TECHNICAL REBUTTAL OF MR. LYMAN'S OPINIONS ON VERSATILE TEST REACTOR

The initial section of this paper responds to a recent blog written by Edwin Lyman from the Union of Concerned Scientists opposing the House Bill H.R. 4378. The second section discusses additional points raised by Mr. Lyman in various materials provided to the House committee staff.

1) Point-by-point rebuttal to Feb. 15 blog

The blog titled "The Versatile Fast Neutron Source: A Misguided Nuclear Reactor Project" was published on February 15, 2018. The House Bill in question (H.R. 4378) authorizes the Department of Energy (DOE) to design and construct a versatile fast spectrum neutron source (test reactor), currently known as the Versatile Test Reactor (VTR).

The need for the VTR is based on the following vision and premises:

- Nuclear energy and the advanced reactor systems will be a strong component of the national and international energy landscape for the rest of the 21st century;
- The capability of testing advanced fuels, materials, and sensors is critical for the long-term success of the advanced fast reactors being pursued by multiple commercial entities in the U.S.; and
- U.S. technological leadership in the area of fast reactor systems, as well as other advanced nuclear technologies, is critical for our national security.
- These systems are likely to be deployed around the globe and U.S. leadership in associated safety and security policies is in our best national interest.

It is natural and understandable that complex technical and policy issues would include differing professional opinions regarding the development of VTR as a high-priority national effort. However, Mr. Lyman's opposition appears to be based, to a large degree, on personal opinions that are inaccurate or misleading. Thus, while fact-based debates on the VTR and related topics are healthy, Mr. Lyman's note deserves a detailed rebuttal to ensure the policy makers can consider the full-picture in their decisions.

The quotes from Mr. Lyman's blog post are provided in italic, followed by additional context and rebuttal.

Mr. Lyman states:
"What may not be clear from the name is that this facility itself would be an experimental fast reactor, likely fueled with weapon-usable plutonium."

The author refers to the reactor as an experimental fast reactor in multiple places within the blog. It is important to clarify that a "test reactor" is under consideration. The reactor would primarily be used for fuels, materials, and sensors testing to advance not only the sodium-cooled reactor designs but also other designs such as lead-cooled fast reactors, lead-bismuth eutectic (LBE)-cooled fast reactors, helium-cooled fast reactors, and molten-salt fast reactors being pursued by various commercial entities. There is no goal to generate electricity with this reactor. The test reactor will additionally develop advanced materials resistant to high fast neutron fluences for applications other than just fast reactors (e.g., fusion materials). This testing mission is similar to the mission provided by the Fast Flux Test Reactor (FFTF) that operated in Hanford, Washington from 1982 to 1992.

The use of plutonium in the fuel is a preferred option but not the only option. However, the statement "fueled by weapon usable plutonium" is misleading. The fuel alloy that contains plutonium-uranium and zirconium is NOT weapon usable. Since this issue is mentioned again in the next quote, a more detailed rebuttal of this statement is provided below.

Mr. Lyman states:
"Compared to conventional light-water reactors, fast reactors are less safe, more expensive, and more difficult to operate and repair. But the biggest problem with this technology is that it typically requires the use of such weapon-usable fuels as plutonium, increasing the risk of nuclear terrorism."

It is not clear what his basis is for stating that fast reactors are less safe. The inherent/passive safety features of fast reactors due to temperature reactivity feedbacks and passive decay heat removal have been studied extensively by the international community. More than 10 countries participated in the largest IAEA Coordinated Research Project ever conducted by specifically evaluating the safety characteristics of the EBR-II reactor. A similar effort is now underway at the IAEA using the data from the FFTF. Many peer-reviewed papers are published addressing the passive safety characteristics of sodium fast reactor technology. The safety characteristics are some of the reasons why there are considerable commercial efforts to design and demonstrate the next generation of fast reactors. Also, because fast reactors operate at low pressure and there is less reliance on active safety systems, the statement about fast reactors being more difficult to operate is misleading. Certain activities are complicated due to the reactivity of the sodium coolant, but reactor operations are not more difficult. Finally, many developers of multiple fast reactor designs would argue that once they overcome the initial commercialization hurdle, the overall cost (capital, operating, and fuel cycle) will be less than conventional light-water reactors. Otherwise, they would not be investing private capital for a design that cannot compete in the global commercial market.

As stated earlier, the statement "weapon-usable fuel" is misleading. It is true that plutonium is weapon usable within a certain isotopic vector. The proposed fuel is an alloy of plutonium, uranium and zirconium, which CANNOT be used for weapons. The idea is to take weapon-usable plutonium and convert it to a non-weapon usable fuel using government facilities under a very strict security protocol. Once that fuel is irradiated in the test reactor, some of the plutonium is destroyed and the isotopic plutonium vector becomes even less weapon usable. Thus, if plutonium is used in the fuel, this enhances the non-proliferation goals as it reduces the amount of weapon usable material stockpiles, reducing the potential for nuclear terrorism.

Mr. Lyman states:
Based on what little public information there is available about the plans for this facility, it would be a fast reactor of at least 300 thermal megawatts (or about 120 MW of electricity if it is also used for power generation). This power level is the minimum necessary to achieve the desired rate of neutron production. This would make the reactor about five times larger than the last experimental fast reactor operated in the United States, the EBR-II, which shut down in 1994. One proposed design, called FASTER, would have a peak power density three times higher than the EBR-II, making it much more challenging to remove heat from the core.

DOE is continuing various parametric and trade studies on the size of the reactor. While 300 MWth appears to be the size range needed to meet the neutron-flux requirements set forward by various end users, a final decision on size had not been made. There are no plans for electricity generation using the test reactor. It is important to highlight that, in the U.S., we operated FFTF safely and reliably, which was 400 MWth, for more than 10 years at power densities equivalent to the VTR design options. Thus, DOE has already demonstrated (in the 1980s) a fast reactor operating at power densities similar to VTR.

Mr. Lyman also comments about the cost of the project and states that
"It's also important to keep in mind that the estimated cost … does not include a facility to fabricate the plutonium fuel, which could add billions to the final price tag."

Consistent with the advice provided by the Nuclear Energy Advisory Committee (NEAC), DOE is conducting the necessary design and trade studies to provide a reliable cost estimate with reasonable uncertainties for a system that satisfies the functional requirements. Until that study is concluded, it is not prudent to comment on the project cost. Certainly, when available, this cost estimate will be shared with the policy and decision makers. For fuel fabrication, the considered option is to use the existing facilities (with modifications as necessary) at the DOE sites to satisfy the yearly throughput needed by the test reactor. The throughput depends on the size of the reactor, but for the size range that is being considered, it is believed that the existing facilities may be adequate. DOE fully intends to include the estimated cost for fuel fabrication needs in the total project cost estimate.

Mr. Lyman states:
"…the DOE's Idaho National Laboratory has been unable to deal effectively with the spent fuel legacy of the defunct EBR-II,…"

This statement is misleading. There are no technical problems in dealing effectively with the EBR-II spent fuel. The work is progressing well based on the availability of annual funding. The schedule depends on the annual funding, as well as the availability of the ultimate disposal path, which is true for any spent fuel. Thus, the VTR spent fuel can be managed effectively. The spent fuel management as part of the overall life cycle of the VTR will be included in the project plan and cost estimates.

Mr. Lyman states:
The primary purpose of the facility would be to assist private companies that want to develop and sell fast reactors, but most of those companies aren't sold on the idea. According to a report last year by the DOE's Nuclear Energy Advisory Committee, "some of the industry representatives (e.g., AREVA, GE-Hitachi, TerraPower, Westinghouse, and Terrestrial Energy) who have an interest in pursuing advanced reactors … [are] of the view … that a test facility was not essential for the commercial advancement of their technology."

This quote appears to be taken out of context. Some commercial companies are proceeding with developing the first prototype in parallel to the test reactor development. For instance, Terrapower is proceeding with the first prototype while acknowledging that achieving their ultimate design goals in terms of high-burnup fuels with high-fluence cladding will require additional testing beyond the first prototype. On the other hand, there is general consensus among the fast reactor development community (including TerraPower and others listed by Mr. Lyman) on the need for a test reactor to assure long-term competitiveness of this technology.

The commercial fast reactor development community organized under a working group known as the Fast Reactor Working Group (FRWG), under the Nuclear Energy Institute (NEI). The group includes the companies listed by Mr. Lyman as well as others who are working on similar technologies. In early 2017, FRWG submitted a letter to DOE identifying their research and development priorities within the federally-funded nuclear energy programs (Jacob DeWitt, Fast Reactor Working Group Chair, "Fast Reactor Working Group Requests," Letter to R. Baranwal [GAIN Director], February 13, 2017). Prominent in the priority list was the need for a fast-spectrum test reactor that can support technology development for multiple concepts in the areas of fuels, materials, and sensor development. The letter articulates the difficulties associated with relying on limited foreign fast-spectrum testing capabilities (e.g., Russia) and the urgent need for domestic capabilities for these commercial efforts to move forward.

Finally, since Mr. Lyman refers to the NEAC report as a valid source ("Assessment of Missions and Requirements for a new U.S. Test Reactor" 2/2017), the report states that "The Ad Hoc NEAC subcommittee recommends that DOE-NE proceed immediately with pre-conceptual planning activities to support a new test reactor (including cost and schedule estimates)." This is precisely what DOE-NE has begun to undertake.

Mr. Lyman states:
Finally, what agency will oversee the safety and security of this risky project? The DOE. By designating this reactor as a neutron source, and building it at a DOE site, it will be exempt from licensing and oversight by the Nuclear Regulatory Commission. While NRC licensing is far from perfect, it would be far superior to DOE self-regulation.

Because this is a test reactor and not an experimental reactor generating electricity, it is perfectly adequate to license and operate the reactor under DOE's legislative authority similar to the current operations of the Advanced Test Reactor (ATR) and TREAT at Idaho National Laboratory, and the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory. However, NRC engagement in the process is fully expected, as NRC is gearing up to license future commercial advanced reactors.-

2) Additional topics raised in other materials

- Basic versus applied research and development – Mr. Lyman questions the appropriateness of DOE facilities that are not solely used for basic science.

A fast spectrum test reactor would provide the domestic capability and U.S. science and technology leadership needed to meet the Administration's goals of national security, economic growth and job creation. The test reactor would function as a user facility supporting early-stage government research, industry and academia.

- Fuel form – Mr. Lyman has expressed numerous concerns regarding proliferation risks.

As discussed in the first section, the fuel compositions under consideration do not include weapons-usable materials. Regardless of the final fuel composition, it will clearly not include Highly Enriched Uranium (HEU).

- Reactor safety – Mr. Lyman has expressed numerous concerns related to public safety and the consequences of an accident or act of terrorism.

DOE and its predecessors have a long track record of designing, building and safely operating unique and innovative reactor and non-reactor nuclear facilities. The test reactor does not present any significant challenges with respect to assuring worker, public or environmental safety. DOE is fully committed to the safety and security of all current and future nuclear facilities and will interface with the U.S. NRC and other key stakeholders to minimize risk.