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Chairman Feinstein, Ranking Member Alexander, and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss small modular reactors (SMRs) and the Administration's request to begin a cost-share program to accelerate the certification, licensing and deployment of light water SMRs. The Department believes SMRs have the potential to provide our nation with clean, cost-effective energy, improved safety, and an opportunity to compete in the global clean energy marketplace.

Today in the United States, nuclear power provides about 20 percent of all electricity consumed. It accounts for 70 percent of our carbon-free electricity. And it has demonstrated an outstanding safety record. Many attributes of our nuclear power operations contribute to this record, starting with independent regulation from the Nuclear Regulatory Commission (NRC). In addition, industry groups such as the Institute for Nuclear Power Operations (INPO) help maintain robust operational excellence in the industry. NRC provides the necessary regulatory enforcement and INPO relies on peer evaluation, peer pressure, information sharing among operators, and financial incentives. Our combination of efforts has established the international "gold standard" for nuclear operations.

President Obama has repeatedly emphasized the importance of clean energy to our nation's future. During his State of the Union speech earlier this year, he outlined a goal of obtaining 80 percent of our electricity from clean energy sources by 2035. It's an ambitious goal. And as he noted, we're going to need all clean energy sources – including nuclear energy – to achieve that goal. As the President has said, "To meet our growing energy needs and prevent the worst consequences of climate change, we'll need to increase our supply of nuclear power. It's that simple."

The reactors being considered by utilities today are in the gigawatt (GWe) class – meaning they provide at least 1,000 megawatts of electrical power. These are large plants and the size of the investment to build them is correspondingly large. A new, GWe class nuclear power plant requires an investment on the order of \$6 to \$10 billion, which poses a challenge even to large nuclear utilities whose market capitalizations are around \$19 billion. A major rating agency has characterized this kind of investment as a "bet the farm" endeavor for most utilities. Certain polices can help mitigate some of this risk, but construction of such plants remains a significant financial risk for a utility.

The Case for SMRs

Small modular reactors may provide an alternative to these larger plants that overcomes some of these challenges. Because we expect that they would be built in factories in a mass production format, SMRs could achieve cost savings through replication, rather than relying upon the economies of scale for larger reactors built individually at each construction site. Of particular note is the prospect for driving down costs over time through the process of learning-by-doing in a factory setting with an experienced workforce. The Department anticipates that SMR power plants will be able to be purchased in smaller sizes that better fit the financial needs of the utilities, and generation capability could be expanded to meet demand.

For this business model to work the economics of factory fabrication will need to prove successful and that is still uncertain. Based upon the experience of cost savings in the U.S. Navy submarine program or in the aerospace industry, there is reason for optimism that these learning effects can be substantial, but it is unproven for this application.

Operational efficiencies may also be possible for SMRs, but the NRC will determine if any such possibilities are acceptable without compromising safety or security. For the SMR business model to be viable, an improved economic case must materialize. The proposed DOE light water reactor (LWR) SMR Licensing Technical Support program will focus on engineering support related to design certification and licensing for two LWR-based SMR designs through cost-shared arrangements with industry partners, which is expected to help to reduce some uncertainties and increase the potential for reducing costs over time.

To understand these issues, the Office of Nuclear Energy has supported a study on the economics of nuclear energy with a particular emphasis on SMRs. This report is currently undergoing review, but one of the anticipated findings is that a mature SMR industry will likely be competitive with natural gas generation. The smaller up-front capital investment should reduce the financial risk of the projects but more work is still needed to reduce the uncertainties around the construction costs for SMRs over time.

Safety Features of SMRs

The Department anticipates that enhanced safety can be more readily achieved in small reactors. Current SMR designs offer notable potential safety advantages. Light water SMR designs proposed to date incorporate passive safety features that utilize gravity-driven or natural convection systems - rather than engineered, pump-driven systems - to supply backup cooling in unusual circumstances. These passive systems should also minimize the need for prompt operator actions in any upset condition. Some concepts use natural circulation for normal operations, requiring no primary system pumps. In addition, many SMR designs utilize integral designs, meaning all major primary components are located in a single, high-strength, pressure vessel. That feature is expected to result in a much lower susceptibility to certain potential events, such as a loss of coolant accident, because there is no large external primary

pipng. In addition, LWR SMRs would have a much lower level of decay heat than large plants and therefore require less cooling after reactor shutdown.

Vendors are proposing an additional host of innovative approaches to significantly enhance SMR safety and security. For example, features like underground siting can offer increased resistance against seismic events while also providing more robust security. These systems are also designed for long periods of unattended operation under accident conditions and no emergency diesel generators are required for several of the designs. Several of the concepts rely only on stored energy in an accident, so that there is no dependence on external power sources. And these are only a sampling of the enhanced safety features that could potentially be part of these systems.

The NRC - through their rigorous, open, and transparent process - will determine the precise requirements for future SMR deployment and issue any future licenses. In that process, the NRC will evaluate whether the smaller size and anticipated improved safety and security envelope enables adequate safety and security with somewhat different operational mandates than those applied to the large plants.

Safety of Multiple Modules

Some have raised questions about safety of multiple modules at a site and whether a serious problem in one module might affect the safety other modules. The Nuclear Regulatory Commission will address any common mode failures and many more questions as the licensing process progresses. The onus will be on the SMR vendors to convince NRC that no common mode failure, including those due to natural events such as a tsunami or earthquake, could lead to a common failure of multiple modules or that a failure of one module could prevent the safe shutdown of other modules. The NRC will demand, as they do for any design, that the safety case proposed by SMR vendors be subjected to intense study and evaluation, both within the NRC staff review and through their standard, extensive, public opportunities for participation in the licensing process.

Fuel

The SMR concepts of near-term interest are based upon the well-understood light water reactor technology. This is important because our current regulatory knowledge base and experience are built on LWR technology. The choice to stay within the proven performance envelope of the existing commercial, low-enriched uranium, nuclear fuel cycle has two important benefits. First, it means that the most promising near-term SMRs can build upon the well-established LWR fuel industry, avoiding the need to establish a parallel fuel manufacturing capability. Second, this fuel cycle minimizes the technical risk of the most demanding technology component of any new nuclear reactor system, a new fuel design, and reduces the time to license within the NRC regulatory system.

Waste Management

For the light water SMR designs that would be considered in the Department's proposed program, the amount of electricity produced per kilogram of waste will be about the same as for current LWRs since these units utilize very similar, and very well-understood, technologies. But in contrast to the current fleet of plants where used fuel pools were not initially designed to hold a lifetime of used fuel, most current LWR SMR concepts propose storing the used fuel underground where it may be more easily protected from external hazards or sabotage. Provisions have also been incorporated in the current SMR concepts to provide long-term cooling so that the used fuel remains safe under potential upset conditions.

In the longer term, after the operational lifetime of an SMR, a used fuel management program will be essential, just as it is for the current fleet. This question of used fuel disposition is currently the subject of examination by the Blue Ribbon Commission. The Department is eagerly awaiting their recommendations to inform the Administration as it develops a strategy on used fuel management. Used fuel from newly deployed SMRs should not need another storage location during the plants' operational lifetime.

Siting

Traditional siting of large nuclear power stations has primarily been limited to locations that have abundant water for cooling, sufficient demand to justify the size of the plant, transportation capabilities suitable to handle the very large components, and other defining attributes that limit the places where large plants are feasible. While these factors will continue to be considered in the siting of SMR plants, the draft designs of most LWR SMRs may be able to overcome these limitations with reduced cooling water requirements, the ability to tailor the generation capacity to meet the needs of the local market, and more flexible transportation options based on transport of much smaller components to any site. Hence, new SMR designs could potentially open up new markets to nuclear, a step that could be useful for meeting our clean energy goals.

Some have taken these design features to imply that SMRs could be sited without due consideration of safety and security. Nothing could be further from the truth. The NRC remains the regulatory authority that must license any commercial reactor including an SMR and their review will be no less thorough for SMRs than it has been for the existing plants.

Advanced R&D

DOE also proposes to support the development of advanced small reactor concepts that depart from the well known light water technology base. These advanced SMRs are in the very early development stage but have the potential to greatly increase the amount of electricity produced per kilogram of waste. Such systems could increase uranium utilization through the use of long-lived cores, for example, which may also have non-proliferation benefits. Moving beyond LWR technology would allow for systems that are better suited to serve markets that

are not practical for the current reactors, such as the use of nuclear energy for process heat or transportable deployments. The fuel cycles for these advanced reactors could also open the possibilities of long-lived cores or could enable transmutation of elements in used fuel.

The R&D performed today will establish the knowledge base that will be needed to inform further development of these designs by industry.

Global Competitiveness

Innovative technologies can effectively contribute to our nation's global competitiveness, which can mean good jobs for American workers. As Secretary of Energy Steven Chu noted in his editorial in the Wall Street Journal supporting SMRs, "If we can develop this technology in the U.S. and build these reactors with American workers, we will have a key competitive edge." As part of a robust nuclear industry supply base in the United States, SMRs may also contribute to our national security interests by helping to increase the global reach of U.S. nuclear technology.

Today, about 60 new reactors are under construction around the world. The TVA Watts Bar 2 unit is completing construction, four Westinghouse AP1000s are in pre-construction in the United States, and four are under construction in China. By any measure, the U.S. share of the global market in terms of new reactor builds is currently small. About 26 reactors are under construction in China alone, almost half of the world's total. China plans substantial expansion of its nuclear power capabilities, with estimates reaching about 130-180 GWe by 2030. They intend to quickly become self-sufficient in reactor construction, and are clearly poised to take over the global lead in nuclear energy capacity in the coming decades.

This situation is in sharp contrast to the early days of nuclear power. In the 1960's and 70's, the United States was the world leader in nuclear technologies; we invented most of the technologies and successfully implemented many of them in commercial systems. In the 1980s, virtually all U.S. nuclear plant equipment was manufactured domestically. Today, that figure is more like 25 percent. The U.S. still has a seat at the table internationally, but domestic deployment of this technology could lead to increased domestic manufacturing, which in turn would likely create increased export opportunities for the U.S.

The nations that export and build the majority of nuclear power plants are expected to strongly influence safety standards for the world. If industry chooses to deploy SMR technology, it can provide an opportunity to gain a share of the global market, and more importantly, leadership in this new area of nuclear technology. A strong U.S. presence in the global marketplace will allow U.S. safety standards to be adopted more broadly around the world while also improving the U.S. position in decisions about waste management and non-proliferation.

Conclusion

While there are significant uncertainties in the future competitiveness of small modular reactors, the Department of Energy's proposed light water SMR Licensing Technical Support program will seek to address those uncertainties and provide a concrete demonstration of their market potential. But the United States is by no means the only country exploring these technologies. The recent report from the Nuclear Energy Agency of the OECD (Organization for Economic Co-operation and Development) listed seven countries with strong SMR programs, some of which are already licensed or under construction.

In addition to meeting part of our own clean energy needs, I've also tried to emphasize that SMRs could help strengthen U.S. competitiveness in the global nuclear technology market. This would not only be supportive of good jobs in America, but also directly supportive of international nuclear safety and our nonproliferation goals.