MINUTES

Submitted by Keith Ammon

Commission to Investigate the Implementation of Next Generation Nuclear Reactor Technology in New Hampshire

April 7, 2023

Attendance:

Commission Members: Rep Keith Ammon, Cathy Beahm, Dan Goldner, Marc Brown, David Shulock, Bart Fromuth (remote), Christopher McLarnon

Absent: Rep Michael Harrington, Sen Howard Pearl, Alex Fries, Matthew Lavender

Public In-Person: Rep Alvin See, Douglas Mailey, Richard Barry, Vikram Mansharamani

Public Remote: Carol Lane - X-energy, Christine Csizmadia NEI, Connor Woodrich, Dave Pyles, Don Bettencourt, Gary Woods, Jackson Bouley, John Tuthill, John Valentino, Joshua Parker, Karen O'Neil-Roy NH DHHS/EPRR, Paul Gunter, Scott Kopple - BWXT, Scott Nagley - BWXT, Rep Walt Stapleton

Meeting:

1. The New Hampshire Commission to Study Nuclear Technology meeting was called to order by Rep Keith Ammon at 10:35 am. The commission had a quorum present.

2. BWX Technologies Presentation: Scott Nagley, Vice President of Business Development, and Joshua L. Parker, Director of Business Development, presented the information.

   Company Overview:

   - BWXT is a leading nuclear technology innovation company known for manufacturing naval nuclear reactors for U.S. submarines and aircraft carriers.
   - The company has a workforce of over 6,600 employees and achieved $2.1 billion USD in revenues in 2021.
   - BWXT operates 12 major manufacturing facilities totaling 3.9 million square feet.
   - They have over 60 years of experience in manufacturing naval nuclear components and reactors and have produced over 300 commercial nuclear steam generators and 1.5 million Canada Deuterium Uranium (CANDU) fuel bundles.

   BWXT's Reach:

   - Apart from manufacturing, BWXT is involved in U.S. Department of Energy (DOE) laboratories, environmental cleanup projects, and NASA sites.
   - They have delivered more than 8,000 fuel elements to national laboratories, universities, and international customers.
   - BWXT has joint ventures with several organizations for specialized projects and operations.

Company History:

- BWXT has a 165-year history of innovation, including contributions in the non-nuclear sector such as the invention of the water tube boiler.
- Their nuclear history dates back to 1946 when they were awarded their first contract with the U.S. Navy for propulsion systems.
- BWXT designed components for the first nuclear-powered submarine in 1953 and has been involved in the manufacturing of commercial nuclear power plant components since 1956.
- The company has made recent advancements in various fields, including nuclear plant design and manufacturing, space technology, medical isotope production, and advanced nuclear fuel manufacturing.

Business Operations:

- BWXT operates in both government and commercial sectors.
- In the government sector, they are involved in naval nuclear propulsion, nuclear environmental restoration and site management, and space and defense nuclear power and propulsion.
- In the commercial sector, they contribute to nuclear power generation, nuclear manufacturing, nuclear fuel production, and nuclear medicine.

The Nuclear We Need:

- BWXT emphasizes the importance of nuclear power in various applications and technologies, including space exploration, defense, and medical isotope production.
- They are developing advanced microreactors, which are scalable and transportable, to meet energy needs in off-grid and remote military applications.

Fuel Development and Manufacturing:

- BWXT has rapid product development capabilities, enabling efficient progression from R&D to full-scale production.
- They focus on design and fabrication development, utilize advanced techniques such as Sol-Gel kernels and PVD coatings, and have production capabilities for reactors and fuel elements.
- Fuel production facilities are strategically located across multiple facilities, including NOG-L and the BWXT Innovation Campus, and specialize in the development and testing of novel fuel concepts.

BANR Technology:

- The BANR reactor is based on HTGR design, offers passive and inherent safety features, and has a flexible power conversion capability.
- It is a modular system, and each module conforms to standard shipping requirements.
- The BANR technology enables rapid modular installation, refueling, and deployment of reactors.

Cost Reduction and Target Markets:

- BWXT focuses on increasing core power and extending core life to reduce the number of reactors needed and associated costs.
- They aim to improve manufacturing throughput, reduce operations and maintenance costs, and expand target markets to include mining/oil

3. BWXT Q&A:

   Rep Keith Ammon: Excellent. Are there concerns about delays or issues you might have to overcome in the fuel supply chain and regulatory hurdles?

   Joshua Parker - BWXT: We are currently facing supply chain issues with Project Pele, but the Department of Defense is providing funding for that. We are vertically integrated and manufacture various components for the reactor. The fuel for the reactor is sourced from the strategic stockpile of enriched material. Regulatory hurdles are being addressed, and we have the necessary licenses for fuel manufacturing.

   Rep Walt Stapleton: What kind of enrichment factor do you use in these reactors? Is it variable depending on the application?

   Joshua Parker - BWXT: We primarily use high assay, low enriched uranium with enrichment just below 20 weight percent uranium 235. We may slightly adjust the enrichment for specific power requirements, but the target is up to 28% enrichment.

   Rep Walt Stapleton: Is the gas reactor replacing the water reactor? Are you phasing out water reactors in favor of gas reactors?

   Joshua Parker - BWXT: Gas reactors, specifically high-temperature gas reactors, are not intended to replace light water reactors. Light water reactors have their role and are being extended in operation. Gas reactors are focused on industrial processes that require higher temperatures. Different reactor technologies, including gas, molten salt, and liquid metal-cooled reactors, are being developed to meet different market demands. Light water reactors will continue to play a role in electricity generation.

   Paul Gunter - Beyond Nuclear: How do you plan to overcome the issue of suppliers not investing in new capacity without strong order books from your company?

   Joshua Parker - BWXT: We are having discussions with end users who recognize the limitations of renewable energy sources like solar and wind. Nuclear power provides energy density and reliability, which becomes valuable for customers who need consistent power. The economics of green energy and decarbonization are being considered, and as the market grows, suppliers will find opportunities to invest in new capacity.

   Rep Keith Ammon: What are the non-electrical applications of your technology, particularly in medical isotopes?

   Joshua Parker - BWXT: Nuclear reactors can be used to generate medical isotopes. Our focus is on producing medical isotopes through processes involving reactors like the CANDU reactors in Canada. We have the expertise to handle fuel and materials safely, which aligns with our fuel manufacturing capabilities. Medical isotopes are an important application of our technology.

4. X-Energy Presentation:

Carol Lane, Vice President of Government Relations and John Valentino, Director of Customer Relationship Management presented on behalf of the company.

X-energy Overview:

- X-energy is a reactor design and fuel manufacturing company established in 2009.
- The company focuses on high-temperature gas reactors and TRISO fuel.
- X-energy was founded by Dr. Kam Ghaffarian, who recognized the need for accessible and clean electricity globally and saw the potential of high-temperature gas reactors.
- X-energy has experienced significant growth, currently employing over 440 people.

High-Temperature Gas Reactors:

- X-energy's high-temperature gas reactor is a grid-scale reactor known as the "four pack" consisting of four modules.
- The pebble bed reactor design allows for high burnup of the fuel, with pebbles cycling through the reactor multiple times.
- X-energy has been working on making TRISO fuel and operates a pilot manufacturing facility.
- The company plans to build a commercial-scale TRISO fuel fabrication facility in Oak Ridge, Tennessee.

Advanced Reactor Demonstration Program:

- X-energy was selected as one of the awardees for the Department of Energy's Advanced Reactor Demonstration Program.
- The program provides a bridge for customers to adopt advanced reactors without taking on the risks of being the first adopter.
- X-energy is designing a four-pack reactor for deployment with Dow Chemical at a Gulf Coast site.
- The company is also constructing a commercial-scale TRISO fuel facility in Oak Ridge, Tennessee.

Other Initiatives and Advantages:

- X-energy is involved in strategic government R&D initiatives for space nuclear reactors and small terrestrial reactors.
- The company aims to modularize and standardize components to enhance manufacturability and supply chain resilience.
- X-energy's reactors offer load-following capability, providing flexibility to blend loads with renewable energy sources.
- The high-temperature steam produced by the reactors has various industrial applications, including clean hydrogen production.

Regulatory and Political Support:

- X-energy has been in discussions with the Nuclear Regulatory Commission since 2018 for both reactor and fuel facilities.
- The company has submitted topical reports and white papers, with plans to submit a construction application in late 2023.

- The federal government has shown bipartisan support for advanced nuclear through initiatives like the Advanced Reactor Demonstration Program and funding for HALEU fuel production.
- X-energy is closely following changes in state environments and is open to collaborating with stakeholders.

Future Plans:

- X-energy aims to deploy its reactors within the next few years.
- The company is currently engaged in fundraising efforts and plans to go public in 2023.
- X-energy is working on operator training simulation and building a plant support center for operational training.

Closing Remarks:

- Carol Lane concluded her presentation by emphasizing the potential of advanced reactors to address energy challenges and contribute to decarbonization efforts. She highlighted the power and energy density of nuclear reactors and expressed X-energy's commitment to advancing the deployment of advanced nuclear technology.

5. X-energy Q&A:

Q: Cathy Beahm: Is the Maryland generation study on converting coal plants to nuclear readily available?

A: Carol Lane - X-energy: Yes, there is a public version available on the Maryland Energy Administration website. I can send you a link to it and also provide the PDF if needed.

Q: Cathy Beahm: Can you explain how the TRISO pebble becomes an active power source once it's in the reactor?

A: John Valentino - X-energy: The TRISO pebbles contain uranium 235, and when they are exposed to a neutron field in the reactor, some of the uranium 235 splits, releasing heat. The heat is then extracted by pumping helium or water over the pebbles.

Q: Rep Keith Ammon: How is the heat regulated in the reactor and what are the safety mechanisms?

A: John Valentino - X-energy: The heat is regulated by controlling the fluid flow, either helium or gas, over the pebbles. In case of a shutdown, control rods are inserted into the reactor core to absorb the neutrons and prevent further reactions and heat generation.

Q: Rep Keith Ammon: Is there any waste of heat or energy during load following that could be utilized for other purposes like hydrogen production?

A: John Valentino - X-energy: During load following, if there is excess heat generated, it can be diverted to other uses such as hydrogen production, thermal storage systems, or desalination plants, depending on the setup. The goal is to avoid wasting heat and maximize efficiency.

Q: Rep Keith Ammon: How would you retrofit a coal plant to accommodate nuclear power generation?

A: John Valentino - X-energy: Retrofitting a coal plant involves evaluating the existing infrastructure, transmission systems, and trained workforce. Some equipment may be reusable, while specific nuclear components would need to be added. The focus is on utilizing existing resources and adapting them for a new purpose.

Q: Rep Keith Ammon: What is the required buffer zone or population distance around your reactor?

A: John Valentino - X-energy: The buffer zone is typically measured by distance, and for our reactor, it is around 400 meters, which is much smaller than the current 10-mile zone around reactors like Seabrook.

Q: Paul Gunter – Beyond Nuclear: Can X-energy provide confidence in its containment strategy by not participating in the Price Anderson Act?

A: Carol Lane - X-energy: We are still in the final design phase and going through the regulatory process. The decision regarding containment strategy and liability coverage will be made between us and our customer in the future.

6. Discussion:

Richard Barry expressed his concerns about the amount of money that has been invested in the decommissioning of the Seabrook Nuclear Power Plant. He suggested that the government should take action to mitigate the costs associated with decommissioning. The possibility of modular reactors was also mentioned, with the understanding that the dynamics and costs may differ from traditional reactors.

Cathy Beahm proposed creating a grid that outlines the different speakers and their respective reactors and tools covered in the discussions. Rep Keith Ammon supported this idea and mentioned the possibility of involving an intern to help with the task.

Douglas Mailey, a member of the public, asked about the final objective of the session and whether specific recommendations or an overview report would be produced. Rep Keith Ammon clarified that one aspect would be to propose adjustments to state statutes and to explore the potential for the industry's development in the state. The engagement of the federal delegation and the availability of funds for the industry were also discussed.

Vikram Mansharamani shared his conversation with the management team of Oklo, a nuclear energy company, and their potential interest in exploring opportunities in New Hampshire. Rep Keith Ammon expressed interest in keeping in touch with Vikram to stay updated on any progress.

Various potential future speakers were mentioned, including representatives from the Department of Nuclear Energy, Holtec, Q Hydrogen, and LightBridge. The importance of understanding the supply chain ecosystem, desalination, and hydrogen as an energy storage option was also emphasized. The potential involvement of the federal government and the need to update relevant statutes were discussed.

Rep Keith Ammon provided updates on his request to the executive council regarding the vacant position responsible for monitoring atomic energy. He shared that the request was acknowledged, and that the governor's office was looking into the matter. He also mentioned a report issued by

the Department of Energy, titled "Pathways to Commercial Liftoff for Advanced Nuclear," which outlines the federal government's vision for advancing nuclear technology.

Rep Keith Ammon proposed drafting an interim report due in July and a final report due in December, with the intention of including input from all commission members. He suggested taking a break during the summer and continuing to plan future meetings. Attendees were encouraged to provide suggestions for potential speakers and connections.

Lastly, the meeting concluded with a discussion on the potential benefits of hydrogen as an energy storage solution and the viability of pump storage systems.

7. The meeting was adjourned at 12:20 PM.