ALASKA STATE LEGISLATURE
SENATE COMMUNITY AND REGIONAL AFFAIRS STANDING COMMITTEE
March 3, 2020
3:31 p.m.

MEMBERS PRESENT

Senator Click Bishop, Chair
Senator Peter Micciche, Vice Chair
Senator Lyman Hoffman
Senator Mike Shower
Senator Elvi Gray-Jackson

COMMITTEE CALENDAR

SENATE BILL NO. 194
"An Act relating to advanced nuclear reactors."

- HEARD & HELD

PREVIOUS COMMITTEE ACTION

BILL: SB 194
SHORT TITLE: ADVANCED NUCLEAR REACTORS
SPONSOR(s): COMMUNITY & REGIONAL AFFAIRS

02/17/20	(S)	READ THE FIRST TIME - REFERRALS
02/17/20	(S)	CRA, RES
03/03/20	(S)	CRA AT 3:30 PM BELTZ 105 (TSBldg)

WITNESS REGISTER

CODY GRUSSENDORF, Staff
Senator Click Bishop
Alaska State Legislature
Juneau, Alaska
POSITION STATEMENT: Introduced SB 194.

MARC NICHOL, Senior Director
New Reactor Deployment
Nuclear Energy Institute
Washington, DC
POSITION STATEMENT: Provided an overview of advanced nuclear reactors.

COREY MCDANIEL, PhD, Chief Commercial Officer,
Nuclear Science and Technology
Idaho National Laboratory
Idaho Falls, Idaho
POSITION STATEMENT: Provided an overview of advanced nuclear reactor safety and deployment.

GWEN HOLDMANN, Director
Alaska Center for Energy and Power
University of Alaska Fairbanks
Fairbanks, Alaska
POSITION STATEMENT: Provided an overview of the potential for micronuclear reactors in Alaska.

SPENCER NELSON, Professional Staff Member
U.S. Senator Lisa Murkowski
U.S Senate Energy and Natural Resources Committee
Washington, DC
POSITION STATEMENT: Provided an overview of federal policy on nuclear energy.

ACTION NARRATIVE

3:31:02 PM
CHAIR CLICK BISHOP called the Senate Community and Regional Affairs Standing Committee meeting to order at 3:31 p.m. Present at the call to order were Senators Gray-Jackson, Micciche, Hoffman, and Chair Bishop. Senator Shower arrived soon thereafter.

SB 194-ADVANCED NUCLEAR REACTORS

3:31:47 PM
CHAIR BISHOP announced that the only order of business would be SENATE BILL NO. 194, "An Act relating to advanced nuclear reactors." He said the Senate Community and Regional Affairs Committee is the sponsor of SB 194 and the committee will hear invited testimony related to the bill.

3:32:43 PM
CODY GRUSSENDORF, Staff, Senator Click Bishop, Alaska State Legislature, Juneau, Alaska, presented SB 194 with a PowerPoint that started with a description of advanced nuclear reactors.

3:32:51 PM

SENATOR SHOWER joined the committee meeting.

MR. GRUSSENDORF explained that advanced nuclear reactors are small enough to transport easily; run for 10 or more years without requiring refueling; can provide power for rural Alaska villages, mining operations, and military installments. They can also provide backup power to regional power grids such as the Railbelt. Advanced nuclear reactors can provide clean, safe, and reliable power which could bring rural Alaska out of energy poverty. They can also be used in urban Alaska.

He said SB 194 would ensure that companies can make investments with the knowledge that there is a market in Alaska once advanced nuclear reactors come online.

3:33:44 PM
MR. GRUSSENDORF displayed slide 3 and explained that, under current law, AS 18.45.025 requires the legislature to designate in law each parcel of state land on which a nuclear facility may be located. Each individual parcel with this designation must also receive a permit from the Alaska Department of Environmental Conservation (DEC) and a license from the Nuclear Regulatory Commission (NRC).

MR. GRUSSENDORF said SB 194 would add "advanced nuclear reactor" to the requirements in AS 18.45.025, define nuclear reactor, and remove the requirement that the legislature pass a law designating each parcel of land that would be used for an advanced nuclear reactor. Other nuclear facilities listed in the statute would not be exempt from this requirement. The bill leaves in local control, DEC licensing, and federally required licensing by the NRC. SB 192 would signal to industry that "Alaska is Open for Business."

3:35:04 PM
MR. GRUSSENDORF said slide 4 lists many of the characteristics of advanced nuclear energy. It is not a specific technology and it can encompass many of attributes listed on the slide. He noted that many companies are currently developing advanced nuclear.

3:35:33 PM
MR. GRUSSENDORF said he broke the reasons that advanced nuclear is a good fit in Alaska into three columns. First, advanced nuclear technology is remote capable. Microreactors could be easily integrated into the power baseload in the 300 small rural communities that have independent grids. Advanced nuclear

reactors could also provide mines with access to reliable and affordable energy, and possibly extend the operational life of a mine by making lower grade ore more profitable. He said the military is always looking for independent grids to supply secure and resilient power. Advanced nuclear reactors potentially have long term operations without refueling. Advanced nuclear reactors are black-start capable, which means they can be started without a significant power source.

Second, advanced nuclear reactors are cost effective. They would reduce electricity and heating costs significantly and would only need to be refueled every 10-plus years. The projected cost is between $0.09 and $0.41 per KWH.

Third, microreactors are climate friendly. They would significantly improve air quality for all of Alaska. Diesel and coal account for 23 percent of the electricity currently generated in Alaska. By contrast, advanced nuclear generation is carbon free.

3:38:06 PM
MR. GRUSSENDORF turned to the chart on slide 6 that shows the projected costs of energy generated from microreactors and diesel fuel. He said the estimated cost for first generation microreactors is between $0.14 and $0.41 per KWH, and future generation estimates are between $0.09 and $0.33 per KWH. He noted that the graph comes from the Nuclear Energy Institute (NEI) Cost Competitive Report. He deferred to Mr. Mark Nichol to discuss the chart further.

MR. GRUSSENDORF explained that slide 7 lists some of the rural Power Cost Equalization (PCE) communities and their electricity rates before the PCE Program. He directed attention to the following statement from the April 2019 PCE Fact Sheet:

> The Power Cost Equalization (PCE) Program provides economic assistance to communities and residents of rural electric utilities where the cost of electricity can be three to five times higher than for customers in more urban areas of the state.

3:39:34 PM
MR. GRUSSENDORF said the next slide shows that the estimated timeline to deploy a microreactor is lengthy. Once a contract is signed, there is licensing, manufacturing, site preparation, construction, training, and startup.

MR. GRUSSENDORF directed attention to the safety points listed on slide 9. He said advanced microreactors are designed to reduce the probability of an accident through the use of passive or inherent safety features as opposed to traditional reactors that require someone to activate electrical or mechanical safety systems in the event of a malfunction. Advanced microreactors are designed to use physics and natural forces to intervene. They operate at atmospheric pressure, the cooling system uses liquid metal or molten salt instead of water, and they operate with minimal or no moving parts. The definition of "advanced nuclear reactor" is the same in both NELA and SB 194.

3:42:08 PM
At ease.

3:42:22 PM
CHAIR BISHOP called the committee back to order.

3:42:55 PM
MARC NICHOL, Senior Director, New Reactor Deployment, Nuclear Energy Institute (NEI), Washington, DC, said NEI members are the owners, operators, developers, constructors, and supply chain for the nuclear industry both in the U.S. and internationally.

MR. NICHOL said NEI supports SB 194 and commends the committee in trying to reduce the burden to bring advanced nuclear reactors to Alaska.

He explained that his overview would address why people are interested in advanced nuclear reactors and their features, including used fuel, safety, licensing, cost, and timelines.

MR. NICHOL commenced with his PowerPoint presentation stating that there is a lot of interest currently in advanced reactors and nuclear energy in general. He turned to slide 2 that lists eight imperatives for nuclear energy; they are the reasons that people are interested in the technology for generating electricity and other energy products. Clean energy, meaning no carbon emissions, is one of the most important attributes, but others are interested in energy resiliency, reliability, jobs, and enhancing U.S. national security and global influence.

3:45:00 PM
MR. NICHOL turned to the chart on slide 3 that illustrates the estimated decarbonization trajectory of various U.S. utilities from 2005 to 2050. He said some states previously had renewable portfolio standards, but they recognized that to achieve 100

percent decarbonization of the electric sector would requires a firm, clean energy source like nuclear energy.

He said utilities are also looking at decarbonizing their portfolios. Several dozen utilities have made their own commitments, some in states that do not have clean energy policies. Generally, their goals are to achieve zero carbon emissions by 2050 with interim milestones within that timeframe. To achieve this goal, many utilities are taking a serious look at advanced reactors to increase their nuclear energy generation.

MR. NICHOL displayed the graphic on slide 4 and explained that when NEI looks at the potential role of nuclear energy in a low carbon electricity future, the first step is to look at what the first fleet of nuclear reactors produces. On a national level, that is currently about 20 percent.

He explained that over time, the current nuclear plants will either retire or receive a second license renewal (SLR) from the NRC for 20-40 years. However, when looking at what portion of electricity could be derived from nuclear in the United States, there are questions about the role of renewable energy, the role of storage, and the role of other sources.

MR. NICHOL said the estimates of how much renewables can produce range from 30-90 percent, but regardless of those estimates there is a clear need for firm, clean electricity such as nuclear. He pointed out that for the U.S. to achieve 20 percent of its energy generation from nuclear would require 90 gigawatts (GW) of new nuclear generation or double the current portfolio of 100 reactors. To increase nuclear generation to 33 percent would require another doubling of reactors. He reiterated that there is a great need for additional nuclear in the U.S.

3:48:05 PM
MR. NICHOL explained that when NEI looks at technologies that will be available in the future, they look at the continuum of innovation illustrated on slide 5. The technologies that are deployable today are large light-water reactors (LWR) like the AP1000 that is being built in Georgia at Southern Company Plant Vogtle units 3 & 4. NEI is also looking at advanced fuel technologies for the current LWRs to help improve their performance and economics.

MR. NICHOL said NEI expects microreactors and small modular reactors (SMRs) to be deployed in the 2025-2030 timeframe.

Microreactors, like the Oklo Aurora plant shown on the slide, have power levels of 1 to 10 megawatts (MW). SMRs are defined as less than 300 MW in power and it is possible to have multiple reactors at the same site. He noted that SMRs can be light-water reactors or non-LWRs. The microreactor and SMR technologies benefit from using the proven and existing technology in today's operating reactors, making them smaller while adding additional features. After 2030, NEI expects small or large advanced non-LWRs that would be based on technologies that might use high temperature gas, liquid metal, or molten salt instead of water to keep the reactor cool.

3:50:01 PM
MR. NICHOL said innovation is the key for advanced technology in reactor design, safety, fuel, and demand response. He explained that smaller designed reactors are simpler and safer. For example, the NuScale reactor operates on natural circulation without pumps which allows for cooling during a power loss like the one at Fukushima, Japan. Additional reactor advancements would use molten salt that operates at atmospheric temperature to avoid having to push pressures or forces outside of a reactor vessel if there was an accident.

MR. NICHOL said fuel is also advanced. Many advanced reactor designs use high assay low enriched uranium (HALEU). It is low enriched uranium to 20 percent so it does not have proliferation concerns. That is greater than the 5 percent that can be produced commercially today, but the U.S. Department of Energy (DOE) is working on programs to help encourage and provide HALEU in the interim.

MR. NICHOL said advancements in digital technology and automation will allow for microreactors to automatically control power levels in response to demand. Also, companies designing microreactors are looking at inherent features where the physics itself would shut down the reactor. Some reactor designs are basing the safety of a natural physics shutdown on a test reactor at the Idaho National Laboratory (INL) that tested the concept.

3:53:11 PM
SENATOR HOFFMAN asked what countries are leading in advanced reactor development.

MR. NICHOL answered that China and Russia are developing advanced reactors and, in some respects, may be ahead of the US.

China is focused on high temperature gas reactors and Russia is focused on fast reactors; both are close to commercialization.

SENATOR HOFFMAN asked what country uses the most nuclear energy.

MR. NICHOL answered that the U.S. has the most nuclear power plants, but France uses more nuclear power as a percentage of power.

CHAIR BISHOP asked if a 1 MW plant brings a dropped load back up immediately or incrementally.

MR. NICHOL replied the NuScale SMR has a feature to bring back power quickly. It has full bypass capabilities for continuous operation at 100 percent power. Then they can dump the steam and go back to 100 percent power onto the electrical grid. The NuScale reactor also has features for a longer-term outage to slowly increase power. He said he did not know if microreactors have the features to dump the energy and continue at 100 percent power, but they can manipulate power quickly by coming up in unison.

CHAIR BISHOP said he looks forward to a fieldtrip to INL next summer.

3:55:58 PM
MR. NICHOL said the advanced reactor technologies result in three key performance improvements: reduced cost in time to market, enhanced safety, and flexibility to manipulate power to match renewables or switch to other energy products instead of electricity.

MR. NICHOL said the graphics on slide 7 show that advanced nuclear reactors are being developed for a variety of different markets.

3:56:35 PM
MR. NICOL reviewed the characteristics and management of used fuel outlined on slide 8. He said some people call the radiation and heat from used nuclear fuel waste, but less than 10 percent of its potential energy has been consumed so it could be recycled and used for another reactor. He noted that the U.S. does not recycle fuel for economic reasons, but countries like France do. He said another characteristic of used fuel is that it is solid and compact. The light-water SMR and the Oklo Aurora reactor are meant to illustrate this. The light-water reactor is a new fuel assembly that looks like a used fuel assembly. It is

solid and very compact given its energy density. The Oklo Aurora reactor shows the fuel inside the reactor to illustrate current thinking about refueling a reactor by taking out the old reactor with its fuel and putting in a new reactor with new fuel. He suggested thinking about it as swapping out batteries. The microreactor would not have used fuel onsite for extended periods even though the storage of used fuel has been demonstrated to be safe.

He said the Department of Energy (DOE) ultimately has the responsibility to dispose of the fuel. They will have contracts with companies that own and operate advanced reactors and they will eventually move the used fuel to final disposal.

3:58:35 PM
MR. NICHOL said a lot of licensing work is ongoing and anticipated with the NRC. The NuScale design is expecting its NRC certification later in 2020 for the first advanced reactor. NEI expects an NRC application to be submitted soon by the Oklo Aurora microreactor. There are a number of advanced reactors that are proceeding toward NRC licensing.

CHAIR BISHOP asked where NuScale is manufacturing its reactor.

MR. NICHOL answered that NuScale is working with the BWXT Nuclear Operations Group in Virginia and Canada, and Doosan Heavy Industries & Construction in South Korea.

SENATOR MICCICHE said he was pleased that the U.S. is forward-looking on potential technology but wonders why advanced nuclear reactors have yet to be developed.

MR. NICHOL answered that national laboratories have been developing and testing advanced technologies for decades, and some of the designs are operating commercially in other countries. Until recently, the U.S. was focused on getting large, 1000 MW LWRs to market. About 2010 people started to realize the need for smaller reactors, and then started to focus on non-light-water reactors.

4:01:50 PM
COREY MCDANIEL, PhD, Chief Commercial Officer, Nuclear Science and Technology, Idaho National Laboratory (INL), Idaho Falls, Idaho, said the INL tested, developed, and successfully deployed the original LWRs in the 1950s. The INL developed many of the technologies that Mr. Nichol mentioned, but they did not reach the deployment stage.

DR. MCDANIEL said there is a new sense of urgency due to decarbonization and the competitiveness with Russia and China where there is now an imperative and the markets are more accepting of advanced technologies. He said the INL is taking a second shot at getting advanced reactors deployed from the U.S. while watching other countries that have started deploying those technologies.

4:02:33 PM
MR. NICHOL said demonstrations of advanced reactors take many forms. It could be the first commercial reactor, which is expected for light-water SMRs; it could be a non-commercial reactor that demonstrates that the reactor works without producing power to sell; or it could be smaller scale demonstrations.

MR. NICHOL reported that the Department of Energy is working on a Joint Use Modular Program at INL to demonstrate the NuScale technology at a plant owned by the Utah Associated Municipal Power Systems (UAMPS). DOE is also in the process of launching the Advanced Reactor Demonstration Program. Funding in its FY2021 budget provided for two demonstration reactors within five to seven years, and two to five additional demonstration reactors in the longer term. The latter might be commercial.

MR. NICHOL said the U.S. Department of Defense (DOD) is extremely interested in microreactors to provide both mobile operational energy and stationary reactors for domestic base installations. The commercial market is not interested in mobile microreactors but the department plans to demonstrate the mobility feature in 2024. DOD envisions piloting a microreactor for a stationary reactor at a remote base by 2027, possibly in locations within Alaska like Fort Greely Army Base, Eielson Air Force Base, or Fort Wainwright Army Base.

He said there are several companies looking at private demonstrations funded by private investors who would not depend on government funding. INL expects private company demonstrations to occur within the next few years.

4:05:41 PM
SENATOR HOFFMAN asked if private companies are soliciting communities for demonstrations.

MR. NICHOL replied he expects private demonstrations to first occur at a national laboratory. Some private companies may go straight to a commercial reactor so they would look for a commercial location.

SENATOR HOFFMAN remarked that that would not include Japan.

MR. NICHOL agree that Japan is not looking at new and advanced reactors due to their continued focus on restarting their shut down reactors.

SENATOR HOFFMAN asked if certain regions of the state are more interested than others.

MR. NICHOL replied it is more dependent on utilities than a region. A number utilities have shown interest, but none have made public announcements of their plans for advanced reactors.

4:07:09 PM
MR. NICHOL reviewed the financing options for design development, plant construction, and operation of advanced reactors. He said over $1 billion in private capital has gone to advanced reactor companies. A few companies, such as municipal utilities, are looking at self-financing. Some third-party capital investors are looking at privately financing reactors, but many other companies are looking for federal support for their projects.

MR. NICHOL explained that the federal government has several tools available to provide financial support. Production tax credits is one tool where an operator receives tax credits for the power they produce. Loan guarantees are a way for the government to reduce the financing costs for investor-owned and municipal utilities. The nuclear industry pays for these guarantees so there is no cost to the taxpayer. The federal government can also use power purchase agreements to assist with financing, and there is some talk about mechanisms where the government agency could pay for the value of the resilience they are receiving.

He said there are also options for state support through tax incentives to help reduce the financial burden in reactor construction. He noted that policies related to carbon reduction are also helpful to make a business case for some projects.

4:09:37 PM
MR. NICHOL turned to slide 12 that shows a graph of the estimated costs of the first light-water SMR. He noted that this work was done with SMR Start to estimate the cost of reactors of

less than 300 MW. The study looked at two 200 MW reactors with a total plant size of 400 MW. They found that the capital cost for the plant would be about $2 billion; the operating costs were estimated to be $27 per MWH and the plant could be constructed in about 36 months. The study also estimated a 10 to 20 percent cost reduction through learnings and repetitive builds.

4:10:28 PM
MR. NICHOL turned to slide 13 and explained that the chart reflects the results of the cost competitiveness assessment that NEI performed for microreactors. It illustrates how the cost of microreactors can be reduced through lessons learned and deploying multiple reactors. The capital cost for the first 10-MW reactor would be about $150 million or $15,000 per kilowatt (KW). Those costs are expected to come down to $0.05/KWH and the time to construct a microreactor would be less than 24 months, with some designs taking less time.

4:12:17 PM
COREY MCDANIEL, PhD, Chief Commercial Officer, Nuclear Science and Technology, Idaho National Laboratory (INL), Idaho Falls, Idaho, started his testimony by reextending the invitation to the committee and other legislators to visit the laboratory to see its demonstration sites, equipment, and the test reactors used to support advanced reactor technology.

4:13:43 PM
DR. MCDANIEL advised that his presentation would specifically address deployment and demonstration activities that happen at INL, and that he was available to address any technical questions about reactor safety. He said there has been a strong interest in clean energy, reliable energy, and national security, particularly the geopolitical risk of not having advanced nuclear technologies when countries like Russia and China are developing and deploying the technologies. He noted that Russia is in the process of deploying many large reactors in almost 30 countries.

He highlighted that Congress has shown unprecedented bipartisan support for advanced nuclear technology with increased appropriations year over year and some new authorizing legislation. He noted that U.S. Senator Murkowski, chair of the Senate Energy Natural Resources Committee, oversaw many of the pieces of legislation signed into law or reintroduced. This includes NEICA that became law in 2018 and NELA that is part of the energy bill senators are considering this week. He said his presentation would also cover the National Reactor Innovation Center (NRIC) that is expected to launch in August 2020.

DR. MCDANIEL detailed that one of the advanced nuclear technology activities is from Terra Power, a company funded by Bill Gates to address climate change and leadership development.

4:15:32 PM
DR. MCDANIEL turned to the graphic on slide 3 relating to industry efforts to safely manage spent nuclear fuel despite political inaction. He directed attention to the U.S. map showing the location of the reactors, and assured the committee that all the nuclear reactors in the U.S. are safely storing spent fuel onsite and will continue to do so until there is a political solution.

CHAIR BISHOP asked if storing spent fuel at Yucca Mountain is open for conversation.

DR. MCDANIEL said Congress and the administration have debated Yucca Mountain for a long time without reaching consensus. The Secretary of Energy spoke with Senator Murkowski today during a hearing about the federal budget for nuclear and said the administration would continue to look for a better solution.

4:16:57 PM
DR. MCDANIEL turned to slide 4 and explained that the origin of the Idaho National Laboratory (INL) came from the National Reactor Testing Station after it was used as a gunning range during World War II. The laboratory was set up in cooperation with Argon National Laboratory in Chicago. That facility was developing fission technologies using thermal and fast neutrons and water and sodium coolants. They were developing technologies both for the military for the naval reactors and for the commercial use of nuclear power.

In 1974, the laboratory changed its name and the missions changed to focus on energy and environmental management. In 2005, a combination with Argon National Lab-West (ANL-W) formed INL. INL has been in operation for the last 15 years as the nation's lead nuclear laboratory. INL works in cooperation with other national laboratories on nuclear energy, including the Argon National Laboratory, the Oakridge National Laboratory, and more than a dozen other facilities within the national laboratory system.

4:18:28 PM

DR. MCDANIEL explained that INL's strategic science and technology initiatives address the sustained development of new technologies in support of the existing reactor fleet, working on fuel cycle issues to take care of waste. They focus on advanced materials and manufacturing, and integrated energy systems for things other than electricity such as heat, desalination, and hydrogen production. INL also plays a strong role with the U.S. Department of Homeland Security to develop secure and resilient cyber physical systems. This is relevant to remote reactor operations where there is limited staffing.

4:19:46 PM
DR. MCDANIEL stated that the vision at INL is to take the tools it has from new test reactors, advanced technologies, cyber security, and human factors to support the development of advanced reactor technology through a program called the Gateway for Advanced Acceleration Innovation in Nuclear (GAIN). GAIN focuses on working with the industry to develop the technologies to get to demonstration.

4:20:27 PM
DR. MCDANIEL advised that the next few slides describe the workforce at INL. When the committee visits they will meet and visit the nuclear science and technology directorate, the materials fuels complex where materials are tested, and the advanced test reactor that is used for the commercial sector and the U.S. Navy to test reactor fuels.

4:20:55 PM
DR. MCDANIEL stated that INL has been demonstrating and deploying reactors since the 1950s for naval reactors for submarines and ships, and for most commercial reactors around the world. INL has demonstrated other technologies for the fast reactor, high temperature gas-cooled reactor, and the molten salt reactor, but they have not been deployed. The National Reactor Innovation Center (NRIC) is now focused on deploying those technologies with support from federal legislation and appropriations.

He detailed that INL is working on microreactors that are less than 10 MW, for commercial use as well as mobile applications for DOD use. Commercial microreactors could be deployed in remote locations for mines initially and eventually in communities.

DR. MCDANIEL noted that the SMR, such as the NuScale reactor, is going straight to deployment. Laboratories have already demonstrated the SMR technology and the expectation is to receive NRC design certification in the near future. The NuScale reactor will be a commercial deployment in Idaho with the hope for additional deployments both domestic and international.

4:23:04 PM
CHAIR BISHOP asked how many megawatts the SMRs will produce.

DR. MCDANIEL answered that the six modules will have a combined load of over 600 MW, but each module will have just 50 megawatts.

CHAIR BISHOP recalled earlier testimony that the price for a 600 MW plant would be around $2 billion.

MR. NICHOL answered correct.

CHAIR BISHOP asked how a 600 MW SMR would be financed.

DR. MCDANIEL answered that the financing would be similar to other nuclear power plants. The license is typically for 40 years and the financing would be for 40 years. He said the financial outlook is better when the license is extended for a second 40 years. Smaller microreactors may have a 10-year lifetime specifically suited to provide 1-3 MW of power and heat at a mine with just one fueling.

CHAIR BISHOP asked if the cost for a small reactor would be approximately $150 million.

MR. NICHOL replied his presentation indicated that a 10-MW reactor was $150 million.

CHAIR BISHOP asked if a 1 MW reactor was anticipated because a lot of rural communities in Alaska do not need 10 MW.

MR. NICHOL answered that there are designs for microreactors as small as 1 MW or less.

4:25:35 PM
DR. MCDANIEL returned attention to slide 10 and noted that the Versatile Test Reactor (VTR) that is supported by the administration and funded by Congress, could be operating at INL by 2026. The VTR is an important tool that would offer the ability to test and develop fuels for fast reactors, a technology that INL developed. The only three countries that

operate fast reactors for experimental purposes for commercialization are Russia, China, and India.

DR. MCDANIEL detailed that INL is hoping to demonstrate advanced-advanced non-LWR technology by 2030. They would be reactors with coolants other than water and with more exotic designs that might be more efficient and cost effective.

CHAIR BISHOP asked if the non-LWR would be safer.

DR. MCDANIEL replied the safety of all the reactors is fairly well established. The reactors that are low pressure, because they are liquid metal cooled or have tri-structural isotropic (TRISO) type fuel with particle protection, are using technologies that have been well tested, but it is a matter of getting them demonstrated and to the deployment stage.

4:27:23 PM
DR. MCDANIEL said slide 11 has more discussion of some of the issues that Mr. Nichol mentioned. He explained that HALEU is not being commercially produced but INL is providing it at the laboratory and is working with industry groups to find ways to make the fuel available for these reactors. He detailed that INL will demonstrate real-time instrumentation via the joint use module program with the NuScale reactor. He said INL is also taking the lead on the back end of the fuel cycle.

4:28:13 PM
DR. MCDANIEL turned to slide 12 and noted that the National Reactor Innovation Center (NRIC) came out of the legislation Senator Murkowski sponsored. He said NRIC is the cornerstone of how INL will use the tools at the laboratory, provide the infrastructure to demonstrate the reactors, and have that lead to deployment for the Department of Defense as well as industry in the U.S. and internationally. The expectation is that the reactors will be deployed in communities once the technology has been demonstrated at a military base or a commercial site like a mine.

DR. MCDANIEL turned to slide 13 and explained that the Gateway for Accelerated Innovation in Nuclear (GAIN) was the foundation on which NRIC was built. It is a tool for industry to be able to access INL tests, technology, and expertise. It has been so successful in the last few years that it is clear that there is a need to demonstrate these reactors. He said demonstrations can be anywhere, but INL is particularly suited because it has already demonstrated 52 reactors, some of which have led to commercial deployments. Other possible demonstration sites are in Washington state and Oakridge, Tennessee, but INL has a track record of demonstrations and is housing the NRIC and GAIN programs that are not specific to Idaho.

4:30:17 PM
DR. MCDANIEL concluded his testimony saying the current situation with nuclear energy is more positive than it has been in the past. A combination of federal funding, bipartisan political support, demonstrating new tools, focusing on the NuScale module demonstration, the VTR program, microreactor demonstrations, and legislation led primarily by Senator Murkowski has put INL is a position to demonstrate advanced reactors in the near term and have them ready for deployment in places like Alaska as the market dictates.

4:31:07 PM
SENATOR HOFFMAN asked how much nuclear energy INL uses.

DR. MCDANIEL replied none at this time. Most of the power that INL uses comes from hydro and some coal through Idaho Power.

CHAIR BISHOP asked if INL has an operational reactor.

DR. MCDANIEL replied INL has advanced test reactors but it does not produce electricity. That will change when the NuScale reactor is up and running. That electricity will go onto the grid and serve 30 potential customer utilities around the Mountain West.

CHAIR BISHOP observed that it will have to be load tested at some point.

DR. MCDANIEL agreed. He noted that when the committee visits they might see a demonstration from UAMPS to show how the reactor could load-follow with the wind and be used in other hybrid energy applications.

4:33:33 PM
GWEN HOLDMANN, Director, Alaska Center for Energy and Power (ACEP), University of Alaska Fairbanks (UAF), Fairbanks, Alaska, explained that ACEP focuses on applied energy research that is relevant to the needs of Alaska residents and industries. Because Alaska produces and uses power in unique ways, ACEP focuses both on power generation and on broad usage that includes heat and transportation.

4:34:22 PM

MS. HOLDMANN explained that ACEP first became interested in small modular reactors (SMRs) and microreactors in 2010. At the direction of the legislature, ACEP worked on a 200-page report to identify whether this nuclear technology might have an application in Alaska. The study sparked interest among ACEP researchers, and the center has continued to track the technology.

She said a big part of the initial report, which Senator Hoffman supported due to his interest in SMR technology, was that this technology had the potential to provide baseload power for remote locations that depend on intermittent sources of renewable energy. There was also interest in looking at options to offset heating loads in these remote locations.

MS. HOLDMANN displayed a map showing the more than 70 Alaska communities that have renewable energy powered microgrids. She said Alaska has over 50 percent of the U.S. microgrids with renewable power connections and 12 percent of the world's total number of microgrids. The state is a national and international leader in microgrid technology, but many renewable energy sources have intermittent output which creates challenges.

4:36:08 PM

MS. HOLDMANN displayed a short video to illustrate the difficulty associated with variable power demands. For example, the power demands in Cordova increase markedly when fish processing comes online. She pointed out that when renewable resources and the loads are highly variable, it makes it very difficult to make incorporating renewables as a meaningful offset to diesel fuel.

She said the concern in rural Alaska about switching from diesel fuel to nuclear microreactors is related to safety and the potential for environmental contamination. However, there are many examples where diesel fuel was the cause of environmental contamination in communities in rural Alaska. She pointed out that very little is done that has no environmental footprint so it is important to think about what is acceptable risk and balance that between what is done today and what the future could potentially look like.

4:38:03 PM

MS. HOLDMANN displayed a map of the panarctic circumpolar region and highlighted that there is no electrical grid on 20 percent of the Arctic landmass. Power in this area is provided primarily through diesel generation, so there is real opportunity for the region to benefit from nuclear microreactor technology. This is particularly important because of the high demand for heat in the Arctic. She said Alaska should be tracking the evolution of this technology to make sure that people and organizations like the Idaho National Laboratory (INL) consider the unique circumstances in Alaska.

MS. HOLDMANN restated that diesel fuel for space hearing is a large concern from a cost standpoint in many places in Alaska. Nuclear microreactor technology is an opportunity to address both heat and electric power.

She directed attention to a photo of a fuel barge accompanied by a Coast Guard cutter delivering fuel oil to Nome in January because the fall storms prevented delivery of the fall shipment. She said the limited need for microreactor refueling would provide a different paradigm for energy security for remote areas in Alaska.

4:40:03 PM
MS. HOLDMANN highlighted a 2010 report by the Alaska Center for Energy and Power (ACEP) and the Institute for Social and Economic Research (ISER) that looked at whether small modular nuclear power was an option for Alaska. She said ACEP went through the following steps that culminated in recommendations and a roadmap for the state:

- Review history of nuclear technology utilization in Alaska
- Consider technical and economic feasibility of proposed SMR technology
- Assess siting and permitting requirement/barriers to implementation
- Host a workshop as a forum for discussion and knowledge exchange
- Create recommendations and develop a roadmap for the State of Alaska

She directed attention to the photo of the Fort Greely SM1 primary reactor facility that was commissioned in 1962 and decommissioned in 1972. She pointed out that microreactors are a very different technology that present much less risk. The reactor at Fort Greely used 93-percent enriched uranium whereas the proposed microreactors address safety by having fuel enrichment levels below 20 percent.

4:41:22 PM
MS. HOLDMANN said even though ACEP did not look at smaller reactors in the 2010 report, the center identified continued research into smaller, less than 10 megawatt, reactors as a priority. The ACEP report recommendations included: a site feasibility study for two locations in Alaska; continued studies of SMR economics and technology development; monitoring federal legislation and support at the national level; and identifying a technology lead for somebody in the state to keep an eye on small reactor technology and interact with people on the national level.

MS. HOLDMANN displayed a map that shows the 10 Alaskan communities with sufficient heating and electric loads to match small modular reactor capabilities that are currently under development.

She said one of the limitations of the 2010 project was that the smallest reactor technology at the time was 45 MW. She suggested that the study is worth updating because microreactor technology can accommodate much smaller loads.

4:43:07 PM
MS. HOLDMANN displayed a chart of the local price thresholds for the 10 communities. She said the data is out of date, but the size of the bars is relevant from an economic standpoint. It shows that it makes the most sense to deploy one of these systems in the Fairbanks area. The smaller communities were not cost competitive when the only option was a 45 megawatt reactor, but microreactors with 1-10 MW output is a game changer. She said she envisions the potential for no diesel generators in rural Alaska in 25 years.

MS. HOLDMANN displayed images of the Fort Wainwright Army Base and the Red Dog Mine to illustrate that military installations and mining operations are other potential locations for microreactors. She posited that there could be a demonstration project at a military base in Fairbanks or another permanent installation within a few years.

She said SB 194 is an important step in making sure Alaska is open for business and willing to actively consider microreactor technology in the future. The nuclear industry and people at the federal level are looking for partners who are actively interested and willing to collaborate on issues related to safety, nuclear equipment disposal, and the size range of reactors. There will be benefits if Alaska is willing to step forward and be an active partner.

4:45:03 PM
MS. HOLDMANN displayed the roadmap that ACEP developed in 2010. She said it goes through a stage gate process that is surprisingly relevant and accurate today. It says the first SMR will be licensed in 2020; the previous speaker said that is on target and a pilot project might happen sooner than 2030.

MS. HOLDMANN said the final three slides are historic and illustrate how technology has developed over time. The first image shows the export of whale oil from Alaska in the 1880s. This was the major energy export at that time. The next image shows horse-drawn wagons of cordwood. In the Interior there was a lot of clearcutting to power paddle wheel boats, and Fairbanks initially was powered with 100 percent biomass. She said the images are a reminder that there can be no assumption that the energy sources used today will be used tomorrow. Thus, it is important for the state to be prepared and think about what the future might look like. She suggested that is an important role for the university that the legislature should be thinking about.

4:47:15 PM
MS. HOLDMANN concluded her testimony pointing out that in 2019, Bethel spent about $8 million for 3.2 million gallons of diesel fuel for just power generation. That did not include space heating. She estimated that about $15 million was spent on both space heating and power generation. She noted that an earlier slide showed that the average baseload power needs for Bethel is about 7 MW. If a 10 MW microreactor were installed for $150 million, the payback would be 10 years. She said there are a lot of other costs to consider but this does demonstrate that this is a conversation worth having.

CHAIR BISHOP referred to the slide showing the heating and electric loads for 10 communities in Alaska. It shows that the Railbelt uses about 900 MW of energy. He asked Mr. Nichol if a $2 billion, 600 MW reactor could be scaled to 900 MW for about $2.2 billion. He also asked how long until a 600 MW plant would need to be refueled.

4:49:45 PM

MR. NICHOL confirmed that the plant could be scaled up. The NuScale design has 12 reactors that are each 60 MW. That is a 720 MW plant and the cost is in the ballpark of $3 billion. He noted that there are also 300 MW plants that could be scaled up to 900 MW.

CHAIR BISHOP asked how often a 300 MW plant would require refueling.

MR. NICHOL answered that refueling for those reactors would be every 1.5 years to 2 years. They would bring in about one-third of the fuel so the fuel actually lasts 3 cycles for a total of 4.5 to 6 years.

4:50:46 PM
CHAIR BISHOP offered his understanding that reactor technology is coming that combines both heat and power, like a combined cycle gas plant where power comes from one end and heat comes off the back end. For example, a major Fairbanks hospital burns 6,000 gallons of diesel fuel a day during cold weather so a nuclear powerplant that produces heat could save a lot of diesel fuel very quickly.

SENATOR HOFFMAN remarked that rural Alaska could use microreactors, but so could the entire world. There would be universal uses.

He noted that Alaska has $1 billion in the Power Cost Equalization (PCE) Fund, and that money could be matched with public/private partnerships and expended throughout Alaska to make living more affordable throughout the state. He suggested the legislature talk to Senator Murkowski to emphasize fast forwarding small reactors in the next decade.

4:53:31 PM
CHAIR BISHOP agreed and pointed out the circumpolar map showed multiple off-grid settlements.

SENATOR HOFFMAN remarked that 10 years ago it was "if" for nuclear energy and now it is a matter of "when."

MS. HOLDMANN replied that is why updating the 2010 study should be a priority.

She referenced Senator Hoffman's earlier question about microreactors reacting to an unexpected fault in the system and explained that SMR technology, like the NuScale reactor, is not that much different from a coal plant where heat generates steam and the back end is the same. She said it is about the switchgear that the utility has and the inner connection to handle faults in the system. Microreactors are more like a nuclear battery with the reactor being replaced after 10 years so there is no onsite refueling.

MS. HOLDMANN said she agrees that there is a lot of potential for all Alaskans to benefit.

SENATOR HOFFMAN asked what the legislature spent on the 2010 ACEP study.

MS. HOLDMANN answered that the Alaska Energy Authority received $200,000 for the study.

CHAIR BISHOP remarked that he was thinking about a committee substitute for the bill.

4:55:40 PM
SPENCER NELSON, Professional Staff Member, U.S. Senator Lisa Murkowski, U.S. Senate Energy and Natural Resources Committee, Washington, DC, said Senator Murkowski is chair of the Senate Energy and Natural Resources Committee and nuclear energy has been a priority for her for a long time.

MR. NELSON said the focus of his overview would be on federal policy regarding nuclear energy. He advised that he was unable to attend the committee meeting in person due to a comprehensive energy bill on the floor that included advanced nuclear.

He reiterated that Senator Murkowski has been relentlessly focused on any kind of technology that would lower energy costs for people who are either in Alaska Native villages or in remote, rural communities that are spending a large percentage of their annual income on electricity and heating. The current option is diesel or nothing, whereas microreactors provide an opportunity for an alternative to fossil fuels.

4:57:50 PM
MR. NELSON said different pieces of federal legislation on advanced reactors, specifically smaller reactors, are uniquely suited to the Alaskan market. One of the first pieces of legislation enacted into law was the Nuclear Energy Innovation Capabilities Act (NEICA). That law established a program for the demonstration of privately funded advanced reactors at national laboratories. It sets up research infrastructure for a lot of

advanced modeling and simulation. He noted that the bill passed the Senate unanimously, demonstrating that there is bipartisan support within Congress for advanced nuclear technologies.

MR. NELSON said the second bill that became law in late 2018 was the Nuclear Energy Innovation Modernization Act (NEIMA). It changed the way nuclear energy is regulated by the Nuclear Regulatory Commission (NRC) to recognize that advanced reactors are very different from light-water reactors (LWRs), especially for not having the same safely and security issues and therefore can be evaluated more quickly. As a result of NEIMA, the NRC is accelerating a lot of its advanced reactor reviews and is also looking for new ways to regulate. For example, the NRC just released a position paper saying that small reactors under 10 MW may be able to address environmental reviews on a generic basis. That will save a lot time by not going through the National Environmental Policy Act (NEPA) analysis.

He said there are a lot of interesting things that can happen on the regulatory front with advanced reactors because they are so much better suited for streamlined regulatory review than some of the larger LWRs.

5:00:35 PM
MR. NELSON said Congress also enacted the 45 J Tax Credit, which is an important modification to an advanced nuclear tax credit. The credit is $18.00 per MWH for the first 6,000 MW of advanced nuclear capacity that is built in the U.S. He said much of that will likely go to Plant Vogtle in Georgia, but there will be leftover capacity for projects like the NuScale pilot plant at INL or the first microreactors.

He said Chair Murkowski's staff has been working on the Nuclear Energy Leadership Act (NELA). It was first introduced in 2008 and again in 2019 and is a bi-partisan proposal with 22 co-sponsors in the U.S. Senate. NELA authorizes federal power purchase authority for advanced reactors for periods up to 40 years. This will take advantage of the fact that many advanced reactors can run for much longer than the current 10-year statutory limit. NELA will allow INL to purchase power for its facilities from some of the advanced reactors they plan to demonstrate on site.

MR. NELSON explained that NELA sets a two-tranche timeline: two smaller reactors by 2025, and two to five reactors by 2035 that could include bigger reactors like Bill Gates' reactor or others. The NELA timelines are aggressive, especially to people who are not working on nuclear. However, NELA raises the ambition for the U.S. Department of Energy (DOE) as well as slants things towards microreactors. He noted that several microreactor design demonstrations are likely by the early 2020s.

5:04:32 PM
MR. NELSON noted that Congress created an important program for the U.S. Department of Energy (DOE) to provide an interim supply of advanced nuclear fuel. Twenty percent enriched fuel that many advanced reactors require for operation is not commercially available in the U.S. The program either converts used DOE fuel or supports new fuel facilities for the first demonstrations. Once the commercial market establishes the fuel supply, the program would end. DOE made an award to recycle used fuel for one of the microreactor demonstrations that will likely be at INL for the [Oklo Aurora Application]. DOE also contracted with Centrus Energy Corporation to begin demonstrating their ability to enrich fuel up to the 20 percent needed for advanced reactors. The hope is that fuel technology and regulations governing advanced nuclear fuel transportation will be ready for the first reactors.

MR. NELSON aid NELA also addresses advanced nuclear workforce needs in the U.S. by reauthorizing a nuclear engineering scholarship program for industry, NRC, and the National Nuclear Security Administration. He noted that NELA is just a bill and not a law, but companies are going forward with their demonstration plans with the hope that NELA will happen.

He noted that the federal budget included appropriations in December 2019 for demonstration funding, which is similar to what NELA calls for. The appropriation includes $230 million for two advanced demonstration reactors within 5-7 years, and some money for later staged reactors. Expectations are for companies to apply for demonstration funding later in 2020. Corresponding demonstration programs are going forward through the appropriation process regardless of NELA.

5:07:57 PM
MR. NELSON said the intent is to get NELA through the Senate as part of the American Energy Innovation Act (AEIA). AEIA is broader than just nuclear energy. It includes all aspects of energy innovation, cyber security, electrical grid security, and workforce development. The U.S. House of Representatives has a companion bill to NELA with corresponding measures. Regardless of NELA enactment, there are expectations for microreactor

license applications to be submitted to NRC, maybe as soon as next week, for demonstrations at INL. The hope is that the microreactor submissions ultimately look at opportunities to deploy in Alaska.

MR. NELSON said SB 194 is important because the bill addresses the ambiguity in building advanced nuclear in Alaska because of the current statutory requirement that the legislature pick sites. Changing the statute would allow the decision to build an advanced reactor between the community and the developer while maintaining NRC oversite. Having the community onboard is important as well as allowing the developer to pick specific sites to provide power from an environmental and land use perspective. Without SB 194, there would have to be a plan to set sites because the sites that the legislature sets might not be the most economic or most politically viable to develop advanced nuclear.

5:11:21 PM
CHAIR BISHOP thanked Mr. Nelson for his comprehensive review. He said the committee intends to bring SB 194 back next week with possible amendments.

5:12:23 PM
At ease.

5:12:39 PM
CHAIR BISHOP called the committee back to order. He said the committee will bring SB 194 back on March 10 for public testimony with the intent to move the bill to the next committee of referral.

[SB 194 was held in committee.]

5:13:02 PM
There being no further business to come before the committee, Chair Bishop adjourned the Senate Community and Regional Affairs Standing Committee meeting at 5:13 p.m.