Testimony of Edwin Lyman, PhD

Senior Scientist, Union of Concerned Scientists

On

The Nuclear Energy Innovation and Modernization Act.”

Before the

Committee on Environment and Public Works

U.S. Senate

March 8, 2017

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

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

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

The accident had a significant impact on Japan's use of nuclear power—it now has only three operating reactors out of a fleet of more than fifty. It pays handsomely for imported natural gas to help meet its electricity demand. A similar accident in the United States would almost certainly compromise the future of nuclear power in this country.

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

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

One of our main concerns with the bill is its promotion of a "risk-informed, performance-based" licensing strategy for advanced nuclear reactors. As discussed in our previous testimony, we do not believe that so-called risk-informed licensing is appropriate for new and novel reactor designs, because the quantitative determination of nuclear plant risk is highly complex and has large uncertainties. The computer models used to calculate risk need to be thoroughly validated by comparison of results with actual plant operating experience before their accuracy can be confirmed. Such experience is not available for new reactor concepts that have not made it beyond the design stage.

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

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

In that light, we appreciate that the current version of NEIMA requires that the NRC "develop and implement … strategies for the increased use of risk-informed, performance-based licensing evaluation techniques and guidance for commercial advanced nuclear reactors within existing regulatory frameworks …" only *where appropriate*. This phrase effectively provides the NRC with full discretion to confine the use of risk-informed licensing to those areas where it determines it is appropriate, and per NRC procedures should also allow significant public input into those decisions. It is our expectation that NRC's technical analyses will reveal that there will be few, if any, aspects of advanced reactor licensing where risk-informed approaches will be appropriate.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

---

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

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

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

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

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

BIOGRAPHY

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