at sea or they were, in some cases, under construction.

It was early days, our Country invested in nuclear powered submarines and ships, aircraft carriers, and an ultimately successful effort to step the tide of communism around the globe. Today, we find a different kind of threat, many different kinds of threats, and one that is a matter of survival for our planet. Just as nuclear power has been enormously important to our national defense with respect to communism and other threats, we need a strong, viable and safe fleet of nuclear power plants to combat a different kind of threat, and that is the growing threat of climate change and the extreme weather and the rising seas that come with it.

Today, there are 96 operating nuclear reactors throughout America that are running more efficiently than ever before and producing clean, carbon-free electricity. In fact, I am told

that 50 percent of our Nation's carbon-free electricity comes from nuclear power. Compared to other industrial sectors, the U.S. nuclear industry remains one of the safest in the world. That is in large part because the Nuclear Regulatory Commission, the NRC, continues to be the world's gold standard for nuclear regulatory agencies.

Unfortunately, though, the nuclear industry continues to feel the pinch of markets as it struggles to compete with other, less expensive ways of generating electricity in this Country. Since 2013, no fewer than nine nuclear reactors have been retired, and by 2025, an additional 10 nuclear power plants are expected to be retired. Most of these facilities are closing due to economic reasons, not because of overly burdensome regulations.

Despite that, these closures and other economic concerns have led some in the nuclear industry to suggest that we target safety regulations in ways that may well undermine the ability of the NRC to continue to be the gold standard of nuclear power regulators in the world.

Let me just pause and say, I want to be clear. I am wide open to improving efficiencies within the NRC, and the plants that they oversee. I think the Chairman has already alluded to this, but just last Congress, we worked together, we worked together with our colleagues on this committee, our staffs, to

pass legislation that restructured the NRC, payment structure, increasing transparency and leveling the playing field for those paying NRC dues.

However, as someone who supports, and has supported for years, the nuclear industry, I implore my colleagues, along with the NRC, and the entire nuclear industry to keep safety a main priority. An old Methodist minister in southern Delaware used to say to me when I was elected Governor, he would say, Tom, the main thing is to keep the main thing the main thing. That is what he would say. The main thing is to keep the main thing the main thing.

And the main thing in this case with respect to nuclear power is always safety, to make sure that we are always striving for perfection, always striving for perfection, and in that regard. If we are not careful, streamlining safety regs for the sake of streamlining could actually hurt, not help, the nuclear industry that we need if we are to turn back the threat that climate change poses to our planet and all of us who live on this planet.

We don't have to go very far in history to see how cutting corners in nuclear safety can have devastating results. Less than a decade ago, a massive earthquake and tsunamis, as we all recall, led to nuclear meltdown at the Fukushima Daiichi nuclear power plant in Japan. That was one of the worst nuclear

disasters the world has ever seen, in a country known for nuclear safety, no less.

The people of Japan are still recovering from this accident today. Around the world, public confidence in the nuclear industry has not fully recovered either.

The cruel irony is that some of the biggest lessons learned from the Fukushima Daiichi accident were things we already knew. Here are a couple of examples. One, the importance of establishing an independent and transparent nuclear reactor. I have alluded to that before. Two, the importance of embracing a culture of safety at all of our nuclear reactors. And three, the importance of deploying, if you will, defense in-depth, layer protective measures to help mitigate known and unknown threats.

It has been said that those who ignore history are doomed to repeat it. So as we fast forward to today, I am concerned that some of the lessons learned from Fukushima actually are already being forgotten, if we are not careful. At a time when we should be investing in next generation nuclear technologies, the last thing we should do is undermine safety. Yet some in the nuclear industry and the NRC seem willing to take some risks that not only ignore lessons learned, but also fly in the face of common sense.

A couple of quick examples. For example, the NRC recently

decided to change course on post-Fukushima protections, making some seismic and flooding protection requirements voluntary rather than mandatory. Mr. Chairman, I ask at this point unanimous consent to submit for the record a letter from Senator Whitehouse and myself to the NRC expressing our concerns with those changes.

Senator Barrasso. Without objection, so ordered.

[The referenced information follows:]

Senator Carper. Thanks, Mr. Chairman.

And I am not done here. The NRC is also considering weakening its reactor oversight process with some of the industry calling for self-inspections. Simply put, these actions don't make a lot of sense to me. If history is any indication, these changes could well end up being penny-wise and pound-foolish, if we are not careful.

Having said that, I am hopeful that today we are going to discuss how we can get the NRC back on track and ensure the commission has all the tools necessary, the resources necessary, to keep our Country's nuclear power the safest in the world. I also hope that we will have some time today to discuss some of the investments in advances going forwarding in nuclear power that need to be made, in order to ensure that nuclear energy remains an effective tool in our arsenal, to power our Country while combatting the threat of climate change that we face here at home and around the world.

Again, thank you all for joining us today. I look forward to this hearing.

And I have another hearing going on in Homeland Security that I need to be in and out of. So I will be here for most of this, but not all. Excuse me as I slip out and come and go. Thank you.

[The prepared statement of Senator Carper follows:]

Senator Barrasso. Thank you, Senator Carper.

We will now hear from our three witnesses, and they are Admiral Robert Willard, the President and Chief Executive Officer of the Institute of Nuclear Power Operations. We have Dr. Peter Lyons, who is the former Commissioner of the Nuclear Regulatory Commission, and a former Department of Energy Assistant Secretary for Nuclear Energy. And we have Dr. Edwin Lyman, who is the Acting Director of the Nuclear Safety Project at the Union of Concerned Scientists.

Welcome to all three of you. I would like to remind you that your full written testimony will be made a part of the official record in the hearing today. So we will ask that you please keep your statements to five minutes, so we may have time for questions. We look forward to the testimony.

Admiral Willard, would you please proceed.

STATEMENT OF ADMIRAL ROBERT F. WILLARD, PRESIDENT AND CHIEF
EXECUTIVE OFFICER, INSTITUTE OF NUCLEAR POWER OPERATIONS

Admiral Willard. Thank you, Chairman Barrasso, Ranking Member Carper and other distinguished members of the Environment and Public Works Committee. Good morning. Thank you for this opportunity to address you today.

I am Bob Willard, the President and CEO of the Institute of Nuclear Power Operations, or INPO. I have been in my position for nearly eight years.

My purpose for the next few minutes will be to overview INPO and its role in shaping commercial nuclear power plant performance, specifically in the areas of safety and reliability. INPO has been in existing for 40 years. The genesis was the 1979 Three Mile Island nuclear accident and the President's Commission recommendations that followed. The Kemeny Report, as it was referred to, called for the industry to adopt higher safety and performance standards, to analyze and share operating experience, and to improve the training of its nuclear operators. Subsequent actions by industry leaders of the day, such as Bill Lee, CEO of Duke Energy, resulted in INPO's creation that same year.

The Institute is an independent, non-profit company funded by its 21-member utilities. Its board of directors is comprised of a dozen utility CEOs whose companies represent roughly 80

percent of the Nation's nuclear electricity generation. Ms. Lynn Good, the current Duke Energy CEO, is its chairman.

INPO's mission is to promote the highest levels of safety and reliability to promote excellence in the operation of commercial nuclear power plants. The excellence distinction is important, as the performance standards the INPO assesses the industry against transcend regulatory compliance and are intended to add additional safety margins for our nuclear plants. We are actually three organizations in one, consisting of INPO, the World Association of Nuclear Operations, WANO Atlanta Center, which is the international counterpart to INPO, and the National Academy for Nuclear Training.

INPO is headquartered in Atlanta, Georgia, and has about 400 employees, which includes about 65 industry loanees who serve INPO temporarily for one and a half to two years. We also leverage industry peers frequently to augment our technical staff. About one-third of our employees are traveling to and from nuclear stations at any given time.

INPO's major operations include plant continuous performance monitoring, plant evaluations every two years, corporate continuous monitoring, corporate evaluations every six years, training accreditation of operations and technical programs on behalf of the NRC, technical assistance to our members, and analysis and sharing of operating experience.

INPO is central to the analysis of trends and events, and the sharing of lessons learned across the industry. INPO's effectiveness is made possible by strong CEO support and accountability, industry involvement as with loanees and peers, a singular focus on safety and reliability, independence, confidentiality, and self-regulatory authority.

To our knowledge, INPO is unique in its role and its means of influencing industry performance. Our relationship with the NRC is complementary but independent. We maintain a memorandum of agreement which outlines the limits of our information sharing, and we meet at least once per year to exchange views on industry performance and various improvement initiatives.

For example, in recent years, we have discussed INPO's evolution toward continuously monitoring the performance of every plant and corporate organization in the industry. Every six weeks, each side is provided an updated summary of its performance from INPO as a precursor to an exchange between our staff and their plant counterparts.

Similarly, each utility corporate organization receives a summary of their performance each quarter. In this way, we maintain a view of performance in between INPO evaluations, which enables us to respond quickly to any signs of decline.

INPO assesses 15 separate performance areas at each nuclear site, including using performance objectives and criteria that

define standards of excellence in area. Following an evaluation, the site is provided an overall numerical grade of one through five, with one representing exemplary or excellent performance, and five would be unacceptable.

This year, INPO is completing year seven of a ten-year strategy in which the objective has been to raise plant performance industry wide to INPO one or two with only rare excursions by any plant to a three level of performance. And we are nearly there.

By many measures, the U.S. nuclear industry is in its seventh consecutive year of improving performance. It is also by WANO standards the highest-performing national nuclear industry in the world.

Finally, I will close by saying that we still have much work to do. INPO analyzes performance in many areas, and then focuses the industry on correcting any emerging adverse trends. We are currently concentrating on reducing preventable reactor trips, eliminating fuel defects entirely, and minimizing preventable human errors.

Forty years ago, INPO was created by the industry to do exactly this work, to aggressively pursue excellence and safety and reliability and to one day achieve it.

Lastly, I will share a pair of U.S. industry performance views. The pair of curves on the first chart to my right, your

left, compares U.S. nuclear industry performance in blue with the rest of the world in orange. This is a widely used indicator called WANO performance indicator index, and illustrates both the elevating performance of the U.S. industry and a widening gap in performance that WANO is endeavoring to close.

The other chart with the single curve to my left, your right, depicts improving U.S. industry performance using plant performance indicator, or PPI, which is our most accurate indicator of current performance. This shows that since 2017, performance has entered the exemplary or excellent range, and is still trending upward.

Mr. Chairman, respecting the committee's time, I will stop there. I look forward to your questions.

[The prepared statement of Admiral Willard follows:]

Senator Barrasso. Thank you very much, Admiral Willard.

Before turning to Dr. Lyons, Senator Carper.

Senator Carper. Dr. Lyons, I want to say as always it is good to see you. Thank you for joining us today, and bringing your colleagues here with you. I think you served for four or five years as a member of the NRC, from 2005 to 2009?

Mr. Lyons. I served one term at the NRC, sir, yes, four and a half years.

Senator Carper. Thank you so much for that service. It is great to see you again.

Senator Barrasso. Dr. Lyons, welcome to the committee.

STATEMENT OF PETER LYONS, COMMISSIONER, NUCLEAR REGULATORY COMMISSION FROM 2005-2009, ASSISTANT SECRETARY FOR NUCLEAR ENERGY FROM 2010-2015 AT THE DEPARTMENT OF ENERGY

Mr. Lyons. Thank you very much. Chairman Barrasso, Ranking Member Carper, it is an honor to testify today on subjects that have been my focus for decades.

By way of introduction, as you heard, I have served as Assistant Secretary for Nuclear Energy, and as an NRC Commissioner. I also spent eight years as Senator Domenici's science advisor, sitting behind some of you gentlemen in a different committee meeting room.

Our nuclear plants represent a vital national resource, providing over half of our clean electricity. As Secretary Perry has said, I don't know how anybody who cares about the climate can't be for nuclear energy. Nuclear power helps provide fuel diversity, which is essential for a reliable grid, and it is the most resilient component of the grid. Nuclear power supports vital financial security benefits. Our nuclear navy and weapons programs depend on it.

Furthermore, we have lost the ability to compete internationally and we are ceding international markets to Russia and China. Along with international leadership goes their leadership, potentially, in the future, on safety and non-proliferation.

As you have noticed, since 2014, nine reactors have closed prematurely and closures are pending for eight more. The economics of nuclear plants is certainly complicated by the low generation costs for natural gas, by State mandates for renewables, by federal tax credits for solar or federal production tax credits, for wind.

The Secretary's Nuclear Energy Advisor Committee recently stated that policy changes are necessary to ensure survival of the existing fleet. Continued early shutdowns are jeopardizing the industry and threaten severe repercussions on national security and grid integrity.

Many U.S. companies are exploring advance designs. And important issues will be available of higher fuel enrichments, the need for a credible used fuel management strategy, and confidence that the NRC will favorably review their innovative designs. The latter will be impossible if the NRC uses only their current deterministic regulations.

Since TMI, the NRC has emphasized continuous learning and a key evolving area for many years has been risk-informed regulation. As the NRC addresses requests for advanced concepts, risk-informed judgments will be essential. The NRC is already using risk-informed principles in a number of ways. For example, in the valuation of the new scale small modular reactor.

Cooperative arrangements are also important to the NRC, including the one with Bob Willard's, Admiral Willard's INPO. They jointly share credit, INPO and DOE, for the industry's safe operations, with spectacular capacity factors. NRC and DOE also cooperate in many areas.

After the Fukushima accident, Japan is rebuilding confidence in nuclear power in ways that show the excellence of the NRC and INPO. Japan now has an independent regulator, like the NRC, and a strong industry organization like INPO.

One of the many issues with Fukushima is that government mandated evacuations cost over 1,000 fatalities among the elderly. Those evacuations were at least partly driven by poor international models for risks of low radiation doses. Senator Domenici created a research program years ago to study radiation effects, and a lot of progress was made, enough to show that the current models are wrong, but insufficient to correct them. The previous Administration, unfortunately, stopped that research, but legislation has been introduced to restart it.

My written testimony suggests that Congress review plans to dispose of weapons grade plutonium, instead of using it to assist in the fueling of advanced reactors to create the absence of a credible waste management strategy, as several of you have indicated, and in my view, the need to restart science-based radiation research.

In closing, to summarize, the United States, in my view, is at serious risk of losing its nuclear energy program. With that loss, our grid would suffer from loss of fuel diversity, reduced resilience and reliability, plus the Nation would lose immense national security benefits. Without a strong domestic industry, advanced reactors, I do not believe, can be deployed.

Our weak domestic nuclear industry is destroying our ability to compete internationally. We are ceding global leadership to Russia and China, and enabling them to set future global non-proliferation and safety standards.

My last point, the United States leads the world with innovative, advanced nuclear designs. The continued shift to risk-informed regulations at the NRC is essential to enable their deployment.

I thank you, and I look forward to your questions.

[The prepared statement of Mr. Lyons follows:]

Senator Barrasso. Thank you very much, Dr. Lyons, for your thoughtful testimony.

Dr. Lyman, welcome to the committee.

STATEMENT OF EDWIN LYMAN, ACTING DIRECTOR, NUCLEAR SAFETY
PROJECT, UNION OF CONCERNED SCIENTISTS

Mr. Lyman. Yes, sir. Good morning, Chairman Barrasso, Ranking Member Carper and the other distinguished members of the committee. On behalf of the Union of Concerned Scientists, I really appreciate the opportunity to provide testimony today on the critical issues of nuclear safety and security.

UCS has half a million supporters. We are neither pro- nor anti-nuclear power, but we have served as a nuclear safety and security watchdog for 50 years. Combatting the threat of global climate change is one of our priorities, and we do believe the operating nuclear reactor fleet should continue to play a role in the low carbon economy. But it must meet high standards of safety and security. I think Senator Carper made that clear.

The Nuclear Regulatory Commission plays an essential role in protecting public health and safety from both accidents and terrorist attacks at nuclear reactors. Stringent Congressional oversight is critical to make sure the NRC does its job well.

We agree with Dr. Lyons' assessment in an op-ed published in The Hill earlier this year, and also his testimony, that the secret ingredient of a successful nuclear power program is high-quality, independent regulation. Unfortunately, at the NRC, this independence is under threat. Over the last few years, I have heard an increasing number of complaints by NRC staff from

different offices that the agency's independence is being compromised by undue influence by the nuclear industry. This influence is readily apparent in some of NRC's actions, including recent decisions that have been primarily in the industry's favor and at the expense of safety and security. I would like to discuss a few of those today.

A good example is the decision this year, it was a three to two vote at the commission, to significantly scale back the new rule to address lessons learned after Fukushima, as Senator Carper discussed. The root cause of Fukushima was a severe, tsunami-driven flooding event that inundated the site to a level far higher than the level that the plant owner had assumed could occur, resulting in a loss of electrical power, failure of cooling systems and ultimately, the meltdown of three reactor cores, contaminating thousands of square miles with long-lived radioisotopes, displacing 160,000 individuals from their homes, and damaging the Japanese economy to the tune of what is estimated \$200 billion to \$700 billion.

The NRC is ignoring this lesson, because they voted not to require plants to upgrade their protection against flooding and seismic hazards to the level that is known today after reevaluating those hazards after Fukushima, leaving these plants vulnerable not only to the current threat, but also to future threats as a result of climate change. UCS greatly appreciates

the letter that Senators Carper and Whitehouse sent to the NRC criticizing this decision.

With regard to the reactor oversight process, which is the NRC's program for conducting oversight of nuclear plant safety and security, we are also very concerned about the proposed changes that could weaken regulatory oversight. The nuclear power sector is getting older. The average age is 38 years. Many plants are now applying for license extensions to up to 80 years. At the same time, reactor owners are under financial pressure and cutting costs.

But reactors that are getting older need more regulatory attention, more inspections and monitoring and maintenance than less. Unfortunately, the scaled back reactor oversight process would cut back inspections of the aging reactor fleet and weaken regulatory responses to safety violations, taking the program in the wrong direction. These would include critical inspection like fire protection, which would be done less frequently. NRC Commissioner Jeff Baran has criticized these. In fact, even Commissioner Caputo has said she agrees in a lot of ways with Commissioner Baran. But the commission has not yet voted on these proposals.

Now, it is not clear from the NRC's own data whether the actual safety is improving the nuclear fleet or not. I provided data in my written testimony that shows that the number of

unplanned shutdowns actually increased over the last few years, while the NRC's inspection findings have decreased significantly. But the NRC, in a review, was unable to attribute that reduction inspection findings to actual improvements in safety.

So one problem from the point of view of the public is, we don't have good transparent information to be able to assess the direction of nuclear safety. That is one issue why I think both the NRC and INPO need to do a better job in communicating that.

I also outlined issues with security inspections. The NRC has cut back on critical force on force security inspections, which are required by law, reducing the number of scenarios that are tested in these mock terrorist attacks in a way that I believe will greatly diminish the ability of nuclear plants to protect against terrorism.

I also highlight issues with spent fuel storage at nuclear plants, including the vulnerability of spent fuel in wet pool storage to fires as a result of seismic events or terrorist attacks. The NRC has not taken the necessary actions to reduce that risk, either for operating or for decommissioning plants. In fact, it is increasing the risk to the public at decommissioned plants by allowing those plants to eliminate their emergency planning zones as long as spent fuel is still in the pool.

I apologize for going over my time, and I would be happy to answer your questions. Thank you.

[The prepared statement of Mr. Lyman follows:]

Senator Barrasso. Thank you so very much.

Let's start with a question from Senator Inhofe.

Senator Inhofe. I appreciate that very much. I chair the Senate Armed Services Committee, and we have the Secretary General of NATO meeting with me in six minutes. So I am going to go first, and I will make it real quick.

Let's start with you, Admiral Willard. First of all, I am glad we are having this meeting. It is important to reiterate that nuclear power generates over double the electricity compared with wind and solar. Most Americans don't know that. Admiral Willard, when I chaired this committee, I chaired the Subcommittee on Clean Air and Nuclear Safety in the 1990s. At that time, the issues we scrutinized were how the NRC conducted oversight.

Now, you have heard some comments that were being made. The reactor oversight process, Admiral Willard, can you elaborate just briefly and maybe give a couple examples of how safety has improved during that time frame.

Admiral Willard. Yes, sir, and thank you for the question.

The reactor oversight process, obviously INPO is very familiar with it. Again, as an independent but complementary safety and reliability organization, INPO is contributing to many of the factors that strengthen overall reactor safety as it would be indicated in the oversight activities of the Nuclear

Regulatory Commission.

In answering the question of improvements over time, I would draw your attention back to the curve at my right. That is actually an indicator that contains 12 areas of safety and reliability factors that are combined to yield that curve, and all have improved in the time frame that you allude to, from 1990 to present. They range from capability factor, which has been mentioned earlier, and online reliability, to safety injection and unplanned scrams, to fuel reliability, chemistry effectiveness, all the way down to industrial accident rate. Again, a dozen different areas specific to safety and reliability of our nuclear reactors that have all undergone vast improvement over time to have achieved the levels of performance that the industry has achieved today.

Senator Inhofe. That is good, thank you very much.

Dr. Lyons, I have used the same quote that you used in your written statement, when you quoted Secretary Perry as saying, "Energy security is national security." I use that quite often in my chairmanship in the Senate Armed Services Committee. Would you expand on why access to nuclear energy is vital to national security? Also, as you brought out, the problem is out there with Russia and Chinese, their aggressive behavior recently.

Mr. Lyons. Thank you very much for the question, Senator

Inhofe. Certainly, the reliability and resilience provided by nuclear power to our grid is an element of national security. Nuclear energy and nuclear power also is critical in supporting our nuclear navy and our nuclear weapons program.

The infrastructure that underpins our nuclear navy and weapons programs is fundamental to the nuclear power program. As the nuclear power program is, as the commercial number of plants decreases, I fear that we are lessening our support to those key national security elements.

I think I mentioned in my testimony that I find it very interesting that not only Secretary Perry has made this set of comments, but the previous energy secretary, Dr. Moniz, who now is involved with the Energy Futures Initiative, has authored a document, in fact the title, I wrote it down, was the U.S. Nuclear Energy Enterprise: A Key National Security Enabler. It is a very, very strong statement. The role of nuclear energy and underpinning our national security is very strong.

As for Russia and China, certainly Russia at the moment is extremely aggressive. China is focusing on their internal domestic program, but starting to move into the international regime.

An interesting statistic is that since 1997, if you look at construction of plants and plants in construction, domestically the United States, that number is three. And two of those are

the continuing construction in Georgia.

Russia, that number is 15. China, that number is 39. In other words, tremendous focus on the domestic program, especially in China.

But if you look internationally, Russia is by far the leader internationally. In fact, that same number internationally for Russia would be 24 plants, either constructed or in construction internationally.

In the past, when the United States designs dominated internationally, we were able to set the international security and non-proliferation goals for the world. As Russia takes over that international leadership, by their aggressive international outreach, we are, in my view, potentially ceding our leadership in non-proliferation and safety to Russia, and I believe eventually, China. In my view, that is of great concern. I would hope Congress would look at actions that could allow our U.S. nuclear industry to compete on an equal footing with Russia and China. That starts with a strong domestic industry. Thank you.

Senator Inhofe. That is great, and I appreciate that comment very much. I have some questions for the record on that subject for you. Thank you, and thank you, Mr. Chairman.

Senator Barrasso. Thank you, Senator Inhofe.

Senator Carper.

Senator Carper. Thanks again to each of you for your service, and your presence today.

Dr. Lyman, Dr. Lyons, this is a question for both of you, if I could. You both mentioned in your testimony the importance of an independent nuclear regulator. I noticed when I was talking about the NRC and the important role they play as the gold standard, I saw a lot of head moving, which I appreciated.

Beyond what you may have talked about in your testimony, are there actions the NRC is taking today that may give you pause, or maybe reason to question, if you will, their independence or actions that they are taking today that would strengthen its independence? Are there actions the NRC is taking today that make you question their independence or actions? Are there actions the commission could take today that would strengthen their independence? We will start with Dr. Lyons. Go ahead.

Mr. Lyons. Thank you for your question, Senator Carper. That was directed to me?

Senator Carper. Both of you.

Mr. Lyons. Okay, well, thank you for the question, then I will send it to Dr. Lyman.

I have great respect for the leadership, the commissioners of the NRC. I have served with them. They continue to evaluate, continue to evaluate changing conditions within the

industry and changing needs for regulation. As they have evaluated changes in areas like the reactor oversight process, I believe they are doing that with a full range of knowledge of the facts and doing it in a way that continues to maintain not only their independence, as well as the safety of the existing plants.

As far as actions in the future, I mentioned the importance of risk-informed regulation. That is not new to the NRC. Back when I was with Senator Domenici, we talked about risk-informed regulation being an important move forward. It is still an important move, and there has been a lot of progress made. But particularly with advanced reactors that do not use light water coolants, and for which then the deterministic regulations based on light water reactors really don't apply, it is very important that the NRC continue its quest for risk-informed regulation. And that, I think, is fundamental to improved safety in the future.

Senator Carper. Thanks for that response.

Mr. Lyman. Thank you, Senator Carper.

Let me tell you what I see in --

Senator Carper. I am going to ask you to be fairly brief in your response.

Mr. Lyman. Yes, sure. In multiple public meetings is that the NRC over recent years is engaged in negotiation with the

industry on the development of standards, regulations and procedures, rather than asserting an independent role of determining the best safety and security regulations and procedures going forward, they are actually, they look for alignment with the industry at every opportunity.

I feel that they have weakened their independence through that process. The way to fix that, there are a variety of things that can be done. One, the revolving door between NRC, senior staff, commissioners, and the industry is one that has been identified at other agencies as contributing to a lack of independence.

Ultimately, it is really the strength of the commissioners, that is the role of the Executive Branch and Congress to ensure that there are strong, independent commissioners who are willing to stand up for safety and security and face down the industry and not take into account their financial crises in making these critical determinations. Thank you.

Senator Carper. Thank you. Dr. Lyons, let me talk about, if I could, the Nuclear Energy Innovation and Modernization Act, which made, as you know, changes to the NRC budget. The system requires NRC to develop a regulatory framework for the next generation of nuclear technology. A question, if I could. Are there other actions, in addition to that, that Congress can maybe or should take to support the safe deployment of advanced

nuclear technologies, including accident-tolerant fuels?

Mr. Lyons. Thank you for that question, Senator Carper. Yes, the Act that you referenced I believe is very important from the standpoint of further improvements at the NRC. That Act encouraged, for example, development of a framework to license advanced reactors. I think it is important to view how the approach to advanced reactors that do not fit within deterministic regulations for light water reactors will be evaluated in the future. The NRC has made a number of steps in coming up with plans to help industry understand how they will move ahead. Your Act, that Act, encourages that.

That Act also set aside the funding for development of regulations for advanced reactors outside of the fee base. That is another extremely important step. Of course, then the budget has to be adjusted appropriately, I would say upwards, to correct for the fact that that money is not coming from the fee basis.

But I think the general move to pull the funding for advanced reactor development out of the fee basis is logical and important. Certainly, simply on again, a logical basis, there is not much reason why the existing plants, in fees that they pay, should be supporting the development of the next generation of reactors. So I compliment those and other aspects of that Act, and I think that yes, it will assist the NRC.

Senator Carper. All right, thanks. I am going to run off to our other hearing and I am going to hopefully get back before we wrap this up and maybe have a second round. I will telegraph my pitch. I want to find out where you gentlemen agree on some stuff that we need to know about. I want to come back to new nuclear technologies, small modular reactors, and talk about safety there, and what aspects of those technologies is really going to enhance our safety, which we are all interested in.

Thank you.

Senator Barrasso. Thank you, Senator Carper.

Senator Boozman. Thank you, Senator Barrasso, Senator Carper, for having this very important hearing. It truly is one of the underpinnings that we have out there. It is not very glamorous, but like I say, it is so, so very important.

Dr. Lyons, the utilization of digital technologies in nuclear plants is critical to increasing power plant safety, modernizing American nuclear reactors and decreasing costs. The NRC has spent over 20 years examining how to approve the use of digital systems. Do you recognize the safety benefits of digital instrumentation and control systems? Also, what specific steps are underway at the NRC in support of broader implementation of digital technology? When can we expect tangible action on this critical issue, rather than spending another 20 years talking about digital systems?

Mr. Lyons. Dr. Boozman, thank you very much for your question.

I might note that when I was at the NRC, by now quite a while ago, at that time Chairman Klein and I worked very hard to begin to build the capability at the NRC for more effective licensing of digital systems. We recognized even then that the analog systems on which the industry has depended for decades are, frankly, becoming obsolescent. As long as they keep working, everything's fine. But when the utilities find it necessary to replace components, frequently those components don't exist anymore, or you could find them in the Smithsonian.

So the move to digital instrumentation is vital. At the same time, there is no question that digital control of the plants does bring different challenges. The NRC has been developing the capabilities to analyze that. So has the DOE. There are very effective programs, I believe, between the DOE and industry, in the so-called light water reactor sustainability program that are helping industry to move toward digital instrumentation.

Since I am not at the NRC now, I can't tell you exactly what the NRC is doing to prepare for this. I know they are well aware that it is coming, they are well aware that it is essential. And I have high hopes that the seeds that Chairman Klein and I planted during my term have led to a very strong

capability at the NRC to evaluate digital systems today. But I don't have current data of what is going on at the NRC, and I certainly can't speak for them. So I hope that is at least a reasonable answer to your question.

Senator Boozman. I appreciate that. Again, this is something, I think, that is very important, that we spend a lot of time and hopefully we can move forward. Again, we don't want to spend another couple decades in the sense of trying to get us into this century.

Admiral Willard, time and again I hear from my constituents in the private sector that more than anything, they need regulatory certainty to be able to stay in compliance. You know you can play with good rules, you can play with bad rules, and if you don't know what the rules are, it really makes it very difficult.

So drawing on your work history, can you explain why certainty is so important to the nuclear industry, and more importantly, how does certainty help with safety?

Admiral Willard. I think the precision in the work that is required in such a consequential industry is very important. The professionalism that I think we enjoy in this industry is the depth of understanding of both the technical systems and of the requirements of the personnel to avoid human error that are essential to being successful and operating a consequential

industry such as nuclear power represents.

At INPO, within the institute, we have developed a technical staff that itself is very knowledgeable and precise in that knowledge, and has a sound understanding of what the human performance expectations are in operating equipment. As you roll up those factors, the level of certainty and excellence of the operations themselves grow, the ability of the regulator to oversee that, the ability of us to evaluate to that I think demonstrates the importance of the factor that you raise.

I think we are showing great success in that area.

Senator Boozman. Very good. Thank you, Mr. Chairman.

Senator Barrasso. Thank you, Senator Boozman.

Senator Cardin.

Senator Cardin. Thank you, Mr. Chairman. Let me thank our three witnesses.

Nuclear power is extremely important to our Country. It is a major source, it helps us deal with environmental risks, and it is important for our economy and national security. Two reactors are located in Maryland at Calvert Cliffs. So I am a strong supporter of the NRC, headquartered in my State of Maryland. Their record on dealing with safety first to me is absolutely essential, and they have made that their top priority, as it should be.

But I must tell you, there are concerns as to whether our

nuclear energy policies in this Country are serving us well for meeting our current needs, let alone the future. You have already referenced a couple of bills that have been filed in regard to advanced nuclear technologies. I filed legislation with Senator Cramer dealing with an investment tax credit for existing plants to modernize, recognizing the economics of nuclear power today is not strong. And we have used tax credits for other forms of energy, including solar, wind, geothermal, fuel cells, et cetera.

So my question is, if we recognize that we have a current fleet of reactors that are beyond their life's term and need to be modernized that we need to deal with advanced nuclear technologies. We also have the small modular reactors that could very well provide help. What would you make our top priorities if we want to make America the leader in the future for nuclear energy? Some have mentioned regulatory reform. Others have mentioned the fact that how we dispose of waste has been, historically that was one of the big issues we have talked about. Or is it the economic issues of operating a plant that the government needs to be involved with? Or is it greater federal involvement in dealing with the new technologies that are being laid out? Or is there something else?

I would like you to give me some idea of your priorities as to what you think is the most important thing for Congress to do

to put America in the lead today and tomorrow on safe nuclear energy for our use.

All three of you, whoever wants to respond, go for it. Dr. Lyons?

Mr. Lyons. Thank you for the question, and one that is very near and dear to my heart. Another one of my roles is that I co-chair a subcommittee of the Nuclear Energy Advisory Committee for Secretary Perry. I co-chair the subcommittee on sustainability of the existing fleet. And we are very, very concerned with the issues that you raise.

You mentioned the possibility of tax credits for modernization. Yes, that certainly is one area that would help.

If I were to pick just a very few areas that I think would be particularly important, the first would be to treat all clean energy resources equally. The renewable mandates, mandates for renewables that we have across the Country, the special treatment that renewables get tends to distort the marketplace. I think if we treated all clean energy sources equally, that would be a major step forward.

Also, in my view, something like a carbon tax would be extremely important. There have been many proposals for different things that might qualify under the general framework of carbon tax. The ones that I think might have the best chance would be the various tax, or revenue neutral approaches that

have been proposed. I am certainly not an expert in these, but I think some way of valuing carbon free electricity is extremely important to the Nation. There are many ways in which it could be done.

I very much appreciated the initiative that Secretary Perry began with FERC to look at possible recognition of the importance of nuclear plants from a standpoint of reliability and resilience on the grid. I appreciate that. I question when it is then, when nuclear and coal are combined and looked at equally, when they have very, very different attributes. And that certainly undermined a lot of support, I think, that might have been generated for that particular approach.

Then finally, quickly, small modular reactors, yes, extremely important. I think they offer a new regime of safety, new regime of, I believe, financing flexibility. I think they will be extremely important to the Country, and I think we must proceed, must, if we are going to move ahead with advanced reactors and maintain a strong industry, I think we must proceed with small modular reactors, both domestically and there are tremendous opportunities internationally.

I am sorry for the long answer, sir.

Senator Cardin. Dr. Lyman, do you want to add anything?

Mr. Lyman. Yes, I see you are over time. It should be clear that safety and security, we believe, are the top

priority. That is essential for the credibility of the industry and for the regulator.

You could just imagine, if you look at the impact of Fukushima on the Japanese nuclear industry, in fact, around the world, you can see that the industry doesn't have a lot of resilience in the event of an accident like that. So the top priority would have to be ensuring that another Fukushima or worse does not occur anywhere in the world. And the key to that is stringent regulation.

The vendors of advanced reactor designs all have really nice stories to tell. But they are not always the best judges of the merits of their own technology. So there needs to be stringent review of the safety and security claims of those reactors and not a rolling back or streamlining licensing as we have heard from some of the other speakers. Thank you.

Senator Cardin. Thank you, Chair.

Senator Barrasso. Thank you, Senator Cardin.

Admiral Willard, your organization's mission is to promote excellence in nuclear power operations. A nuclear reactor that is operating at your high standards of excellence is safe and efficient. Based on your experience, how does the principle of nuclear safety align with strong economic performance of reactors?

Admiral Willard. Thank you, Chairman. That is, I think, a

great question, and one that we often find ourselves answering. The same attributes that lend themselves to high safety standards within our nuclear operations, so the professionalism of our workforce, their highly trained nature, the qualities of our equipment, the ability to exercise those, are the same things that lend themselves to the reliability of our plants. You mentioned it in your opening statement, that the plants that are efficient and stay online are generating electricity and are productive.

So when you roll up the various qualities that we promote in the standards of excellence across the industry, they lend themselves to both safety and reliability and therefore, economic viability.

Senator Barrasso. Dr. Lyons, the Nuclear Energy Innovation and Modernization Act was signed into law in January. The intent of the law is to facilitate the development of advanced nuclear reactors. So how does the balance of performance and risk in existing safety regulations influence companies looking to then in the future license and build advanced nuclear technologies?

Mr. Lyons. Thank you for that question, sir. I guess first of all I would say that energy, that any new industry entrant knows that safety must be job one. They also know that the performance of their design may determine their eventual

market opportunities. But as they focus on their performance, they must also have pretty high confidence that the NRC will be ready and able to evaluate their design and whatever innovative features are present in their design.

And in most cases, in the advanced reactors, they are departing substantially from the light water reactor technology base that the NRC is very expert in. So it seems to me that one of the most important points, and I think the Act that you reference helps on this, the new entrants, the new companies, must have high confidence that the NRC will use risk-informed criteria in evaluating their designs. Because the deterministic rules set up for LWRs simply are very, very clumsy to try to apply to a non-light water reactor.

So to me, risk-informed regulation is vital. And the NRC has been moving, I think, quite well in that direction. They have a long way to go, as they move further away from light water systems.

Senator Barrasso. Following up on that, Admiral Willard, the Nuclear Regulatory Commission is currently reviewing the first application for a small modular reactor. So more applications for advanced nuclear technology are expected.

How is the institute preparing to incorporate new nuclear technologies into its standards?

Admiral Willard. Thank you, Chairman. Whenever a new

technology is being introduced, the institute begins by advancing its understanding of that technology itself. A good example is the AP1000s that are currently being built in Georgia and INPO already has placed some of our personnel through licensing and certification courses, so that we now have operators that are certified on the AP1000.

We compare those new technologies to our excellence standards and make a determination as to whether any of those standards should be in some way changed. And then ultimately, we begin through processes that range from the accreditation of their operators to advance visits to set them up for success in their startup fuel load, and subsequent operations.

So we have a template that we exercise with any new technology that is being introduced. In fact, today, there is a Chinese small modular reactor that is under construction that we are in that process, happens to be a member of WANO Atlanta Center, a pebble bed reactor design, and we are growing our understanding of the pebble bed technology in advance of exercising that process.

So we will be ready for any small modular reactor or future reactor design when it comes.

Senator Barrasso. Thank you, Admiral Willard.

Senator Duckworth.

Senator Duckworth. Thank you, Mr. Chairman.

Mr. Chairman, on behalf of my colleague from Maryland, Senator Cardin, I would like to ask unanimous consent to submit for the record a July 2019 New York Times article, two letters addressed to Chairman Svinicki, one sent in July 2019 from the Chairman of the House Energy and Commerce and Appropriations Committees, and one sent in April 2019 from Senator Carper and Senator Whitehouse, and a statement and other materials relevant to today's hearings. Among others, these documents discuss concerns with the Nuclear Regulatory Commission's suggested changes to various proposals that would weaken or reduce vital safety measures in place at our Nation's nuclear power plants.

Senator Barrasso. Without objection, so ordered.

[The referenced information follows:]

Senator Duckworth. Thank you, Mr. Chairman.

I thank all the witnesses for being here today. Dr. Lyman, thank you for your testimony.

As you know, Illinois has more nuclear reactors than any other State in the Nation. Like you, I believe they are playing a very important role in ensuring we have access to zero carbon emitting power.

However, my support for nuclear power is conditioned on them being operated safely and securely. There are staff and Senators in this room today that may recall passing the Energy Policy Act in 2005. That law intended to give whistleblower protections to include employees, contractors and subcontractors at DOE and NRC. A drafting error has caused confusion on who has these rights, because we failed to define what a person is. Almost 15 years later, many do not have whistleblower protections under that specific law. I have a bill that fixes this drafting error and clarifies that whistleblower protection rights for DOE and NRC employees may be enforced as Congress intended.

Dr. Lyman, could you please explain why Congress expanded whistleblower protections to include employees of DOE and NRC? And could you also address why it is so urgent and important that this Congress pass my legislation, Senate Bill 1330, to make sure that these rights may be enforced as Congress

intended?

Mr. Lyman. Yes, Senator Duckworth, thank you for that question.

I can say why we think it is important for NRC and DOE employees to be able to have the recourse and full whistleblower protections under the law, simply because the NRC, speaking of the NRC staff particularly, they have significant responsibility for ensuring the safety and security of nuclear power plants. As part of that responsibility, they need the ability to speak freely when they have safety concerns that they encounter that they feel are not being addressed through their management or in other ways, including the industry influence that I referred to before.

They need to have every mechanism available so that they can pursue their safety concerns and a safe environment without fear of retaliation. Therefore, it is essential that they have all the whistleblower protections that Congress can provide. So to that extent, we certainly agree with your legislation to correct this loophole, or error, which has persisted for so long. Thank you.

Senator Duckworth. Thank you, Dr. Lyman.

As you discussed in your testimony, the NRC regularly conducts force on force testing at nuclear power plants. These tests are critical to ensuring we understand what our security

vulnerabilities, like those from a terrorist attack, are at these facilities. Over the past decade, the results have been fairly consistent with one failed exercise per year.

I am concerned that the NRC is considering reducing the number of force on force exercises to conduct in favor of exercises planned and conducted by the licensee. I understand that the NRC is reviewing staff recommendations now on this very issue.

What are your recommendations, Dr. Lyman, to the committee and NRC, on how force on force tests should be conducted?

Mr. Lyman. Thank you for that question. It is essential that nuclear power plants be protected against contemporary terrorist threats based on the best intelligence information. So the primary, the most important thing is to make sure that the design basis threat and the characteristics of the adversaries that are assumed in developing and testing security plans are consistent with known capabilities of terrorists around the world.

Unfortunately, the NRC is scaling back on those protections because the industry has complained that the design basis threat and the capabilities of adversaries are too, essentially, adversaries are too capable and it is unrealistic. But again, that information is based on intelligence information, so the industry doesn't have the knowledge to really overrule those

decisions. Unfortunately, that is the trend.

There need to be multiple exercises to be able to test the full range of potential threats that a nuclear power plant could encounter. So certainly reducing the number of scenarios that are run during each inspection is a bad idea. And replacing NRC-run force on force inspections with observation of an industry self-inspection is not adequate, because of the potential for conflicts of interest and gaming these exercises when the industry is in charge of them themselves.

So these are some of the issues that would need to be addressed to make sure the system is robust. One example of the threat of drones, which is increasing the malevolent use of drones, is a concern. The NRC just recently decided not to increase their design basis threat to consider the use of drones by adversaries. Thank you.

Senator Duckworth. Thank you. I think it is vital that the NRC continue to conduct these tests. We are seeing on the Boeing 737 Max 8 tragedies what happens when we allow industry to evaluate itself and self-certify. I yield back.

Senator Carper. Could I speak out of order just for a moment, just to say thank you?

Senator Braun. [Presiding] Go ahead.

Senator Carper. My colleagues may recall last week I invited the members of our committee to sign a get-well card to

a gunman who was almost killed in Afghanistan two months ago. He is from Delaware; his mom says he loves to get cards. He has had four brain concussions, crushed vertebrae, crushed leg, all kinds of damage. He is recovering and he is down in the Tampa VA hospital now. But we sent him, signed by 21 Senators, a get-well card. I talked to him on Veterans Day, just to see how he is doing. He had gone to see the Tampa Bay Buccaneers play the day before. He is mobile, he is in a wheelchair, but he hopes to be able to walk again and someday run again.

But he was just deeply moved and touched, as was his family, by all of you doing that. I just want to say a special thanks.

Senator Braun. Thank you.

Dr. Lyons, the discussion earlier was about if you could only level the playing field. What would happen if any of the supports currently in place for renewables, as well as all the stuff that has been embedded in the code for fossil fuels, if that was eliminated, where would it put our current nuclear fleet in terms of economic competitiveness, if there were no props there for other forms of electric generation? Roughly. Where do you think it would be?

Mr. Lyons. Senator Braun, I can't give you a precise answer to that question. It certainly would be a substantial step toward helping the economic situation of the existing

fleet. When there have been evaluations, for example, of profitability of our existing fleet, of reactors, of course it differs plant to plant. One of those evaluations was done by the Union of Concerned Scientists.

But an interesting point in those evaluations is that it is a relatively small margin. Typically, if I am remembering correctly, about \$5 a megawatt hour that separates profitability from non-profitability in the existing fleet. So the suggestions you make I believe would be positive in that direction. I can't give you a precise answer. I could certainly suggest groups that could give you a precise answer.

Senator Braun. What percentage is five megawatts on, in other words, what would happen if, say, we just lightened regulation in general, without going more deeply into the investment tax credits and other things that are more significant? Is that a very -- you say only five megawatts. What is that percentage wise?

Mr. Lyons. Five dollars per megawatt.

Senator Braun. Five dollars per megawatt, yes.

Mr. Lyons. If I am doing the numbers correctly in my head, sir, that is about a quarter or so of the average price. The average price now for nuclear power generation cost is 3.2 cents per kilowatt hour. I would simply have to stop and do all this in my head, I think it is about one-sixth of that would be --

Senator Braun. So close enough to where it could become economically viable. Good enough. Thank you.

Mr. Willard, when it comes to advanced nuclear technology, and I think there was discussion earlier about the instrumentation going to digital format, which I believe Purdue University just took across the finish line, is that true? I think of the 24 or 25 universities that were working on it, I think that did occur. The fact that it would not be heralded out there tells me a little bit about the profile of where advanced nuclear technology is.

But when it comes to that modality, is it the silver bullet when it comes to climate change considerations and can we, and would it be a replacement for the current nuclear fleet or an addition to it? Because the current nuclear fleet looks like it is slowly going out of business. And it looks like if we are going to have nuclear around, with all its attributes, it would have to be through the small modular reactor. This is for Admiral Willard.

Admiral Willard. Yes, thank you for the question. And this might be better answered by Dr. Lyons.

The transition of technologies to digital, the transition of technologies to small modular reactor, and the transition to future reactor designs, are all intended to provide increased efficiency and productiveness in the way that our nuclear fleet

would operate, as well as increased safety, passive safety capabilities. And it would take advantage of our most modern digital technologies. We are all invested in that, more or less, as we make the transition to advanced reactor designs over time.

Currently, our fleet and its licenses, without a next license extension, has a lifespan that ranges to about 2055, where an additional license extension, that would be 2075 for some percentage of our future. This fleet was built in 25 years.

So to your point, there is some urgency in recapitalizing our nuclear industry, given the timelines that we are on. The new technologies are intended to make it more operational, more passively safe, and much more efficient in terms of its production. So I think that when you say silver bullet, not sure that I would coin that term for this. But certainly, the new designs will take us to a next generation of energy production in this very important baseline of clean energy.

Senator Braun. Thank you. Dr. Lyman, very quickly, advanced nuclear technology, small reactors, does that pass the safety test in terms of being something we could scale and do sustainably, in your mind?

Mr. Lyman. Well, it is possible, with proper oversight and regulation, that a smaller nuclear reactor could have better

safety features than a larger reactor. But my concern is that too much credit is being taken for these inherent advantages, leading to exemptions or relaxing standards in other areas before it is warranted.

And it is important to remember, these reactors are still on paper. Until they have actually been operating for some time and you have confidence in that operation, there is so-called risk-informed, something that has to be done very carefully, because you don't have enough information. So they have to be deployed very carefully and only incrementally over time would you get the confidence to actually perhaps reduce the level of regulation.

Senator Braun. Thank you. Senator Van Hollen.

Senator Van Hollen. Thank you, Senator, and thank all of you for your testimony here today. I have long supported nuclear power as part of the energy mix, especially given the fact that it is a carbon free source of energy. But that support comes subject to stringent safety standards. I think it is absolutely important that we continue to maintain a safe nuclear power environment.

As Dr. Lyman said earlier, this industry is not resilient when it comes to nuclear accidents and the aftermath. We saw that in Fukushima. So I would think that everybody would have a stake in making sure that we don't roll back any safety

standards, and don't create any perception that we are weakening those safety standards. I think that is critical to public support, and I also think it is critical to public safety.

There has been a discussion about the advanced nuclear reactors. I think everybody is interested in where we can go with that, again, subject to safety oversight. But I have a question related to that on the nuclear nonproliferation side. Because my understanding is the expansion of more advanced reactors will include designs that will likely use more proliferation sensitive fuels, like uranium enriched to higher levels than for conventional reactors, and involve closed fuel cycles, where spent fuel will be reprocessed into plutonium.

So my question is, as people talk about going in this new direction, what do we do at the IAEA and other places to get international consensus as to how to limit what will apparently be a greater risk, even greater risk of proliferation with respect to advanced reactors? Why don't we start with Dr. Lyman, and if we could just go down that way?

Mr. Lyman. Thank you, Senator Van Hollen. It is a very important question, and one that we worry about quite a bit. The fuel cycle is a critical element of nuclear power. If you talk about expanding nuclear power around the world, you have to make sure that it does not increase the risk of nuclear weapons proliferation or nuclear terrorism.

So to that end, we do not support any advanced reactors, so-called advanced reactors, that use fuel cycles involving materials that are directly weapon usable, such as plutonium. So we don't believe that it is necessary for the future of nuclear power, in fact, we believe it is detrimental to the future of nuclear power because of the additional liabilities those bring.

You also raise an interesting issue about enriched uranium. Many new reactor designs would use uranium that is enriched to higher levels than current light water reactors, but still below the threshold that is considered higher enriched uranium. But those higher levels are not immune to proliferation or terrorism threats. It is very important, we have argued, that there needs to be an assessment if there is going to be expanded production of this so-called high assay low enriched uranium around the world, what is the impact of that on proliferation of nuclear terrorism.

Senator Van Hollen. Thank you. Any other comments?

Mr. Lyons. Thank you for your question, Senator.

Generally agree with the comments that Dr. Lyman just made. Not fully, but generally. Certainly there will be a trend with a number of the advanced reactors toward high assay LAU, which stays below the 20 percent that is generally regarded as moving toward weapons usable.

As far as closed cycles, let me approach it this way, sir. When I served as Assistant Secretary for Nuclear Energy, unfortunately we made, I would say, no progress toward a used fuel management strategy in this Country. At that time, the Administration of President Obama was recommending consent-based siting of repositories. That has not moved ahead. Yucca has not moved ahead.

I think with the continued impasse on used fuel management, I think it is time in this Country to at least evaluate whether a closed cycle would change the quality of the debate on used fuel management, enough at least to do significant research in that area. There are other new ideas that have come along, too, such as the deep boreholes.

But my main point would be that in my time there, we did not progress on used fuel management. The Country needs a used fuel management program, and I think we need to look at a wide range of opportunities that might change the debate.

Under any circumstances, though, more to your point, fuel facilities, the fuel cycle, needs to be under strict IAEA control. The IAEA has the capabilities. I am a very strong fan of what they have been doing around the world. For any of these cycles, whether it is the current cycle, future cycles, we need the IAEA involvement. I would be very happy to see all fuel cycles facilities even under stricter international control.

That is a partial answer, sir.

Senator Van Hollen. Thank you. Thank you, Mr. Chairman. Unfortunately, there is a vote on. Thank you all.

Senator Barrasso. [Presiding.] Thank you very much, Senator Van Hollen.

Senator Markey.

Senator Markey. Thank you, Mr. Chairman, very much. A few States focus on this issue more than Massachusetts, because for resident of Plymouth and Newburyport and other cities and towns in Massachusetts, nuclear oversight means the difference between sleeping easy and living a nightmare.

For today's hearing, Massachusetts advocates submitted comments on their experiences with efficient nuclear oversight at the Pilgrim Nuclear Power Plant and the Seabrook Nuclear Power Plant. Mary Lampert, of Pilgrim Watch, writes that "Luck alone is preventing the next accident. Reactors are old, require maintenance and repairs due to downgraded components, but are not getting the care today due to industry's shrinking profit margins and the Nuclear Regulatory Commission's inattention."

Natalie Hildt Treat of C-10 writes, "it should be the role of the Federal Government to ensure a strong and continuing oversight of nuclear reactors and their deadly byproducts, and not cede authority to industry actors, for whom public safety is

only one performance metric.”

These testimonies illustrate perfectly the frustration and fear that communities face when the Nuclear Regulatory Commission fails to prioritize safety over industry solicitations. Mr. Chairman, I ask unanimous consent to submit these testimonies, as well as testimony from Henrietta Cozentino of the Plymouth League of Women Voters, and Diane Turco of Cape Downwinders.

Senator Barrasso. Without objection, so ordered.

[The referenced information follows:]

Senator Markey. Thank you, Mr. Chairman.

The Nuclear Regulatory Commission granted Pilgrim an exemption from emergency planning and preparedness requirements, despite the fact that much of its used radioactive fuel is still sitting in spent fuel pools. Dr. Lyman, do you agree that it is dangerous and shortsighted for the NRC to remove key safety requirements while fuel is still in spent fuel pools at Pilgrim?

Mr. Lyman. Thank you, Senator Markey. I do agree. As long as there is spent nuclear fuel in the spent fuel pool, there is the risk of a potential zirconium fire in the event that cooling is lost, either through an accident or a terrorist attack.

Senator Markey. Dr. Lyman, do you agree that we should go even further in requiring the swift removal of radioactive fuel from high density pools to dry casks?

Mr. Lyman. Yes. We support additional requirements for the accelerated transfers of spent fuel from high density spent fuel pools to dry casks, which would reduce the fire risk.

Senator Markey. Thank you. This week, I am reintroducing my Dry Cask Storage Act, to make sure that we go further with safety and planning for fuel storage at these risky sites. Cutting these planning and emergency response requirements for cost savings just cuts away at the Nuclear Regulatory Commission's legitimacy in the eyes of Massachusetts residents.

The reactor oversight process is the heart of the Nuclear Regulatory Commission's nuclear safety mandate, but NRC staff have recommended that the commission unnecessarily and unjustifiably weaken this key program. Proposed changes would minimize the significance of some NRC inspection findings, a dangerous move, considering how many so-called lower risk findings can point to high-risk problems.

Pilgrim serves as proof. After accumulating three low to moderate risk findings, the Nuclear Regulatory Commission placed Pilgrim in the lowest active safety category. As a result, the plant received heightened oversight in order to guard against disaster.

Dr. Lyman, do you agree that the proposed changes to the reactor oversight process would mean that other plants with safety issues like Pilgrim might escape the NRC's notice?

Mr. Lyman. Yes, Senator. So many proposals that are under consideration would make it harder for the agency to recognize deteriorating safety trends, and therefore, take timely actions. Those kinds of changes would really be a mistake.

Senator Markey. Thank you. My concern is that when the teacher is only allowed to give out As, it will look like all the students got smarter, but it just makes it impossible to figure out who is failing in the class. That is what would happen with the proposed changes to the reactor oversight

process. It is not making us safer; it is just cooking the books.

Finally, to test how well nuclear reactor operators can protect their plants from attack, the NRC requires performance-based inspections with attack simulations. Over recent years, the NRC has repeatedly weakened these force on force inspection requirements. Dr. Lyman, do you agree that having plants conduct their own security test is not an effective way to assess whether they can defend against an actual attacker?

Mr. Lyman. Yes, I do agree. Those self-inspections do not satisfy the requirements for independent verification of the security force performance at nuclear power plants.

Senator Markey. So if the weakened reactor oversight process is like grade inflation where everyone gets an A, the weakened force on force exercises are like letting students design and grade their own test. That is even more dangerous.

This isn't the way to keep people safe. This is in the way to carry out the NRC's mission. This will only ensure that more communities will face the same fears that we have here in Massachusetts.

With your permission, Mr. Chairman, Mr. Lyons, would you like to chip in for 15 seconds?

Mr. Lyons. If I may, Senator Markey, I would just beg the point that I was at the NRC when we evaluated the safety of

spent fuel pools and dry casks. That has been extensively evaluated when decisions are made at the NRC now. But when a decision like the one at Pilgrim is made, that is made based on calculations of how long it would take, as the fuel -- let me start over. When the fuel comes out of the reactor, it is very hot. However, it cools over a period of months, and as it cools, it moves away from a point at which a zirconium fire becomes a concern.

Senator Markey. I have to stop right here. I apologize to you. I subscribe --

Mr. Lyons. My only point would be that it would be considered by the NRC.

Senator Markey. If you could submit that information. I do subscribe, however, to Dr. Lyman's views on these issues. Thank you, Mr. Chairman.

Senator Barrasso. Thank you so very much.

Members are still going to be able to submit questions in writing for the record. So the hearing record will be open for two more weeks.

I want to thank all of you for your time and your testimony today. This hearing is adjourned.

[Whereupon, at 11:34 a.m., the hearing was adjourned.]