U.S. Senate Committee on Energy and Natural Resources
Hearing on U.S. Leadership in Nuclear Energy and S. 903,
the Nuclear Energy Leadership Act

The Honorable Jeffrey S. Merrifield, Commissioner
U.S. Nuclear Regulatory Commission (1998-2007)
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Chairman Murkowski, Ranking Member Manchin and members of the Committee, it is a pleasure to testify before you this morning. I am appearing here today in my role as a Partner and Section Leader in the nuclear energy practice group of Pillsbury Winthrop Shaw Pittman Law Firm, which is the world's oldest and largest nuclear focused practice. In that role, I represent a wide diversity of advanced reactor developers, utilities, nuclear suppliers and other stakeholders in the nuclear industry.

Additionally, I am the Chairman of the Advanced Reactor Task Force for the Nuclear Industry Council (NIC) which is the leading business consortium advocate for nuclear energy and American nuclear exports. I am also a Member of the Board of ClearPath a conservative clean energy foundation as well as the Chairman of E4 Carolinas which is a 150+ member "all-technologies" energy association for North and South Carolina. With those caveats, the comments I am making today are my own.

My testimony today will focus on S. 903, the Nuclear Energy Leadership Act, the state of the advanced reactor industry, the potential opportunities for growth and export of U.S. nuclear technologies, and areas where support from Congress and the Trump Administration would be helpful in spurring these positive developments.

Over the last several years, Congress has enacted a series of nuclear focused acts that have been very helpful to advanced nuclear reactor developers, and I commend this Committee and its counterparts in Congress for the bipartisan efforts that have been made in support of clean nuclear energy over the last several years. At a time when the spirit of bipartisanship has waned in other parts of this town, I commend the Chairman, the Ranking Member and other members of this Committee for continuing the long legacy of cooperation and

engagement in addressing our nation's vital energy policy needs.

I am pleased that the Committee is moving to provide support for the development of advanced nuclear technologies. I personally believe that we must take prompt and significant action to address the impacts of global climate change and I am convinced that nuclear power plays a key role in that regard. Today, nuclear power provides almost 60% of the carbon free energy in the U.S. and 35% worldwide. If we are to make any appreciable reduction in global carbon emissions, nuclear must remain a vital and growing source of clean energy here and abroad. The efforts of this Committee are key in that regard.

The E4 Carolinas energy association, that I chair, has over 150 members who are users, developers and supporters of wind, solar, fossil and nuclear energy as well as smart grid and energy storage technologies. Our organization is dedicated to the notion that no single technology will be able to address our nation's energy and power needs and for this reason we are home to some of the nation's leading hubs for smart grid, energy storage, advanced construction and advanced reactor technologies. We recognize that while we have made tremendous strides in the deployment of renewable assets, principally wind and solar, in order for us to meet our future power and industrial needs in this country, nuclear energy must remain a vital component of our nation's energy mix.

My detailed comments today will not focus on the existing nuclear fleet as I will leave those matters to other panelists, but I will say that it is vital that we maintain our existing nuclear plants in the U.S. As Germany and several U.S. states have shown, the elimination of existing, safe nuclear plants in favor of a "renewables only" program has only resulted in increased carbon emissions. Our country needs to deploy more wind and solar assets, but in order to address climate change, we will need to maintain our current nuclear units, and in my view, double the amount of nuclear power that we have in this country over the next twenty years.

During the four years I have chaired the Nuclear Industry Council (NIC) Task Force on Advanced Reactors, I have had the opportunity to witness first-hand the growth of interest in advanced reactor technologies, not only here in the United States but around the world, specifically during trade missions the NIC has led to a number of countries that are considering deployment of U.S. nuclear technologies. As you may know, there are significant parallel efforts underway in Canada to deploy advanced reactors, and I am pleased that the Nuclear

Regulatory Commission (NRC), and its counterpart the Canadian Nuclear Safety Commission, are working to identify methods where they can collaborate on braking down barriers and simplifying the process to allow bilateral recognition of regulatory review methods and standards.

There are a variety of other countries around the world in Africa, Asia and South America which currently do not produce nuclear power, but who are looking at advanced nuclear energy technologies, that are smaller, easier to build and have enhanced safety features as a potential source of clean power and desalination. These are real export opportunities for our country. Furthermore, as North America has among the most advanced high temperature gas, molten salt and fast reactor technologies available, we must not lose this opportunity to effectively compete on the world stage.

Now I would like to turn to S. 903, the Nuclear Energy Leadership Act.

Let me get to my punchline first: I believe S. 903 is an excellent piece of legislation that will incentivize the development and deployment of advanced nuclear reactors in the United States. It will help enhance the ability for the U.S. to regain its leadership role in the international nuclear energy marketplace, and will assist in creation of many thousands of lifelong, well-paying and satisfying careers for blue and white collar workers alike. By spurring advanced nuclear deployment, S. 903 will provide flexible, economical, safe, clean energy options, and allow us to meet carbon reduction and environmental objectives that are critically important to the economic security of our country. For all of these reasons, I strongly encourage this committee to swiftly pass this legislation.

Now let me expand on some of the reasons for that statement.

Section 7 - Need for High Assay Low Enriched Uranium

The first area in which I would like to focus is Section 7 and the Advanced Nuclear Fuel Security Program.

While the pending development of advanced reactors brings with it the potential for improved economics, lowered operating costs, higher utilization factors, enhanced safety margins and greater modularity, the fuels used to operate these reactors will be of a much greater variety in their form and composition. Additionally, many, but not all of these advanced designs, will utilize higher enrichments (assays) of low enriched uranium (between 8% and 19.75%) a

material that is referred to as HALEU. The enrichment of HALEU is higher than that utilized by current light water reactor ("LWR") fleet (typically 4%-5%) but is not so high as to constitute weapons grade material.

As I stated in a report I wrote on this subject back in February of 2018, "To fully document the potential for the advanced reactor designs, Third Way, which is a Washington, D.C.-based think tank, issued a report on May 18, 2017, that indicated that there are currently 56 advanced nuclear concepts in North America under development with large numbers also underway outside the U.S.[1] From information that the authors (Pillsbury) gathered, the vast majority of these reactor designs are planning to utilize higher enrichments of fuel, and some of these designs are proposed to come to the U.S. market in the mid to late 2020s. Further, a March 2017 survey of 18 leading U.S.-based advanced reactors developers found that 67% of the companies said that an 'assured supply of High Assay LEU' was either urgent or important." [2] As the development of a fuel supply and regulatory approval can take multiple years, work must begin immediately to ensure sufficient supply of HALEU.

The infrastructure for the production of civilian nuclear fuel, as well as the regulatory processes overseeing its production and use, has been based on the existing LWR market. Virtually every element of the nuclear fuel cycle[3] has been tailored precisely for these lightwater reactors. As development and future deployment of many of the current advanced reactor designs requires utilizing fuel with higher enrichments of uranium, appropriate sources of this material will need to be identified or created, as no commercial, domestic source currently exists. This includes the means to enrich uranium, transport it, manufacture fuel forms and store and dispose of spent fuel. For its part, the NRC will also need to tailor its regulatory framework to meet this need.

Since I wrote that report, there have been some developments in this area worth noting. First, the FY19 Energy and Water Appropriations Legislation (PL 115-244) that was passed last year, helpfully included $20 million to begin processing U.S. Navy spent fuel into HALEU fuel. While this was an important action, the proposed process that DOE is developing in Idaho may result in HALEU that contains residual radionuclide components that may not be acceptable for some

[1] http://www.thirdway.org/infographic/the-global-race-for-advanced-nuclear

[2] Advanced Fuels – Looming Crisis in Fueling Advanced and Innovative Nuclear Reactor Technologies, ClearPath/Nuclear Infrastructure Council White Paper on High Assay Low Enriched Uranium, p.2.

[3] The nuclear fuel cycle includes all the steps needed to mine, process, enrich, manufacture, use, store and permanently dispose of radioactive materials, including U-235 based fuels that are used for civilian and naval power and propulsion purposes.

advanced reactor designs due to its neutronic characteristics.

Additionally, the Department of Energy (DOE) recently announced its intention to award a contract to Centrus Energy to utilize its American Centrifuge Technology for constructing a 16-centrifuge pilot cascade by 2020 to produce a small amount of HALEU for use in research and development. In parallel, Urenco has also indicated that it is considering adding a cascade to its enrichment facility in New Mexico that could also produce HALEU.

While all of these developments are positive, the language included in Section 7 would set out specific targets for the Secretary of Energy to make HALEU available for this developing market – 2 metric tons by the end of 2022 and 10 metric tons by the end of 2025. This is vitally needed to ensure that our nation's advanced nuclear innovators are not held back by the inability of the market to provide HALEU in a timely manner. Additionally, the provisions in the section that provide for DOE leadership in the development of HALEU transportation packages is needed as today we are relying on existing transportation packages that, while they are safe, are aging, are generally designed for a maximum of 5% enriched uranium, and are insufficient in quantity and volume to meet the future anticipated need for HALEU.

Finally, I would note that the existing fleet also stands to benefit from the provisions included in Section 7. Lightbridge Corporation, in collaboration with Framatome, is designing a metallic fuel, utilizing HALEU, for the deployment with the existing nuclear units, that has the the potential for enhanced safety improvements over current fuel, as well provide for the ability to increase the power output of existing nuclear reactors.

Sections 2 and 3 – Authorization of Long-Term Power Purchase Agreements

Over the years, our law firm has worked on behalf of our clients in deploying dozens and dozens of nuclear reactors around the world. One of the vital components, in both the domestic and international deployment of these reactors is the use of power purchase agreements to create a financeable funding stream that will incentivize investors on both the debt and equity side to finance these units. This capability, when combined with investment or production tax credits, both of which are admittedly outside of the jurisdiction of this Committee, can be enormously helpful in spurring the investment of private capital in energy innovation.

The language included in Section 2, which would modify the U.S. Code to allow 40-year power purchase agreements for public utilities, as well as the power purchase agreement (PPA) pilot in Section 3 of the bill, have the potential to serve as a vital "kick-start" for advanced reactor deployments here in the U.S. Armed with these commitments, advanced reactor developers will be able to more effectively engage with individuals and institutions that may be willing to invest in these innovative reactor technologies, but who need a bit of additional "assurance" that there is sufficient long-term demand to justify putting their capital at risk.

Section 4 – Advanced Nuclear Reactor Research and Development Goals

I would like to strongly endorse the provisions contained in Section 4 which call for a series of demonstration projects to be funded by the Department of Energy to spur the deployment of innovative advanced reactor designs. Under these provisions, not fewer than two advanced reactor designs would be funded by DOE and completed by the end of 2025. At least two, and potentially five additional designs, would be funded and completed by 2035.

As it has done since the establishment of its predecessor, the Atomic Energy Commission (AEC), the Department of Energy has historically played a vital role in supporting efforts of the private industry to develop and deploy innovative energy technologies. Our current fleet of nuclear reactors was a direct beneficiary of the supportive efforts of the AEC and DOE, as were the many thousands of wind turbines and tens of thousands of acres of solar cells that are dotted across our nation. It is perfectly appropriate that DOE should be assisting in the manner envisioned in the legislation, and I applaud the sponsors for their farsighted vision in including these provisions.

I would also note there is a subtle, but very important element to this section. The provisions in Section 4 do not simply refer to power generation facilities, but also for "other manners for the purpose of demonstrating the suitability for commercial application of the advanced nuclear reactor." This is noteworthy. Advanced nuclear reactors are not just about electricity production. The industrial grade heat that they can provide – ranging from 500 to 770+ Celsius – can be used to supplant natural gas for the processing of petrochemicals, the desalination of water, or can be used to create hydrogen on an industrial scale. No other source of power has the ability to conduct these activities with such heat density, and in a manner that has a minimal physical and carbon footprint. The future customers of these designs are not just large integrated utilities as has been the case in the past, but petrochemical producers, mining companies, remote communities, developing

nations, and areas that have a desperate need for the abundant, clean, desalinated water that can be produced by these exciting technologies.

Section 8 – University Nuclear Leadership Program

Congress, and the members of this Committee, are to be commended for the time and effort that they have put into raising attention and supporting programs in science, technology, engineering and mathematics – known as STEM programs – to ensure that as a nation, we continue to produce the talented women and men who can enable the U.S. to remain a world leader in the development and deployment of cutting-edge technologies, including nuclear.

Dating to my days as a Commissioner of the NRC, I have supported efforts to maintain the vibrancy of our university-based nuclear engineering programs. However, in order to design and deploy advanced nuclear plants, the full range of engineers including mechanical, civil, electrical, chemical, computer, process and system engineers, among others, are needed to effectively design these nuclear plants. I am a Founding Board Member of the Energy Production Infrastructure Center (EPIC) at the University of North Carolina Charlotte and in 2008, with several others, helped obtain $75 million in funding to create a national center dedicated to training the next generation of energy-engineering professionals. This center was funded with tens of millions in industry support and embraces applied energy training, closely partnered with the energy industry, to produce its future graduates.

In building a nuclear power plant, or virtually any power plant, at least half of the total cost is typically associated with engineering and construction. Toward that end, EPIC is creating a National Center for Advanced Construction. This center will be dedicated to learning lessons from recent nuclear construction efforts and applying advanced methods and techniques in collaboration with a wide variety of engineering and design companies to reduce the cost and time needed to deploy nuclear reactors. You will be hearing more about this program in the months to come, but I would hope that the provisions in Section 8 would apply beyond those institutions that produce nuclear physicists, but also those colleges and universities producing engineers and analysts who are vital contributors to the deployment of advanced nuclear technologies.

Finally, the ability to deploy these tremendous advanced reactor designs is highly dependent on having the skilled women and men who can build them. In the time I have spent touring our nation's nuclear plants, it is quite clear that like their white

collar colleagues, including the pipefitters, welders, electricians, plumbers and other tradespeople that build and maintain nuclear plants, also are an aging workforce. As this legislation continues to move swiftly toward adoption, I would urge the Committee to consider measures to ensure the steady supply of technicians and tradespeople for this industry as well.

Ensuring the Vitality of our Current Fleet and American Leadership in Nuclear Power

The companies and people who operate our nation's 98 nuclear power plants have done a tremendous service in providing clean, safe, reliable and resilient power. As a country, not only should we continue to support this key element of our carbon free generation, but we also need to adopt effective policy measures to support the private sector as it leads with the development a new generation of advanced nuclear reactors. It is these companies that will allow the U.S. nuclear industry to regain a leading role in the international nuclear export market. S. 903 is an excellent step towards ensuring that the U.S. remains a leader in nuclear technology, and I urge its prompt adoption by this Committee. I also strongly urge this Committee to work with your counterparts in the Appropriations Committee to ensure that these and other important efforts needed to accelerate advanced reactor innovation are fully funded in 2020 and beyond.

Thank you for allowing me to testify on this important subject.