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to
Hearing of the Committee on Homeland Security
Subcommittee on Cybersecurity, Infrastructure Protection,
and Security Technologies
U.S. House of Representatives

The DHS and DOE National Labs: Finding Efficiencies and Optimizing Outputs in Homeland Security Research and Development

April 19, 2012

Introduction and Summary

Good morning Chairman Lungren, Ranking Member Clarke, and the distinguished members of the Committee. Thank you for the opportunity to testify before you today on the critically important relationship between the Department of Homeland Security (DHS) and the Department of Energy (DOE) National Laboratories.

I am Dr. Michael Carter, currently a Senior Scientist at Lawrence Livermore National Laboratory (LLNL). In 2002 I had the privilege to serve as a technical advisor to the DHS Transition Planning Office and served as the first Director of Radiological and Nuclear Countermeasures in DHS S&T Directorate (DHS S&T) and subsequently as the Deputy Director of the Domestic Nuclear Detection Office (DNDO). I returned to Livermore in 2006 and have since served in multiple capacities including the Program Director for Counterterrorism Programs at LLNL. The recommendations I provide are based on my experience and knowledge gained from these activities.

DHS has been tasked with a very broad mission including the responsibility for homeland defense against determined and adaptive adversaries and preparation for and response assistance to natural disasters. "Making the Nation Safer," a National Academy of Sciences report prepared soon after the events in 2001, stated *"strengthening the national effort in long-term research that can create new solutions should be a cornerstone of the strategy for countering terrorism."* This need for long-term research prompted the establishment of an S&T Directorate within DHS.

The DOE National Laboratories—principally the National Nuclear Security Administration (NNSA) laboratories (Livermore, Los Alamos, and Sandia) and two Office of Science laboratories (Oak Ridge and Pacific Northwest)—have provided critical support to the DHS S&T over the past decade. Their focus has been on S&T development to tackle some of our nation's most difficult challenges, which are typically longer-range than the immediate day-to-day operational issues facing DHS. I will highlight in my testimony examples involving efforts at LLNL.

As the tenth anniversary of the founding of DHS approaches, I look ahead with concern. Determined and adaptive adversaries—now and in the future—pose some truly drastic threats to our nation which we currently have no way to stop, inadequate means to mitigate the effects, and insufficient concerted investment in S&T to devise systems and technologies to improve our defensive and responsive capabilities. The nation would greatly benefit from increased DHS attention to sustained, focused investments in S&T to address threats such as an engineered or emergent biological pathogen and a smuggled improvised nuclear device. These are examples of specific areas where the DOE National Laboratories are prepared to deliver unique S&T support to our national security. However, in response to changing priorities and reduced resources, the funding from DHS to LLNL has decreased from its peak in FY 2006 of $131M to an estimated funding level of $40M in FY 2012.

I believe that the DOE National Laboratories are well suited to shoulder responsibility for providing research and development (R&D) to counter serious homeland security threats. DHS reliance on the capabilities of the DOE Laboratories is a workable, effective answer to a pressing national need. I base this recommendation on four points:

- *Solving hard, enduring S&T problems*. The DOE National Laboratories were established to serve the national interest by solving challenging S&T problems best tackled by multi-disciplinary teams using state-of-the-art research capabilities. Many of the challenging S&T issues facing DHS fall into this category. Overcoming these challenges will require sustained investment in R&D suitable for the DOE National Laboratories and aligned with their national security mission.

- *Leveraging existing S&T investments*. The DOE National Laboratories perform considerable work for federal sponsors in mission areas closely aligned with those of DHS, develop technologies that can be adapted to DHS missions, and/or have special research capabilities that can be applied to unique DHS mission needs. It is advantageous and cost effective for the nation and DHS to leverage these previous investments.

- *Providing an S&T expertise base focused on homeland security issues*. Working with diverse set of law enforcement and emergency response agencies, DHS has unique needs for S&T solutions that fit within their operational requirements. This calls for the S&T professionals supporting DHS to understand its operational needs, help shape requirements, and execute R&D programs to meet DHS mission challenges. These S&T professionals would also be available to provide technical assistance to support ongoing operations and prepared to assist the Department's response to a terrorist event or natural disaster.

- *Developing trusted partnerships.* DHS would benefit from an enduring relationship with FFRDCs that understand their unique operational requirements and can serve as "honest brokers" and trusted partners. The DOE Laboratories are also natural partners in establishing and sustaining a pipeline of young scientists and engineers

emerging from our Universities interested in careers in S&T dedicated to national security missions. The Laboratories have served these roles for the DOE since their creation.

These benefits were implicitly recognized by the Homeland Security Act of 2002, which established the Department and set the foundations for DHS S&T through the transfer of funding, responsibility, and key technical capabilities to counter nuclear and biological terrorism from DOE to DHS. The Homeland Security Act also authorized DHS to establish contracts with one or more federally funded research and development centers (FFRDCs) to carry out its responsibilities. Congress specifically authorized multiple methods, including a joint sponsorship agreement, for DHS to utilize the DOE National Laboratories. The examples I provide demonstrate that the partnership between DHS and the DOE National Labs has proven vital in leveraging the nation's S&T capabilities to protect the homeland. This partnership needs to be rejuvenated and continued.

Bio Security

In the immediate aftermath of 9/11 and the anthrax attacks, the DOE National Laboratories were called upon to provide the technology for the nation's biosecurity program. They were ready to do so because the underlying technical foundation for the Biowatch program was in place. The technology development for Biowatch started through Laboratory Directed Research and Development (LDRD), an internal investment program at the DOE Laboratories targeting exploratory S&T to meet current and emerging mission needs. Scientists at the Laboratories recognized Biosecurity as a critical national security need and pioneering work began on the technology for rapid agent detection via polymerase chain reaction methods (PCR) in the 1990s. The LDRD work led to program support from NNSA's Office of Non-Proliferation Research and Development's Chem/Bio program.

Thanks to exploratory investments and the existence before 9/11 of a DOE program focused on a critical national security need, these DNA-based PCR detection methods quickly became available and have demonstrated the capability to detect, identify and characterize a threat organism in less than an hour. Detection systems have now operated for almost a decade, analyzing more than a million samples without a false alarm. Biowatch samplers are now located in more than 30 U.S. cities monitoring for the early signs of bioterrorism enabling early treatment and intervention.

The DOE Laboratories continue to lead the way in the development of advanced assays and DNA-based detection methods by leveraging their expertise in microfluidics and bioinformatic analysis of DNA sequences utilizing high-performance computing. Researchers have developed massively parallel, high-density DNA microarrays able to detect thousands of potential viruses and bacteria. This capability provides the potential for the detection and identification of previously unknown pathogens by searching for similarities in genetic sequences of known pathogens. Advances in detection technology funded by DHS S&T also provide benefit to the public health community. These DNA

microarray-based detection methods have been used to identify a contaminating pig virus in a human vaccine for rotavirus.

In 2004, DHS S&T established the Biodefense Knowledge Center (BKC) at LLNL to develop and deliver knowledge products critical for anticipating, preventing, characterizing, and responding to an attack using biological warfare agents. BKC personnel have authored dozens of rapid-turnaround analyses and in-depth threat and capability-based technical assessments on biodefense topics; published awareness bulletins focused on technical analysis of the potential for nefarious uses of biotechnologies; and developed information management tools that provide unique knowledge discovery capabilities for biodefense analysts nationwide. They have also authored 12 Material Threat Assessments, 26 Awareness Bulletins, 55 agent-specific factsheets; published a biothreats agent factbook; and responded to more than 100 technical reachback requests from DHS and other operational entities. In addition, the BKC maintains an information system at three security levels with more than 34 million documents from a wide variety of government sources.

More recently, under sponsorship from DHS S&T, the BKC has partnered with the U.S. Customs and Border Protection (CBP) Agricultural and Biological Terrorism Countermeasures (ATBC) Program to develop improved methodology to intercept suspicious enabling biological material and equipment that could support bioterrorism. This new capability has been integrated into the Automated Targeting System for routine use at the National Targeting Center and will be accessible to all 22,000 CBP Officers at our nation's ports of entry. This successful partnership between CBP and the BKC was acknowledged in a commendation letter from then Assistant Commissioner Thomas Winkowski to DHS S&T. Mr. Winkowski specifically called out the need to "further build this partnership, one that bridges science and law enforcement, to undertake the daunting tasks and vital work that remain in preventing ag/bio-terrorism."

Nuclear Security

In the aftermath of 9/11, nuclear terrorism emerged as a top threat to our national security. Early assessments identified key weaknesses in the technology base for detecting and interdicting a smuggled nuclear device, including the ability to robustly detect shielded nuclear material at our borders. DHS S&T developed an R&D roadmap to improve the radiation detection technology base with particular focus on the operational needs of the DHS components. This roadmap identified the need to develop better gamma and neutron detection methods to dramatically improve detection sensitivity and reduce false alarms from other radioactive but non-threatening materials. Because of the classified nature of nuclear weapons, the fundamental understanding of the signatures of special nuclear material and nuclear weapons resides primarily at the DOE/NNSA Laboratories (Los Alamos, Livermore and Sandia). These Laboratories therefore played a key role in developing the R&D roadmap and investigating potential solutions to improve detection systems performance.

The Nuclear Security R&D programs that began almost a decade ago are beginning to bear fruit with the development of new detector materials and detection methods. These new materials provide dramatic improvements in affordability, operational utility, and effectiveness in detecting and discriminating materials that could be part of a weapon from other radiation sources. In particular these more effective radiation detection materials enable the next generation of hand-held detection systems for secondary inspections at our ports of entry. New detection methods and advances in signal processing enable significant improvements in detection and identification of threat materials and significant reductions in false alarms rates. DHS DNDO has also supported R&D on alternative neutron detection methods in response to the worldwide shortage of Helium-3 used for conventional neutron detection systems.

The R&D has resulted in dramatic improvement in detection and identification capabilities, but major challenges remain. However, resources for the DNDO's Transformational and Applied R&D program have been significantly reduced in the last two years and a focus on near-term solutions has replaced attention to the enduring challenges of standoff detection and detection of shielded materials. Agencies such as the DOE and DoD continue to pursue R&D in radiation detection but this research is often directed toward a set of requirements that do not necessarily fit DHS operational needs. DHS, DOE, DoD, and the Director of National Intelligence (DNI) work closely together to leverage scarce R&D resources to meet urgent needs in domestic nuclear security but in order to ensure effective technology development and deployment, DHS must sustain an R&D program focused on the unique operational requirements of the Department and its stakeholders.

The National Laboratories have also played a key role in training and supporting DHS operational elements in their front-line role of detection and interdiction of nuclear material. Working closely with CBP, DNDO established a technical reachback network at the Laboratories with trained scientists available for technical assistance to front-line law enforcement officers 24 hours a day. This reachback support network has fielded hundreds of support requests and continues to work with DNDO, CBP and other DHS entities to support and improve the alarm adjudication processes. DOE Laboratory scientists bring a unique understanding of the signatures of nuclear materials and weapons as well as experience with the detection technologies deployed in the DHS operational environment. The training and technical support network will be critical if and when we are faced with our first domestic nuclear smuggling event.

Scientists and engineers at the National Laboratories have also worked with DNDO in creating and assessing the Global Nuclear Detection Architecture (GNDA). This global view of the radiation detection systems deployed both domestically and internationally enables considered assessments of the capabilities and vulnerabilities in our collective abilities to detect and interdict a nuclear terrorist attempt. Working with partners across the interagency the Laboratories have supported the integration of this network of systems and, through detailed technical assessments and operational analysis, have developed options to expand the deployed detection architecture to further reduce the risk of nuclear terrorism. Understanding the signatures of nuclear materials and the

operational effectiveness of deployed systems and inspection processes is key to an "honest broker," independent assessment of the capabilities and gaps of the GNDA. LLNL is now developing a searchable database and visualization system to help DNDO visualize and interrogate the GNDA and provide enhanced insight into detection assets worldwide.

The National Laboratories are uniquely positioned to perform such systems analysis in support of DNDO and its interagency partners. LLNL, in particular, has played a critical and unique role in support of DNDO's red team efforts. LLNL has partnered with DNDO in understanding the nuclear threat space, designing and developing surrogates for the key nuclear signatures, planning and executing red-team operations, and developing lessons learned. This program has successfully worked within DHS and across the interagency bringing credible, independent assessment of technology and field operations dedicated to detection and interdiction of nuclear smuggling.

Another example of a successful partnership model is the National Technical Nuclear Forensics Center (NTNFC) within DNDO. The NTNFC has two major roles: acting as the lead for interagency coordination in the nuclear forensics arena and supporting a wide variety of expertise-based programs including exercise development and planning. These programs include the Nuclear Forensics Science Panel, the Federal Expertise Development Program, and pipeline development activities (e.g., university fellowship programs). NTNFC leadership is clearly committed to their mission and has worked to create strong partnerships across the interagency as well as with the DOE Laboratories that provide the enduring technical capabilities that support the mission.

This success, however, is limited. While the NTNFC plays a key coordination role, the center is not a majority stakeholder in the forensics community, either in budget or scope. This limits their ability to affect the priorities of their interagency partners including the FBI, DOE, DoD, and the DNI. Efforts have been made to create a coherent set of requirements for both pre- and post-detonation nuclear forensics, but local priorities at each agency still have a strong influence on how they expend their resources. The DOE Laboratories act as integrator, working across this space, but often without the integrated programs to invest in the required laboratory infrastructure, drive innovation, and solve grand challenge problems.

Aviation Security and Explosives Countermeasures

In response to the liquid explosives threat in London in 2006 and the prospect of a broad suite of homemade explosives threats, DHS turned to the DOE Laboratories within NNSA, which have a deep scientific understanding of explosives stemming from 60 years of work in the nuclear weapons program and other DoD missions. These Laboratories are home to an extensive experimental infrastructure and a multi-disciplinary scientific and engineering staff with expertise in development and characterization of explosive compounds, explosive detection, modeling and simulation of explosive properties using high-performance computing, and assessment of explosive effects.

Livermore's High Explosive Applications Facility (HEAF) is one example of a $100-million facility, constructed for and operated by the LLNL's nuclear weapons program, that supported activities focused on the improvised explosive device threat to aviation security. Researchers in HEAF and other similar facilities at Los Alamos National Laboratory and Sandia National Laboratories teamed together to provide technical support to DHS. The Department sought to establish guidelines for allowed liquid quantities through passenger checkpoint screening and enhancement of technology and screening protocols for both checked baggage and passenger screening.

Scientists at HEAF have formulated hundreds of homemade explosive compounds (HMEs), characterized their explosive properties, and evaluated their potential risk to aviation security. LLNL has also tested explosive screening technologies to understand and improve their detection performance against a broad array of military-grade and homemade explosive materials. In DHS S&T-sponsored Project Newton, the Laboratories are developing structural models of aircraft and the evaluating the effect of explosive blasts on the structure to determine the mass of conventional high explosives required for catastrophic damage. Laboratory characterization of HME properties are then used to establish the equivalent mass of different HMEs that would result in the same level of catastrophic damage. This work at the DOE/NNSA Laboratories complements live-fire aircraft testing, detection development, and certification testing done at the DHS Transportation Security Laboratory. This R&D supporting DHS S&T and the Transportation Security Administration (TSA) has had significant impact protecting the nation's aviation infrastructure and passengers from ever-evolving terrorist tactics.

The DOE/NNSA Laboratories have also worked with DHS S&T, TSA, and several mass transit agencies across the nation to secure mass transit systems from asymmetric attacks using high explosives. The Laboratories have assembled multi-disciplinary teams of structural engineers, computational scientists, physicists, mathematicians, and statisticians to assess vulnerabilities and mitigation methods. This work includes system-wide vulnerability assessments, non-destructive and destructive analysis of construction materials and methods, simulation of explosive properties and potential failure modes, and development and deployment of solutions that significantly reduce system vulnerabilities. These DHS-sponsored programs have resulted in improved measures to ensure public safety and protect billions of dollars of infrastructure at a cost of a few tens of millions of dollars in security and safety enhancements.

Need for Enduring Partnerships

In each of the programs above, a key enabler to success is partnership between the federal program managers and the scientists and engineers at the National Laboratories. In the decade since 9/11, these partnerships have made critical contributions to the nation's homeland security efforts. The DOE National Laboratories have deep technical capabilities, particularly in the area of countering weapons of mass destruction, which are key to the DHS efforts to develop effective, sustainable countermeasures against the

threats of WMD. The Laboratories have established extensive capabilities in high-performance computing, precision measurement science, nuclear and radiological materials, high explosives, and modeling and simulation expertise, which would not be affordable otherwise. These technical capabilities are a direct result of investments made by multiple government agencies, as well as investments from the Laboratories themselves in directed R&D programs to address key national security priorities. Because of these and other investments, DHS's programs are highly leveraged.

In our most successful programs, our scientists and engineers work with DHS to understand the threat space, develop an understanding of the operational requirements, evaluate alternatives, research and develop technology, test potential solutions in an operational environment, provide training and operational support to front-line operations, and develop lessons learned. These end-to-end programmatic partnerships have near-term impact and provide a basis for sustainable mission roles for the Laboratories. The National Laboratories can bring unique, core capabilities to bear, partner with DHS, develop technical solutions to difficult national security challenges and develop a dedicated, knowledgeable workforce focused on mission success.

The nation would be best served if the relationship between DHS and the DOE National Laboratories were more than just a contractual relationship. A partnership with joint, enduring commitment between DHS and the DOE Laboratories would ensure focusing the Laboratories' expertise and unique capabilities on S&T needs for homeland security with requisite sustained support from DHS. Reducing the risk of WMD requires a sustained effort to develop effective solutions, which in turn, require the mission-focused research, development, testing, and evaluation that the DOE National Laboratories offer. The combination of the right technologies, in the hands of a trained, equipped and supported front-line workforce will be a key component of interdicting or responding to the WMD threat.

What's Facing Us Now?

Concurrently, the nation is facing serious federal budget issues and a dangerous, evolving WMD threat. As Congress and the Executive Branch work to tighten Federal discretionary expenditures, we as a nation must not lose sight of the requirements to protect the homeland against the threats of catastrophic terrorism. The nature of the WMD threat, especially biological terrorism continues to evolve and our ability to counter it lags further and further behind.

At the same time, the threat grows more formidable and more sophisticated. Recent trends in explosive threats to commercial aviation have demonstrated that our adversaries adapt to our deployed countermeasures. Recent work on genetic modifications to pathogens such as the H5N1 virus highlight the increasing risk of an engineered pathogen deliberately or accidently introduced into the environment. DHS efforts to develop technologies for early detection and characterization of emergent pathogens are critical to our ability to stay ahead of the threat. An attack using an engineered biological agent or a

smuggled nuclear device would result in human and economic consequences that are orders of magnitude more severe than anything we have experienced to date.

To be successful in protecting the homeland, DHS must be ahead of the evolving threats and adaptations of our adversaries. Effective and enduring solutions are science-based, intelligence-informed, and developed with the DHS end-user community requirements in mind. Enduring solutions to difficult problems take time to mature. The typical technology maturation times from the beginning of an R&D program to the transition to the operational community can often be more than a decade.

Concluding Remarks

The threat of the use of WMD, rather than fading with time, is growing more serious; yet, the focus on the S&T required to effectively counter the WMD threat has eroded. Since the stand-up of DHS, DOE no longer provides R&D funding to the National Laboratories in chemical, biological, and explosives countermeasures. There is increasing downward pressure on S&T resources within DHS as focus turns to near-term technology gaps in the day-to-day operational missions of the Department and its stakeholders.

DHS and Congress should not lose focus on the difficult challenges in protecting the homeland from the threat of WMD. I believe DHS should partner with the DOE National Laboratories as FFRDCs to meet critical national needs in homeland security. The Laboratories have demonstrated that they bring unique, specialized S&T capability and expertise to the mission. In particular, DHS should:

- Utilize the DOE National Laboratories for enduring, difficult problems where multi-disciplinary teams are required to anticipate, innovate, and deliver solutions to meet the most demanding DHS mission needs

- Work with the DOE National Laboratories as FFRDCs and enable program partnerships which bring together the operational elements of DHS with the S&T workforce from the National Laboratories to better ensure technology development focused on the Department's unique requirements

- Leverage investments in the DOE National Laboratories made by other sponsors (DOE, DoD) and adapt technology to Homeland's unique mission requirements

- Develop a sustainable, mission-focused set of homeland security S&T professionals with deep understanding of the DHS operational environment and solutions that can be incorporated into the homeland security operations and culture

By strengthening the partnerships between DHS and the DOE Laboratories, we will be able to better serve the mission of DHS to defend the homeland. I encourage this Committee's continuing support of S&T activities supporting the DHS mission, and I thank you for the opportunity to testify before the committee.