The Regents of the University of California

NATIONAL LABORATORIES COMMITTEE
September 28, 2021

The National Laboratories Committee met on the above date by teleconference meeting conducted in accordance with Paragraph 3 of Governor Newsom's Executive Order N-29-20.

Members present: Regents Cohen, Kounalakis, Reilly, and Sures; Ex officio member Estolano; Advisory members Horwitz, Powell, and Timmons; Chancellors Hawgood, Khosla, and Larive; Staff Advisor Lakireddy

In attendance: Regents Hernandez, Leib, Lott, Makarechian, and Zaragoza; Regent-designate Blas Pedral; Faculty Representative Cochran, Secretary and Chief of Staff Shaw, Senior Counsel Lounsbury, Provost Brown, Vice President Leasure, Laboratory Director Budil, Chancellors Muñoz and Wilcox, and Recording Secretary Clark

The meeting convened at 4:05 p.m. with Committee Chair Sures presiding.

1. **APPROVAL OF MINUTES OF PREVIOUS MEETING**

Upon motion duly made and seconded, the minutes of the meeting of July 20, 2021 were approved, Regents Cohen, Estolano, Kounalakis, Reilly, and Sures voting "aye."[1]

2. **STATE OF THE LABORATORY: LAWRENCE LIVERMORE NATIONAL LABORATORY**

[Background material was provided to Regents in advance of the meeting, and a copy is on file in the Office of the Secretary and Chief of Staff.]

Committee Chair Sures welcomed Director Kimberly Budil as the newly appointed Director of the Lawrence Livermore National Laboratory (LLNL). Director Budil was appointed to this role and began serving in March 2021; she is the first woman director in LLNL's history.

Director Budil provided remarks to the Regents on the current state of the Laboratory. LLNL was established in 1952 as the United States' second nuclear weapons laboratory, founded by UC Berkeley Professor Ernest Orlando Lawrence and Edward Teller after the completion of the Manhattan Project, as a companion laboratory to the Los Alamos National Laboratory. LLNL had been experiencing significant growth and employs close to 8,000 people, including more than 1,000 people who had been hired during the COVID-19 pandemic. Growth had been driven by LLNL's core programs for the National Nuclear Security Administration, the part of the U.S. Department of Energy to which LLNL

[1] Roll call vote required by the Bagley-Keene Open Meeting Act [Government Code §11123(b)(1)(D)] for all meetings held by teleconference.

belongs. LLNL currently had an annual budget of about $2.5 billion. LLNL is uniquely compact in size, one mile square, and this fosters collaboration. During the pandemic, LLNL had learned how to continue this collaboration without having everyone on site. Director Budil shared that there is an additional site in the Tracy Hills for explosive and high hazard work. LLNL is managed by the University of California and its partners, Bechtel, BWX Technologies, and Amentum through Lawrence Livermore National Security, LLC.

Director Budil provided in-depth information on LLNL's mission. LLNL is a national security laboratory with a nuclear core. LLNL's core mission was the Stockpile Stewardship Program, maintaining the security and effectiveness of the nation's nuclear deterrent. Director Budil shared that she had recently signed her first annual assessment letter, which certifies directly to the President of the United States LLNL's technical assessment of the viability of the current U.S. nuclear weapons stockpile. The Stockpile Stewardship Program creates a rich environment of science, technology and engineering capabilities that LLNL leverages for its other core missions. These other core mission areas were reduction of the threat from weapons of mass destruction, multi-domain deterrence, and energy security and climate resilience. LLNL has a long legacy in the energy security and climate resilience arena, and unique capabilities to not only understand the climate, but to understand what to do about a change in climate.

One current important area of focus was biosecurity. LLNL had worked on biology for several decades, originally focusing on the impact of radiation on human health. LLNL was involved in the human genome project, has developed technologies for the rapid detection and screening of bioagents, and continues to apply high-performance computing in new and interesting ways to assist the development of drugs and therapeutics. LLNL initially thought about this work in the context of national security countermeasures, but in the case of emerging diseases, like COVID-19, one's body does not care if the disease is an engineered threat or a naturally occurring threat. LLNL understood the need to speed up the ability to identify emergent diseases, develop countermeasures, and to shorten the timeline for deployment of therapeutics.

A second current area of focus was climate, and the current challenge was adapting to and mitigating the impacts of a changing climate. By combining its expertise in modeling and simulation and fundamental climate science with its engineering prowess, LLNL can have a significant impact.

In the realm of biosecurity, LLNL has a deep and rich set of relationships with UC. One of the core partnerships was the Accelerating Therapeutic Opportunities in Medicine (ATOM) collaboration. This was a significant foray into building an ecosystem to rapidly design and test new therapeutics using high-performance computing. The goal was to build a platform that pharmaceutical companies could use to develop new drugs and therapeutics in a more cost-effective and timely manner. New academic and industry partners continued to increase the capability of this initiative. During the pandemic, LLNL engaged in a significant effort on SARS-CoV-2, trying to understand the molecule and testing potential therapeutics and antibodies. LLNL was able to rapidly apply its existing tools to the

pandemic problem. Director Budil noted that partnerships with industry and academia were important for LLNL. LLNL had enormous capability in high-performance computing and a significant footprint in computational biology, but the amount of intellectual capital outside LLNL was greater than what LLNL would ever have inside. Partnerships played a key role in advancing LLNL's capabilities and allowing it to have greater impact. LLNL's commitment to public service was illustrated by another activity related to COVID-19, when a group of LLNL engineers, working in their garages, developed a novel ventilator technology which used a supply chain different from that for the conventional ventilators that were in short supply early in the pandemic. LLNL was able to work quickly to find an industrial partner and to commercialize this technology.

LLNL was engaged in a number of interesting projects in bioengineering. One project aimed to understand the processes in the brain. LLNL developed a neuroprobe that could be implanted in the brain and measure signals. Using this technology, researchers at UCSF can begin to understand the processes by which memories are formed in the brain by directly measuring signals and activity in the hippocampus. Another project with UCSF researchers uses LLNL's computational tools to advance the understanding of traumatic brain injury, with very detailed diagnostics. These data could potentially be significant for patient treatment.

LLNL developed a report for the State of California, "Getting to Neutral," which examines the State's plan for achieving carbon neutrality by 2045. LLNL researchers carried out a detailed assessment of various carbon reduction technologies, costs, and tradeoffs. Land management techniques might be used to sequester more carbon in the soil; direct carbon capture could remove carbon from the atmosphere, transport it, and sequester it in underground reservoirs; carbon could be converted into other forms and put back to use, rather than being released into the environment. The report was optimistic, finding that technologies exist today at a reasonable level of maturity to enable the achievement of this ambitious goal for California. LLNL was building its relationship with the State of California as well as local and regional partners and working to identify opportunities for large-scale technology deployment, in order to demonstrate that some of the approaches discussed in the report are feasible, and feasible at a scale to have a significant impact. Locally, LLNL was working with the City of Livermore to deploy some of these techniques and to help the City achieve some of its climate goals. LLNL does significant work in climate modeling and was leading an effort for the next generation of computers to develop a more sophisticated and higher-resolution model that would allow researchers to examine the impact of climate change at global and regional scales. This model would allow communities and regions to develop meaningful planning for adaptations and mitigations.

Director Budil discussed high-performance computing at LLNL. This had been an area of focus since LLNL's founding. The Laboratory has the number three computational machine in the world, Sierra, and a number of other machines that are listed in the top five hundred in the world. LLNL was expecting to receive the first exascale computer that would be dedicated to national security in 2023. LLNL was continuing on a trajectory of not just bringing large and powerful computers to the site, but finding ways to exploit them to their fullest capability to solve complex problems. One example of this work was using

highly complex simulations to understand the impact of wildfires. LLNL's Data Science Institute hosts UC students for three weeks to work on a challenge problem with graduate students and LLNL mentors. The students have the opportunity to participate in other LLNL activities and gain a view of a potential career path.

Another important research area at LLNL was high energy density (HED) science. HED science is the study of matter at the highest temperatures, pressures, and densities in the universe. LLNL has been developing an ever more powerful series of laser facilities that can compress matter to these very extreme conditions. The current facility at LLNL was the National Ignition Facility, which was designed to permit exploration of the physics of thermonuclear ignition and burn, but which can be put to many other uses. One of the key elements for understanding thermonuclear ignition and burn is reaching an ignition gateway. Director Budil described this very complex procedure, which was difficult to achieve. The original proposal for this process using lasers was made in the 1960s, shortly after the development of the laser. LLNL had now successfully shown that its facility can achieve fusion ignition, and this opened up exciting new possibilities, including a potential fusion energy future using this technology.

Currently LLNL was building its Livermore Valley Open Campus (LVOC), which would be a key component in bringing the University community together with LLNL researchers, taking advantage of the many facilities on site to facilitate partnerships. The campus has an Advanced Manufacturing Laboratory which draws industry partners, computing capabilities, and a new Collaboration Center and office complex. Director Budil stated that she looked forward to having a greater UC presence on the site and invigorating the student and faculty pipeline for LLNL. She presented a chart showing the numbers of graduates from various institutions in the LLNL population of scientists, engineers, and postdoctoral scholars. The population was strongly dominated by UC graduates. LLNL valued its relationship with UC, which drove its publication rate and was essential for LLNL to build its capabilities.

LLNL took pride in the honors and recognitions won by its employees and sought to be recognized in the international scientific community. LLNL researchers had won many Department of Energy Early Career Research Program awards.

LLNL had recently launched a long range strategy project, something that took place about every 20 years. The planners involved in this effort were thinking about what LLNL needs to be preparing for 20 years into the future. They were mid-career researchers, and this work allowed them to step out of their day-to-day activities and think strategically about LLNL capabilities, have discussions with government and private sector representatives, and help shape the Laboratory that they will one day run.

Director Budil then discussed LLNL's culture. LLNL prided itself on its culture of innovation and impact. LLNL strives to create an environment that is intellectually challenging as well as welcoming and inclusive. LLNL senior leadership had created a new framework and a set of activities to build LLNL culture. LLNL had conducted a survey of its institutional culture a few years prior. The current activities focused on how LLNL

brought people to the site, recruiting and engaging people in LLNL's work, the local work environment, mentoring, development of supervisory skills to help employees advance in their careers, and a culture of career-long learning. LLNL was reviewing its workforce demographics. Forty-five percent of the current workforce had been at LLNL for less than five years. There had been significant turnover and an opportunity to address the diversity of the workforce. The COVID-19 pandemic had shown that there are many bad ways to communicate, and that it takes time, effort, and purpose to communicate well. LLNL had applied this insight in communicating with its workforce in a personal, engaged way. LLNL would achieve excellence through diversity.

Director Budil concluded her presentation with LLNL's timeline for "return to new normal." LLNL had learned to implement hybrid work arrangements and had put in place a much more flexible policy to enable employees to better balance work and life demands during the pandemic. Much of LLNL's work is hands-on and classified, and many people need to be on site. LLNL was trying to balance these considerations in moving toward its new normal.

Regent Kounalakis thanked Director Budil and applauded LLNL for its focus on energy security and climate change.

Chancellor Hawgood congratulated Director Budil for the collaborative nature of LLNL's work. He recalled that UCSF and LLNL began the ATOM project about four to five years prior, and it had been enormously successful in large part because of the collaborative atmosphere at LLNL. Director Budil had mentioned work on neuroprosthesis; this year, this work had allowed UCSF, for the first time, to be able to literally read the mind of a paralyzed patient and to be able to interpret his intent to speak, and to turn those electrical signals into words on a computer screen. This demonstrated the enormous power of LLNL. The further development of the Livermore Valley Open Campus would allow for further collaboration on site. UCSF looked forward to continued work with LLNL in the future.

Regent Cohen asked how LLNL fostered a culture of collaboration. Director Budil responded that UCSF's partnership had been enormously beneficial to LLNL. She stated that she and her team were focused on trying to take on complex, large-scale problems, and on a scale that no one institution had the capability to do. Built into this was an understanding that partnerships and collaborations are foundational for success. In the realm of biosecurity, LLNL had wondered for years how much expertise it should have in house and how much it should collaborate with outside institutions. Director Budil felt that LLNL had now arrived at a good point where its biosecurity expertise was centered on the unique capabilities at LLNL, and where it was able to build effective partnerships. The partnerships and collaborations, particularly with academic partners, brought in new ideas and energy, and different perspectives on problems, and were exciting for LLNL researchers. LLNL is a government-funded institution and must make the best use of its resources. The way to have an impact on large problems at the scale desired is to find the best researchers and bring them together in different ways. Chancellor Hawgood added that UCSF's partnership with LLNL had transformed what UCSF was capable of doing.

Regent Hernandez congratulated Director Budil on her historic role as the first woman to serve as Director of LLNL. He asked if LLNL had remained at the forefront of defense research, from a national security and Department of Energy perspective, recalling that LLNL and Los Alamos National Laboratory had in the past been regarded as the crown jewels of the National Laboratories. Director Budil responded in the affirmative. LLNL had embarked on the Stockpile Stewardship Program 30 years prior, with only a sketch of the projected capabilities that would be needed: computing at a certain scale, modeling and simulation tools with a certain level of fidelity, a need to better understand the underlying physics, chemistry, materials science, and engineering, and high energy density capabilities. In all these areas, the capabilities in place today at LLNL far exceeded what the creators of the Stockpile Stewardship Program imagined would be possible. Next year would mark the 30th anniversary of the last nuclear test, and LLNL had dramatically expanded its knowledge and toolkit and had trained a new generation of stewards. Director Budil expressed confidence in LLNL's ability to continue to do this work without returning to nuclear testing. This was a story of the success of science and technology in the national security realm. LLNL was continuing to build partnerships and relationships with colleagues, stakeholders, the Department of Energy, the National Nuclear Security Administration, and the Department of Defense.

Staff Advisor Lakireddy asked how hybrid workplace arrangements might help with partnerships and collaborations. Director Budil responded that LLNL had earlier had an unfavorable view of telecommuting and remote work, and only a small fraction of work was done this way. The experience of the pandemic had changed all this. LLNL had thought about what works well. As one example, LLNL had deployed new technologies for communicating both in the open and in classified environments, without the need for travel. The efficiency gained through classified videoconferencing from a desktop computer was extraordinary. The barriers to having dialogues with stakeholders in Washington, D.C. were lower, and this environment was preferable to communication by telephone. This situation had also extended this flexibility to a part of the LLNL workforce that had never had this flexibility before. Professional scientists and engineers at LLNL already had flexibility with work hours, much like academics, but this was not the case for many employees, who often live far from the Laboratory. The experience during the pandemic had shown LLNL that these employees can be productive in the flexible environment, and in many cases, more productive.

Advisory member Powell congratulated Director Budil and her team on the National Ignition Facility experiment she had described earlier, which achieved a yield of more than 1.3 megajoules. This was a profound advance following decades of research and billions of dollars invested in facilities. Professor Powell reported from his own recent experience of serving on committees at LLNL that the pride and energy of LLNL employees was palpable. He asked what LLNL would take on next. Director Budil responded that the ignition experiment would be repeated. The outcome of the experiment had opened a range of opportunities. The next target fusion gain increment was possible. Once this was possible, there was the question of how one could achieve higher yields and begin to use the fusion environment to study different kinds of physics. These were the most extreme conditions available in the laboratory. This achievement opened up scientific and mission-

focused research opportunities and made it plausible to build an inertial fusion energy system. This would not happen soon, but getting through the ignition gateway was the first step. Researchers needed to start thinking about which technology pathways could support this, such as simpler target designs that could achieve these types of yields. LLNL could now carry out one fusion experiment a week; it would probably be necessary to carry out ten per minute for a fusion power plant. There was a significant gap in the required science and technology. LLNL wished to lay the foundations for this program and begin pursuing it in earnest. Director Budil noted that it was necessary to recapitalize and upgrade the LLNL facility. LLNL was working with the National Nuclear Security Administration on resources for maintenance and improvements.

Regent Makarechian asked if there was an estimate of the economic return on investment in LLNL for California and the nation. The whole world would benefit from this work on fusion energy. He asked about patents on these discoveries. Director Budil responded that the question of economic return was interesting and difficult to answer. An entire ecosystem would have to be built around a new type of energy system. There were questions of how one would license a fusion energy power plant and about the support facilities it would need. The economic impact would be large, and it was hoped that the capital costs would be more modest than those needed to build a fission power plant, so that this would be economically viable. With regard to intellectual property and patents, she noted that LLNL carries out a great deal of technology development. LLNL has a number of mechanisms by which it either shares intellectual property or licenses it to other organizations. In collaborations, LLNL typically works out arrangements regarding intellectual property at the beginning of the relationship, the matter of who owns what. This was a significant part of the negotiations as the ATOM partnership was launched. ATOM brought together large pharmaceutical companies, universities, National Laboratories, and two different government agencies, and this raised many questions about the role of each partner. LLNL often licenses technologies; sometimes LLNL researchers license technologies and take them out of LLNL to start companies. There were various models for this. LLNL researchers who participate in technology development and licensing activities receive royalty income on patents, and the Laboratory receives a small share of licensing and royalty income. LLNL has had a number of significant “hits” in technology in its history, in a wide variety of fields. The U.S. government expects LLNL to ensure that the public benefits from LLNL research, and LLNL takes its licensing and technology transfer activities seriously.

Regent Makarechian where the investment return dollars go, whether to the Department of Energy, to other entities, or to LLNL for future use. Director Budil responded that a small share stays with LLNL, a small share goes to the researchers, and the rest to the company that licenses the intellectual property.

Regent Makarechian stated that, if the extraordinary energy experiments at the National Ignition Facility proved successful, no one could put a value on this. Director Budil concurred.

Provost Brown congratulated Director Budil on signing her first annual assessment letter and emphasized the tremendous responsibility of LLNL for national security with this certification. He asked if there were ways that UC could better partner with LLNL on talent development. Director Budil responded that UC could play an important role for LLNL. LLNL was already engaged in leadership development work with the Haas School of Business at UC Berkeley. The collaborative work with UC campuses was critically important. LLNL recently had a discussion with the Vice Chancellor for Research at UC San Diego about joint appointments. LLNL recruits in a very competitive environment and wishes to recruit employees who would stay and build a career. The opportunity for LLNL employees to collaborate with the campuses and to mentor students, and the possibility of meaningful joint appointments, was very important. As part of its work for the national security mission, LLNL transmits confidence to its stakeholders in the U.S. government, confidence that LLNL's judgments are sound and that evidence supports LLNL assessments. Confidence came from the credentialing process for LLNL experts. Having Laboratory employees work with the best people in the field and demonstrate their judgment in scientific problems was part of this process of transmitting confidence in the quality of LLNL experts and the soundness of their judgment. The relationship with UC was a critical part of this. The UC system offered LLNL many rich opportunities to expand the network of partnerships and collaborations.

Regent Estolano praised Director Budil and LLNL for the "Getting to Neutral" report for California's climate strategy. This document demonstrated the value of the National Laboratories as part of the UC system in moving forward California's leadership in this area. She had visited the Livermore Valley Open Campus and was struck by the forward-looking approach to industry partnerships and the potential for shared resources. She asked if people were moving into the new office spaces and the Advanced Manufacturing Laboratory or were still working remotely. Director Budil responded that the Advanced Manufacturing Laboratory was at work, and the space was largely filled with partners. Industry was bringing new tools and technologies to LLNL and working with LLNL on bringing technologies to market. The Open Campus made these efforts easier, without barriers to access. She expressed satisfaction at the new office building and was excited about plans for further development and activities on the Open Campus.

Regent Estolano commented that the City of Livermore would also experience benefits from the presence of the Open Campus. This was an example of what UC and the National Laboratories can do to spur economic development in California.

The meeting adjourned at 5:15 p.m.

Attest:

Secretary and Chief of Staff