



WE DO THE SCIENCE

# Office of National Laboratories

Harnessing a Network of Laboratories to Meet  
Tomorrow's Homeland Security Challenges



**Homeland  
Security**

Science and Technology





*"There is established within the Directorate of Science and Technology an Office for National Laboratories, which shall be responsible for the coordination and utilization of the Department of Energy National Laboratories and sites under this section in a manner to create a networked laboratory system for the purpose of supporting the missions of the Department."*

Homeland Security Act of 2002 (P.L. 107-296, Section 309 (a) November 25, 2002)





## Letter from the Director



I am pleased to present an overview of the work we do at the Department of Homeland Security (DHS), Science and Technology (S&T) Directorate, Office of National Laboratories (ONL). Our dedicated ONL team manages the Department's use of its research, development, test and evaluation (RDT&E) laboratories and the Department of Energy (DOE) National Laboratories' infrastructure, technical expertise and capabilities. Our work brings significant value to the homeland security mission space.

First, ONL offers a centralized laboratory-based RDT&E function for DHS through a network of five in-house laboratories, along with access to auxiliary laboratory capabilities. Together, these RDT&E laboratories provide technical expertise, infrastructure and core capabilities in the areas of chemical, biological, radiological, animal disease, explosives detection and mitigation, and first responder focus areas.

Second, S&T's laboratories often serve as the first stop for portfolio and program managers as they plan to address customer requirements. Each S&T laboratory aligns strategically to the enduring mission needs of the Department. Our independent, yet mission-aligned support is crucial to satisfy the RDT&E requirements of DHS operational components and Homeland Security Enterprise (HSE) customers. We seek out, maintain and leverage our own networks of interagency partnerships that provide proximate laboratory capabilities to make sure we can always meet component needs.

Third, S&T's labs provide indispensable RDT&E capabilities that address DHS strategic mission priorities and homeland security challenges—from opioids to coronavirus and most points in between. S&T's laboratories require dedicated resources to maintain modern capabilities and strategic investment in their infrastructure to support the dynamic DHS mission. Whether the mission need requires threat characterization, detection, response or mitigation, S&T's laboratories provide technologies and knowledge to help prevent terrorism and enhance security, while making major contributions to secure and manage our borders and strengthen our national preparedness and resilience. Our responsibility is to deliver the most impactful solutions to directly address our customers' needs. Everything we do has a direct and measurable impact on the agents and officers on our borders, in our air and seaports of entry, and for the countless first responders throughout the nation.

I look forward to sharing with you the capabilities offered by ONL and showcasing how our network of laboratories delivers critical solutions that make a positive impact on the security of our nation.

Julie S. Brewer

Director, Office of National Laboratories







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# Introduction

## WHO WE ARE

Our extensive network enables the United States' brightest scientists and engineers to apply their expertise and develop solutions that address our most dangerous threats and homeland security vulnerabilities.

**Our Mission:** Enable DHS S&T's solution delivery through a coordinated network of laboratories, providing technical expertise and RDT&E capabilities to deliver timely solutions and support departmental acquisitions.

**Our Vision:** Achieve a safer and more resilient nation through an integrated homeland security-based laboratory network.

**Our People:** Dedicated public servants and support staff who bring determination and focus to the mission.



## WHAT WE DO

### Our Role in Helping to Secure the Homeland

Whether operating in times of calm, preparedness, crisis or response, our new reality is that American scientific and technological know-how must exist on the cutting edge of innovation and produce capabilities that match current and future needs.

ONL embraces its centralized role with all laboratories that provide developmental assistance for products and solutions to support the homeland security community and keep our country safe. ONL is arranged into two branches that work collaboratively with the laboratories and key stakeholders to deliver vital science and technology capabilities.

Our Utilization Branch facilitates the effective use of our five in-house RDT&E laboratories and their capabilities located across seven sites, the Department of Energy (DOE) National Laboratories and other auxiliary RDT&E capabilities and technology transition activities. The branch is a driver for S&T in setting the laboratories' research agendas and assuring continuity of capabilities; establishing, managing and maintaining strategic partnerships; leading strategic alignment initiatives; and representing ONL on technology and science interagency working groups.

Our Operations Branch provides oversight for the five S&T laboratories and sites to make sure they remain primed and equipped to fulfill mission needs. It fills a vital role by ensuring that each laboratory operates in a safe and secure manner compliant with federal, state and local regulations. The branch plans and budgets the resources to provide a range of capabilities that include: physical facilities and support structures, federal staff, management and operations, contractors, equipment, information technology, safety and security and other laboratory support needs. An adequate and sustained level of Procurement, Construction and Improvements (PC&I) funding is necessary to install modern and reliable equipment at the S&T labs. This PC&I funding allows S&T's lab-based infrastructure to maintain modern capabilities at all S&T laboratories and sites and to remain responsive to DHS operational components' mission needs.

## OUR CAPABILITIES

Our S&T laboratories align to the homeland security mission space by providing the following support:

- 24/7 technical assistance and timely products crafted by subject matter experts that deliver the knowledge necessary to help plan for and respond to chemical threats
- 24/7 bioforensic analysis and biological threat characterization
- Test and evaluation of tools for first responders
- Diagnostics and vaccines for foreign animal diseases (FADs)
- Detection of explosives and other contraband at transportation hubs



## OUR PARTNERSHIPS

Our relationships with the DOE National Laboratories and numerous other departments and agencies position ONL as the connective tissue for laboratory engagement across the government and allow DHS to scale laboratory capabilities quickly and effectively. Examples of homeland security- oriented research conducted through ONL's coordination with laboratories and partners include:

- Critical infrastructure/protection analysis
- Radiological and nuclear countermeasures
- Chemical, biological and nuclear forensics
- Multi-scale modeling and simulation
- Explosives detection and mitigation
- Test and evaluation for first responder technologies
- FAD research, diagnostics and training
- Cybersecurity research
- Biodefense countermeasures, biodetection capabilities and preparedness



## OUR IMPACT

### We Identify Efficiencies in Delivering Laboratory Capabilities to Meet Mission Needs

We effectively manage use of our S&T laboratories in tandem with DOE laboratory capabilities to adapt the right technologies to mission requirements and inform investment decisions. These efforts maximize DHS's return on equity by making effective use of assets and prior investments to minimize costs, while accelerating the use of mission-required technologies.



*NUSTL conducts an operational field assessment (OFA) focusing on the comfort, usability and breathing resistance of the prototype filter module developed by DHS S&T to provide respiratory protection for firefighters during overhaul operations. A NUSTL engineer collects assessment results and records observations.*

### We Contribute Knowledge, Science and Technology to Solve Problems

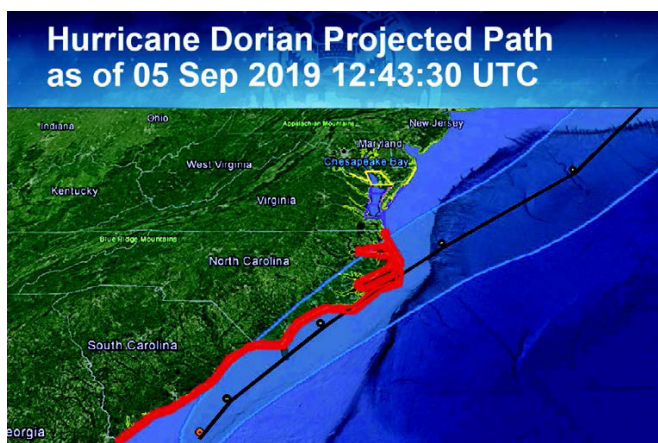
The S&T laboratories help the homeland security community convert technologies, research and knowledge to operational status through the development of cooperative research and development agreements (CRADAs), patents, publications and other means. The S&T laboratories use CRADAs to establish partnerships with industry, academia and others to transfer technology to the commercial sector for wide use. For example, the TSL established more than 50 CRADAs, resulting in the maturation and implementation of emerging explosives detection technologies, including automated threat detection, advanced imaging technology, improved checked baggage and carry-on baggage systems and bottle screening technology.



*Exterior view of aircraft explosive testing simulator during test conducted by TSL.*

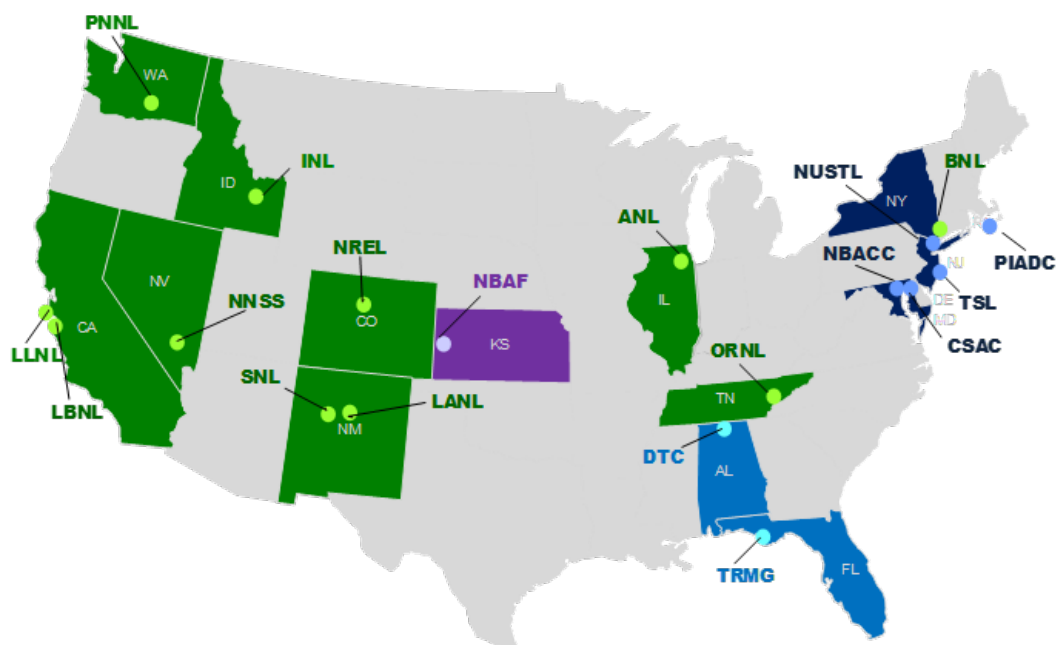
### We Provide Rapid Response for Emergent Needs

Our networked laboratory capabilities provide rapid response to members of the homeland security community that require time-sensitive information and immediate support through relevant knowledge, tools and facilities. For example, the CSAC supports various government agencies and other organizations with 24/7 expert analysis in emergencies or incidents involving chemical threats and hazards. This consists of hazard analyses of chemical facilities located within hurricane impact zones, among many other applications.



*CSAC played a vital role in the DHS response to Hurricane Dorian. The lab provided critical chemical facility information and analysis of toxic chemical hazards and risks for over 2,000 chemical facilities in Florida and the southeastern U.S., Puerto Rico and the Bahamas.*

## DOE AND DHS S&T LABORATORY FACILITIES



### DOE National Laboratories:

- Argonne National Laboratory (ANL) – Lemont, IL
- Brookhaven National Laboratory (BNL) – Upton, NY
- Idaho National Laboratory (INL) – Idaho Falls, ID
- Lawrence Berkeley National Laboratory (LBNL) – Berkeley, CA
- Lawrence Livermore National Laboratory (LLNL) – Livermore, CA
- Los Alamos National Laboratory (LANL) – Los Alamos, NM
- National Renewable Energy Laboratory (NREL) – Golden, CO
- Nevada National Security Site (NNSS) – Nye County, NV
- Oak Ridge National Laboratory (ORNL) – Oak Ridge, TN
- Pacific Northwest National Laboratory (PNNL) – Richland, WA
- Sandia National Laboratories (SNL) – Albuquerque, NM

### DHS S&T Laboratories

- Chemical Security Analysis Center (CSAC) – Aberdeen Proving Ground, MD
- National Biodefense Analysis and Countermeasures Center (NBACC) – Fort Detrick, MD
- National Urban Security Technology Laboratory (NUSTL) – New York, NY
- Plum Island Animal Disease Center (PIADC) – Orient Point, NY
- Transportation Security Laboratory (TSL) – Atlantic City, NJ

### TSL Homemade Explosives (HME) Capabilities and Sites

- Detection Technology Center (DTC), located within the Terrorist Explosive Device Analytical Center's Improvised Explosive Detection (TIEDS) Center – Huntsville, AL
- S&T Tyndall Reactive Materials Group (TRMG) – Panama City, FL

### Construction and Commissioning

- U.S. Department of Agriculture (USDA) National Bio and Agro-Defense Facility (NBAF) – Manhattan, KS



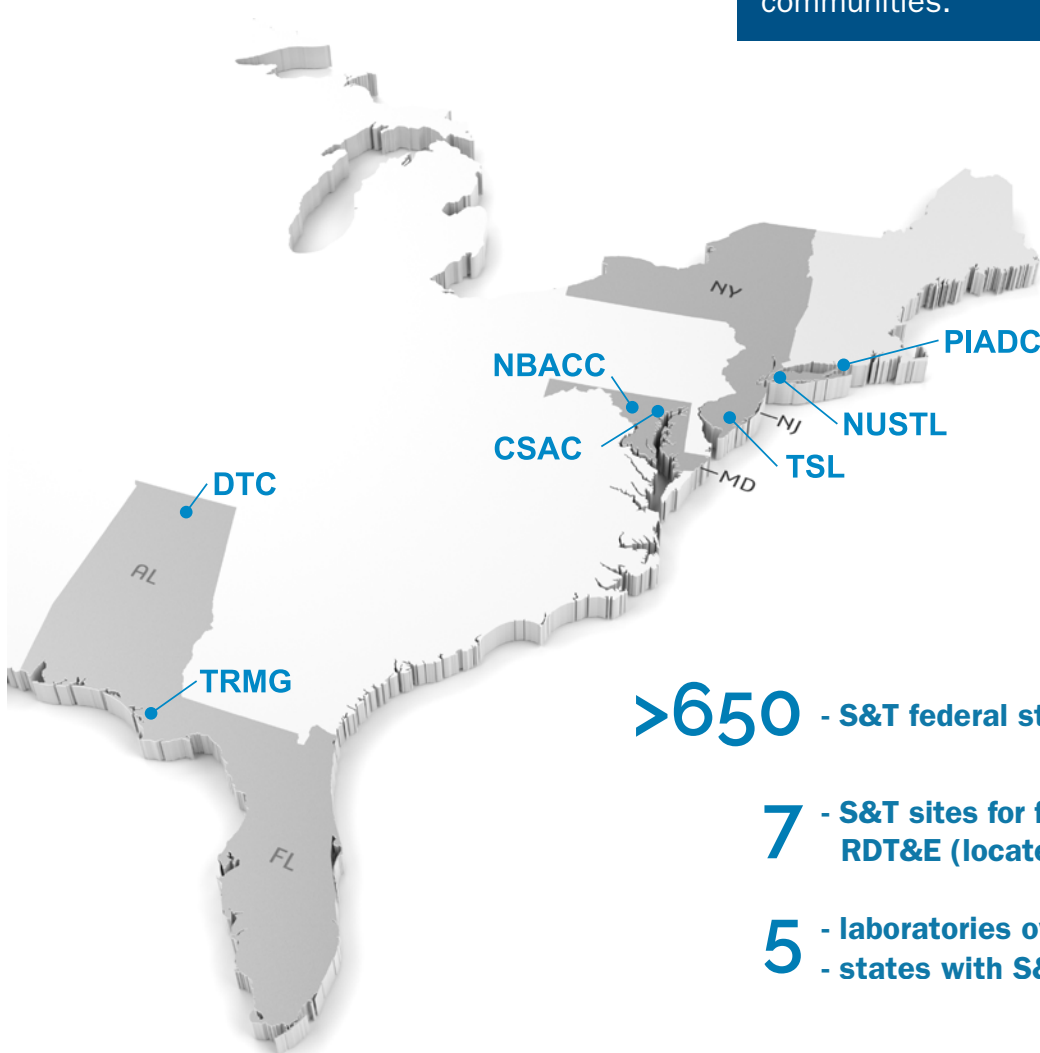
# S&T's RDT&E Laboratories

## Providing Resources to Address Homeland Security Vulnerabilities

The S&T laboratories provide specialized technical expertise and world-class research facilities to DHS and its partners. These facilities support a diverse portfolio of capabilities to serve DHS and the extended homeland security community.

## DID YOU KNOW?

More than 650 federal and contract positions support the five S&T laboratories and related sites. These labs and sites serve as centers of gravity for science, technology, engineering and math (STEM) professions in each of their local communities.



**>650** - S&T federal staff and contractors

**7** - S&T sites for facility-based laboratory RDT&E (located in AL, FL, MD, NJ, NY)

**5** - laboratories owned and operated by S&T  
- states with S&T laboratories and sites



## CHEMICAL SECURITY ANALYSIS CENTER (CSAC)



*The CSAC main building.*

Established in 2006, CSAC is the nation's only federal studies, analysis and knowledge management center for characterizing and assessing the threats and hazards associated with an accidental or intentional large-scale chemical release event or attack in the U.S.

CSAC provides an enduring science-based threat and risk analysis capability with a core focus on chemical risk and consequence modeling, analytical chemistry, chemical toxicology, synthetic chemistry and chemical informatics.

CSAC services the broader HSE and stakeholders by maintaining a technical assistance program staffed and available 24/7 to provide operational support and subject matter expertise; designing and executing laboratory and field tests; and providing a comprehensive knowledge repository of chemical threat information that is synthesized and continuously updated with data from scientific, intelligence, operational and private-sector sources.

Located in the Edgewood Area of Aberdeen Proving Ground, Maryland, CSAC fosters research collaborations with the U.S. Army Combat Capabilities Development Command Chemical Biological Center, Department of Defense, Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense, the U.S. Army Medical Research Institute for Chemical Defense and the U.S. Army Public Health Center.

### Chemical Consequence and Threat Modeling

CSAC provides chemical analysis for decision makers to know the threat, understand consequences, weigh options and take action to limit the impact of an accidental or intentional chemical event.

### DID YOU KNOW?

In August and September 2019, CSAC supported national hurricane response, providing chemical facility information and analyses of the toxic chemical hazards and risks within the potential hurricane impact zones. CSAC conducted assessments and analyses of over 2,000 chemical facilities in Florida and the southeastern United States, Puerto Rico and the Bahamas, providing critical facility information and hazard analysis. CSAC also participated in DHS Emergency Support Function #14 – Long-Term Community Recovery, through Business and Critical Infrastructure Cross Sector conference calls and technical analysis for community and recovery planning support.

### 24/7 Technical Assistance

CSAC is available for immediate, complete, accurate and actionable S&T-based chemical threat and hazard expertise in support of incident response, ongoing operations and requests for information.

### Chemical Hazard Analysis

**Daily Reports:** CSAC produces curated clips from news articles and provides them to DHS operational components and homeland security stakeholders. These reports focus on the chemical security mission space and are based on a review of global and domestic press and media.

**Weekly Reports:** CSAC develops a synopsis of chemical intelligence and analysis.

**Tailored Chemical Assessments:** CSAC develops assessments for operational components, federal, state, local and private sector partners.

### Chemical Emergency Surveillance and Response

CSAC conducts consequence-based analysis and assessment of chemical warfare agents and toxic industrial chemicals (TIC) for the development and deployment of chemical detection and surveillance capabilities.

## Chemical Release Studies

CSAC performs large-scale TIC and toxic inhalation hazard (TIH) release field testing, laboratory experimentation and modeling.

Using the Jack Rabbit I and II outdoor chlorine release field trials, CSAC funded the University of Arkansas Chemical Hazards Research Center to develop highly specialized test beds for future research, including wind tunnel facilities and a chemical reaction chamber.

In addition to improving the chemical hazard modeling that supports better planning for release incidents and more effective emergency response, Jack Rabbit I and II yielded unanticipated findings about the potential for vegetation and natural barriers to play a role in green remediation after a chemical release. These findings could guide private-sector stakeholders in the chemical, rail, highway and shipping industries to implement passive mitigation measures to reduce the impact of a chemical release.



*In Jack Rabbit II, nine large scale chlorine release experiments were conducted ranging from five to 20 tons each. The ten-ton release in Trial 5 is pictured here, ten seconds after the tank was breached.*

## Cheminformatics

**Chemical Agents Reactions Database (CARD):** CARD provides accurate, comprehensive and actionable information for chemical threat forensics and attribution.

**Non-Traditional Agent Library:** This library provides an interagency link to documents, data and knowledge products.

**Data and Knowledge Management:** CSAC maintains a fusion of chemical, operational, intelligence and industrial data with analytical tools.

## DID YOU KNOW?

Each year hundreds of millions of tons of TIH chemicals, like chlorine and ammonia, are transported through America's population centers. Because these essential chemicals are also toxic and pose a risk to the public through accidental release or an act of terrorism, it is important to understand the behavior and consequences of large-scale releases.

To understand and address the risks of accidental or intentional chemical releases, CSAC partnered with the Defense Threat Reduction Agency and Transport Canada, as well as other governmental and industry stakeholders, to conduct the Jack Rabbit I and II outdoor chlorine release field trials and follow-on studies. The unprecedented experiments and resulting data supported:

- Improved chemical hazard modeling
- Better planning for release incidents
- More effective emergency response
- Improved mitigation strategies to reduce the impact to affected populations and infrastructure
- Improved HazMat and industrial safety

## NATIONAL BIODEFENSE ANALYSIS AND COUNTERMEASURES CENTER (NBACC)



*The NBACC is purpose-built to support the HSE's biodefense needs. It can perform research in maximum biocontainment laboratories on human and animal pathogens and toxins up to biosafety level (BSL-4).*

Established in 2002, NBACC is the first national laboratory created by DHS and is operated in partnership with the Federal Bureau of Investigation (FBI). The NBACC is located at the National Interagency Biodefense Campus in Fort Detrick, MD. NBACC's mission is to provide the scientific basis for the characterization of biological threats and bioforensic analysis to support attribution of their planned or actual use. The NBACC consists of the National Bioforensic Analysis Center (NBFAC) which operates at the direction of the FBI Laboratory Division, and the National Biological Threat Characterization Center (NBTCC) which operates at the direction of DHS S&T.

### NBFAC

NBFAC provides 24/7 bioforensic analyses and support for traditional forensic analyses within biocontainment for federal law enforcement. It has custom-built bioforensic casework laboratories, dedicated technical staff and ISO 17025 accredited processes and assays at BSL-2, 3 and 4. It identifies and characterizes biological agents in evidentiary samples with simultaneous analyses using agent-based assays. This work includes bacterial and viral culture, polymerase chain reaction and immunoassays, as well as methods-based capabilities that include genomics (whole genome sequencing and bioinformatics analysis), electron microscopy and mass spectrometry (MS). NBFAC's agent and methods-based capabilities at BSL-2, 3 and 4 provide flexibility to identify and characterize a wide range of biological agents.

### DID YOU KNOW?

NBACC established unique capabilities to address shortfalls in the nation's bioterrorism preparedness and response capabilities identified after the American Anthrax ("Amerithrax") attacks of 2001. Amerithrax was a multi-agency investigation led by the FBI when letters laced with anthrax powder were mailed to an NBC News anchor, U.S. senators and media offices. Five people were killed and 17 were sickened. The FBI investigation, in partnership with the NBACC, identified the culprit.

### NBTCC

When DHS identifies new threats, NBTCC determines the potential hazards that ultimately inform threat assessments. The NBTCC conducts experiments and studies to better understand biological vulnerabilities and hazards and the preparedness and response capabilities required to mitigate their impact. From fiscal year (FY) 2011 through FY 2019, NBTCC has transitioned products that address 92 traditional agent knowledge gaps, providing timely and high-quality data on the characteristics of biological threat agents and dual-use technologies. It has generated improved assessments of the risk of a biological attack and the capabilities required to mitigate the consequences of such an attack.

In response to the largest Ebola outbreak recorded and importation of cases to the U.S., the NBTCC conducted Ebola virus stability and disinfection research to understand the risk of virus transmission through contaminated surfaces. The NBTCC also engaged NBACC's unique aerobiology capabilities to assess SARS CoV-2 (the virus that causes COVID-19) to understand its survivability across multiple environments. In both instances, results were used to inform decontamination methods, waste disposal practices and risk assessments for DHS components, law enforcement and first responders.





*The biocontainment suit ensemble is designed to provide maximum protection to personnel. When workers exit the biocontainment laboratory, the suit is decontaminated with a thorough chemical showering process that inactivates any contaminating materials.*

## World Class Facilities for Biodefense

Together the NBFAC and NBTCC offer a national resource for understanding the risks posed by malicious use of biological agents and the operational capability to support the investigation, prosecution and prevention of biocrimes, bioterrorism or other threats.

NBACC is committed to maintaining a culture of safety and biodefense homeland security missions require special attention to safety. Its BSL-4 accreditation allows NBACC to perform R&D on pathogens that produce high morbidity and for which no vaccine or treatment exists, making it one of 13 operational or planned maximum biocontainment facilities in the U.S.

### DID YOU KNOW?

NBACC has supported more than 350 federal law enforcement cases.

## Providing Efficiencies Through Partnerships

NBACC is a partner in the National Interagency Confederation for Biological Research in Frederick, Maryland and Fort Detrick components, including:

- Centers for Disease Control and Prevention (CDC)
- Food and Drug Administration
- National Cancer Institute
- National Institute of Allergy and Infectious Diseases Integrated Research Facility
- Naval Medical Research Center Biological Defense Research Directorate
- U.S. Army Installation Management Command
- U.S. Army Medical Research and Development Command
- U.S. Army Medical Research Institute of Infectious Diseases
- USDA Foreign Disease-Weed Science Research Unit

As an interagency partner, NBACC coordinates a range of scientific, technical, operational and infrastructure-related activities that enhance scientific collaboration and productivity. NBACC also coordinates with other national laboratories to enhance research capabilities, share lessons learned and provide training more efficiently.

NBACC collaborates with other federal agencies, including the Department of Defense and National Institutes of Health, to address gaps and needs in biodefense, providing characterization and analysis of potentially dangerous pathogens that could pose a threat to the HSE.

## NATIONAL URBAN SECURITY TECHNOLOGY LABORATORY (NUSTL)



*A skyscape image of New York City where the NUSTL is located in the borough of Manhattan.*

The NUSTL serves the first responder community by ensuring they have effective technologies and tools to prevent, protect against, respond to and recover from homeland security threats and hazards. In its current physical location, NUSTL is a hub for DHS in leveraging and maintaining key partner relationships in New York City representative of a broader first responder community. Examples of NUSTL's partnerships include:

- United States Customs and Border Protection (CBP)
- United States Coast Guard
- Other DHS Operational Components
- New York City Fire Department
- New York City Police Department
- Other State and Local Responders

### Test and Advisory Services for First Responders

NUSTL provides a full spectrum of test and evaluation, as well as technical advisory services. These services include:

- Technology demonstrations and experimentations
- Developmental and operational test and evaluation, as well as laboratory characterization tests
- Technology focus groups
- Market surveys
- System optimization for operational deployments of technology
- Training and exercise support

### DID YOU KNOW?

NUSTL has provided technical support during radiation detection trainings and exercises for more than 2,000 first responders.

Direct access to New York's urban test environments proves indispensable to partners looking to test their capabilities in partnership with NUSTL. Lessons learned from NUSTL work in New York City and in Manhattan are already at scale when shared with the larger national First Responder Community.

Many of these activities are performed under the System Assessment and Validation for Emergency Responders (SAVER) program to provide the first responder community with knowledge products that are the basis for making informed technology and equipment procurement decisions. SAVER products present responders with information on what technologies are available in the commercial marketplace and how they perform in realistic conditions with actual first responder operators.



*A first responder evaluator wears in-suit communications equipment during NUSTL's operational assessment.*

These knowledge products are shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to federal, state and local responders. More than 1,000 reports are posted in the SAVER document library located online at [www.dhs.gov/science-and-technology/saver-documents-library](http://www.dhs.gov/science-and-technology/saver-documents-library).

NUSTL's technical advisory services extend across a wide range of threats, hazards and capabilities. The laboratory maintains specialized expertise in radiological/nuclear emergency preparedness planning, knowledge of unmanned aircraft systems and associated countermeasures, as well as a wide range of personal protective equipment.

### Radiological/Nuclear Response and Recovery Research and Development

In addition to test and evaluation of first responder tools, NUSTL manages and conducts R&D in support of radiological/nuclear response and recovery capabilities and activities. With federal interagency partners, NUSTL's R&D program develops technical resources, tools, modeling and guidance to help state and local agencies initiate a response in the first minutes and hours following a radiological/nuclear incident.



*A still image from the Radiological Dispersal Device (RDD) Response Animations; posted online for state and local first responder organizations to access nationwide.*

### DID YOU KNOW?

NUSTL is responsible for DHS's first-ever patent. Its scientists created the Citizen's Dosimeter, a potentially life-saving portable device that measures an individual's exposure to radiation.

NUSTL's R&D activities successfully transition capabilities to first responders and the federal response assets that support them to save lives, protect responders and minimize impact to the community and economy.

NUSTL works side-by-side with responders in the field to identify their most pressing needs and challenges and engage with the development community to ensure the delivery of operationally relevant solutions that improve effectiveness, efficiency and safety. This hands-on approach not only strengthens first responder capabilities in daily operations, but also in response to critical incidents and catastrophic events.

From R&D to T&E, NUSTL sustains partnerships with responder organizations across the nation and at all levels and disciplines – law enforcement, fire services and emergency management officials, as well as innovators and industry.



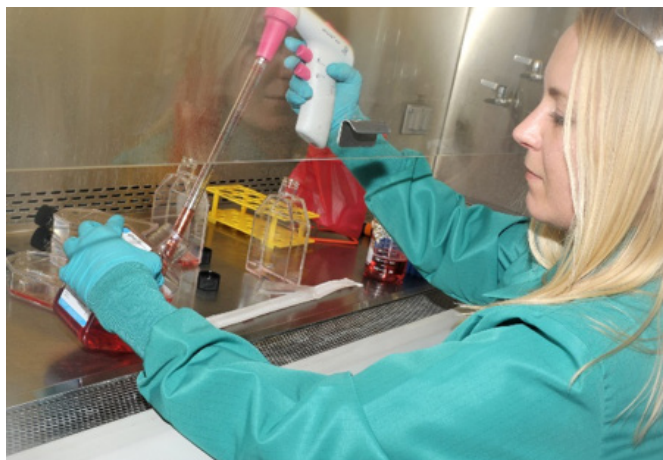
## PLUM ISLAND ANIMAL DISEASE CENTER (PIADC)



*PIADC's main laboratory and office building.*

DHS S&T owns and operates the PIADC facility and laboratory spaces on Plum Island, where S&T staff are co-located with USDA Animal and Plant Health Inspection Service (APHIS) and USDA Agricultural Research Service (ARS) scientists and researchers. The PIADC science program partners with APHIS and ARS in vaccine and diagnostic development for high-threat FADs.

PIADC became part of DHS in 2003 and has been protecting the nation's agriculture against transboundary animal diseases for over 65 years. PIADC is the only laboratory in the nation that can conduct diagnostics and research on high-threat FADs, including foot-and-mouth disease (FMD) and African swine fever (ASF). PIADC is a BSL-3 laboratory with nearly 400 employees operating the facility with a focus on developing countermeasures for these high-threat FADs.



*Scientist at PIADC adding new growth media to cell lines that are used to grow ASF virus and FMD virus.*

## PIADC's Work Protects Our Agriculture and Food Security

PIADC scientists conduct critical research on FADs like FMD and ASF that is essential in protecting our agriculture, economy and food security. FMD is a viral infection of cloven-footed domesticated animals, which include cattle and swine, while ASF infects both domestic and feral swine. Our food and agriculture industries contribute more than \$1 trillion to the U.S. economy. A FAD outbreak would have widespread economic consequences that could exceed \$50 billion across infrastructure that must be protected, including:

- 17 percent of U.S. jobs
- Over 2.1 million farms
- Over 94 million cattle and over 70 million pigs
- Over 200,000 food processors
- Over 6,000 meat, poultry, egg and milk processors
- Over 1.2 million retail facilities

### DID YOU KNOW?

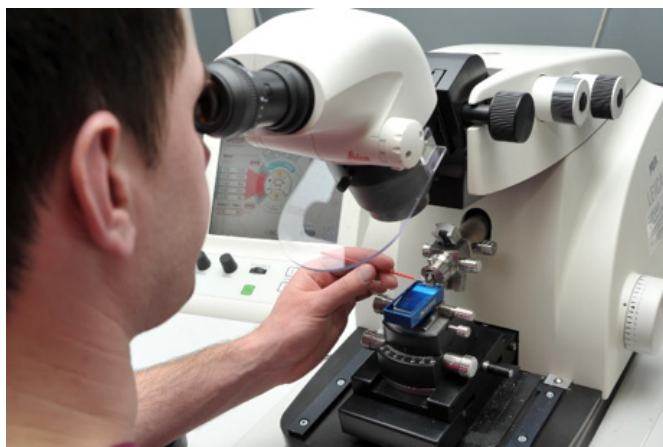
PIADC continues to develop and produce patents that help to provide for the security of our nation's food supply.

Among the key accomplishments of the laboratory are:

- Established the PIADC ASF Task Force
- 6 U.S. Patent and Trademark Office (USPTO) granted patents in 2018
- 6 current and 15 completed CRADAs with industry partners, including the National Pork Board
- 11 current and 43 completed Interagency Agreements with USDA APHIS and ARS
- 18 peer-reviewed papers published since 2016

## PIADC's Strong Partnerships Promote FAD Prevention and Containment

With ONL's stewardship, PIADC provides oversight, technical expertise, coordination and facilitation for DHS agricultural defense programs with other agencies. Since 2003, DHS has worked in partnership with USDA at Plum Island to develop new vaccines and diagnostic tests to respond to and control FAD outbreaks.



*Scientist at PIADC preparing fixed tissues for electron microscopy.*

In 2018, in response to an unprecedented outbreak of ASF in China and neighboring countries in Southeast Asia, a PIADC ASF Task Force was created due to the potential threat of ASF being introduced to the United States and the loss of our swine export market, which is the largest in the world. This task force is aimed at interagency coordination of ASF applied research, diagnostics and collaboration with industry, academia and international partners working on ASF countermeasures. The PIADC ASF Task Force consists of USDA and DHS experts with special expertise in ASF research and diagnostics. Their subject matter expertise and the laboratory's capabilities are leading domestic efforts to mitigate the threat of ASF.

Through its co-located partnership with USDA, PIADC's DHS leadership and staff provide a safe, secure and compliant environment to execute mission-specific objectives. Through PIADC, USDA ARS conducts research and develops means to prevent, control and



*Plum Island, home to PIADC.*

recover from outbreaks of FMD and other diseases like ASF. USDA APHIS uses PIADC facilities to conduct training for international, federal and state veterinarians who function as first responders in the event of an outbreak. USDA APHIS provides the nation with diagnostic services for high threat FADs and serves as a critical resource for surge capabilities by helping maintain the North American FMD Vaccine Bank for use in the event of an FMD outbreak in the U.S., Mexico or Canada.

### DID YOU KNOW?

PIADC developed a novel, safer FMD vaccine platform and associated companion diagnostic test for the differentiation between infected from vaccinated animals. The new test kit produces results in four hours versus the previous test that took 24 hours. This is the first serology-based FMD test ever licensed and manufactured in the U.S., resulting in an increased surge capacity and decreased response times for first responders to aid in the recovery from a potential FMD outbreak on U.S. soil.

## TRANSPORTATION SECURITY LABORATORY (TSL)



*Aerial view of the TSL's 16-acre campus co-located at the W.J. Hughes Technical Center highlighting the vast Explosive Storage Area providing an expansive inventory of specialized, conventional and improvised threats for testing.*

TSL is a national leader in detection science. The lab was established as part of the Federal Aviation Administration in 1993 and transitioned to DHS in 2006. It is the principal detection sciences laboratory for DHS and its operational components and provides RDT&E capabilities for the broader HSE. TSL plays a primary role in helping the Transportation Security Administration (TSA) protect our nation's air transportation system by testing and certifying threat detection technologies for use in over 450 commercial airports. This equipment includes technologies for detection of explosives and other threats on passengers and in their checked bags and carry-on items. In addition to this primary function, TSL leverages its expertise to assess and test threat detection systems used by other DHS operational components, like the U.S. Secret Service and CBP.

### Expertise

TSL's staff includes more than 150 federal and contractor employees. Its professionals include physicists, chemists, engineers and mathematicians with world-class expertise in explosive science and detection technology.

### Unique Facilities and Laboratory Capabilities

TSL's main campus at the W. J. Hughes Technical Center at the Atlantic City International Airport is a 21.5-acre secure facility with six hardened test cells specifically designed to safely test explosive detection equipment. Supporting these test cells are physics and chemistry laboratories that formulate and characterize non-conventional explosive test articles and explosive simulants. TSL stores, handles and tests various military-grade and commercial test articles representing threats from around the world.

### DID YOU KNOW?

In 2019, TSL provided critical data to CBP that was distributed to entrants in S&T's Opioid Prize Competition, which sought novel approaches to detecting opioids in mail parcels. This was a global competition that drew more than 80 entrants.

TSL worked alongside several federal entities, including DHS, CBP, the U.S. Postal Service and the White House Office of National Drug Control Policy to select the winner, a Massachusetts firm that developed a novel method to scan and analyze mail for illegal shipments of illicit drugs, including fentanyl.



*A TSL researcher prepares a filter for analysis using a thermal desorber connected to a gas chromatography triple quadrupole-mass spectrometer. The detection of explosive threats via vapor sampling requires that the air be sampled and pre-concentrated using a specific type of filter. This type of vapor phase explosive detection is enabled through the use of these innovative, TSL-developed methods and tools.*



Two auxiliary DHS laboratory capabilities managed by S&T are aligned to TSL by function. They provide efficiencies in information sharing along with laboratory infrastructure used for homemade explosives detection and threat characterization. These include the TRMG at Tyndall Air Force Base in Panama City, Florida, and the DTC (located within the TIEDS Center) at Redstone Arsenal in Huntsville, Alabama. These capabilities extend the reach of TSL's core services by providing additional data collection capability for homemade explosives and rapid threat detection assessment.



*A TRMG laboratory space. The facility handles improvised explosives synthesis and characterization.*

## Public-Private Partnerships

Transportation Security Equipment (TSE) vendors and system developers can take advantage of TSL facilities and expertise by entering into CRADAs with TSL. Currently, TSE system developers work with TSL to prepare different technologies for eventual certification. These agreements allow small innovative developers, as well as mature system vendors, to develop and optimize their technologies rapidly with minimal risk and at low cost.

## Efficient Certification

At the successful conclusion of developmental test and evaluation, prototype detection hardware and software are subject to TSL's rigorous independent test and evaluation leading to certification.

## DID YOU KNOW?

- TSL performs laboratory certification tests to ensure that the technology deployed in our airports can detect today's most dangerous threats.
- In 2019 there were over 100 visits to TSL by system developers.
- TSL employs use of 50 active CRADAs with developers of screening systems, working closely with industry to mature explosives and contraband detection technologies to meet federal requirements.
- CBP is leveraging transportation security equipment technology and TSL test and evaluation support to help it detect illegal opioids being shipped by mail.

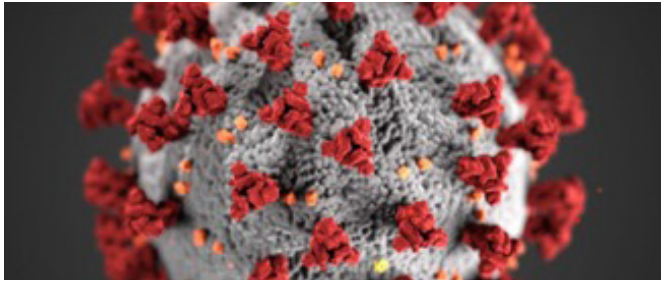


*Scientists at the TSL are helping in the development lifecycle process of detection technologies for the secondary screening process in support of the TSA Alarm Resolution Program to support its objective.*



# SPOTLIGHTS

## ONL LABORATORIES AND COVID-19 RESPONSE



*SARS-CoV-2 is the virus that causes COVID-19.*

### NBACC COVID-19 R&D

Building on experience gained through response to the Ebola outbreak (2014-2016), S&T executes laboratory studies at the NBACC to produce novel insights on SARS-CoV-2 environmental stability and decontamination. The federal government's COVID-19 response is leveraging NBACC's capabilities for applied research focusing on the survivability of the virus on commonly used surfaces, in the air, and in human saliva and respiratory fluids.

Leveraging the results of research conducted by NBACC, S&T released a predictive modeling tool to estimate natural decay of SARS-CoV-2 under a range of common U.S. temperatures and relative humidity and incident sunlight. The tool was designed to assist response efforts and estimate the environmental persistence of the virus under certain combinations of temperatures and humidity. It has revealed a set of conditions that are better and worse for virus survival.

On May 6, 2020, NBACC staff provided the following key findings on a national evening news program:

- Solar radiation rapidly reduces virus stability on outdoor surfaces
- High humidity may reduce virus survival
- The virus dies faster at higher temperatures
- Bleach and isopropyl alcohol are effective decontamination solutions

NBACC is continuing to execute laboratory research to refine and expand its results. The results of this upcoming work will provide essential information to protect those responding to the COVID-19 pandemic, including first responders and health care providers, and provide best practices for individuals to reduce potential for contamination.



*Infectious materials can pass between individuals from multiple routes of transmission. Respiratory transmitted viruses can be expelled in sneezes, coughs or even conversation, and some of these will be deposited on common surfaces that then form the basis of infection for another person.*

### CSAC COVID-19 Response

CSAC works with the TSA, the Combatting Terrorism Technical Support Office (CTTSO), the United Kingdom (UK) Centre for the Protection of National Infrastructure (CPNI) and the UK Department for Transport (Dft) to evaluate the impact and efficacy of various options for reopening airlines. CSAC is modeling transmission of SARS CoV-2 in aircraft to identify potential mitigation measures. CSAC will use an airplane model developed jointly with the UK to examine aerosol transmission on aircraft.

## THE DOE NATIONAL LABORATORY NETWORK

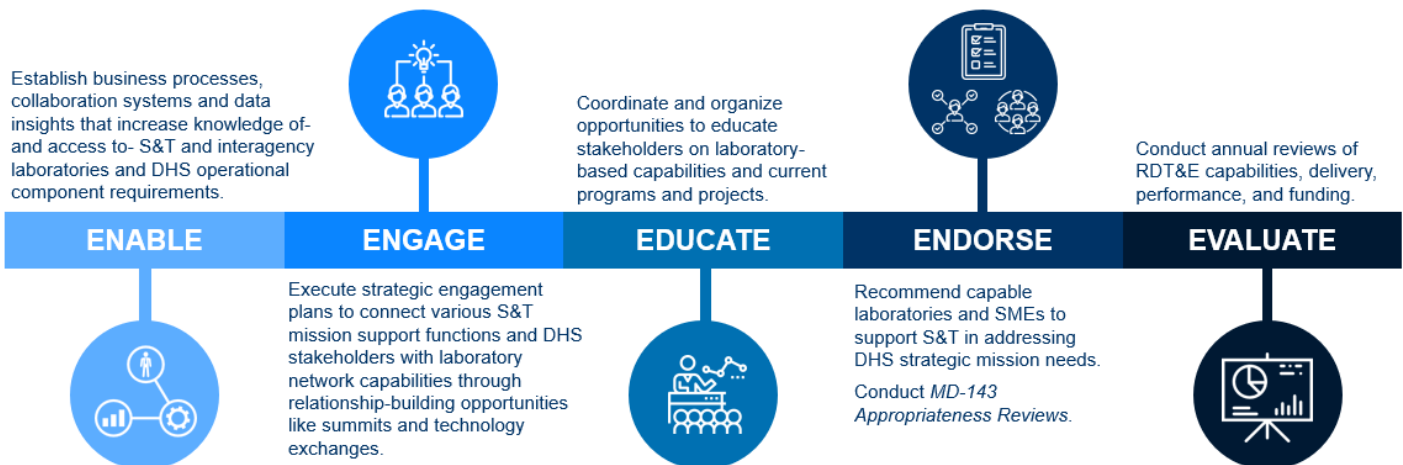
As emerging threats, natural disasters and acts of terror are identified, ONL is an essential player in harnessing S&T resources to address needs with science and technology solutions. The ONL Utilization Branch identifies research programs at the DOE National Laboratories that may accelerate delivery of technological solutions. ONL facilitates the connection between DHS and the national laboratories, allowing for easy exchange between the entities. This is achieved by fostering partnerships and aligning the work occurring across S&T to the capability offerings that exist within S&T's laboratories and the DOE National Laboratories.

## ONL Maintains a Trusted Relationship between DHS and the DOE National Laboratory Network

ONL assists with R&D coordination between DHS operational components and the DOE National Laboratories to address the Department's difficult, multidisciplinary and crosscutting technology challenges. The DOE National Laboratories have performed research for DHS, exploring a wide range of critical areas, including:

- Big data and its impact on the DHS mission space
- Response and recovery from a radiological/nuclear accident or incident
- Forward-looking studies to enable DHS to better understand the future state of technologies
- Impact of severe weather events on the electrical grid and other critical infrastructure
- Cybersecurity and its impact on the HSE

## ONL's 5-Es deliver a coordinated laboratory network





## S&T LABORATORIES PROVIDE EXPERTISE AND RDT&E TO MEET CURRENT AND FUTURE HOMELAND SECURITY CHALLENGES

### CSAC is a Primary Resource in Combatting the Opioid Crisis

America's opioid crisis is one of the worst drug crises in U.S. history. Over the past six years, the quantity of confiscated opioids like fentanyl at U.S. ports of entry has multiplied substantially. In 2013, the CBP seized only two pounds of fentanyl. By 2018, this number soared to 1,800 pounds. Fentanyl is a synthetic opioid pain reliever, approved for treating severe pain. Overdose deaths involving synthetic opioids other than methadone, which includes fentanyl, increased almost 47 percent from 2016 to 2017. Roughly 28,400 people died from overdoses involving synthetic opioids other than methadone in 2017.



*CBP K9 officer checks mail for contraband at the Miami mail facility in Florida.*

CSAC is committed to acquiring, deconstructing, assessing and synthesizing chemical information to provide U.S. law enforcement and policymakers the information needed to combat the opioid crisis. It is a big chemistry problem. Fentanyl has four sites for active molecules and, based on rearranging the molecular groups already found on opioids from seizures, there are 30,000 different combinations possible. Not all are expected to be effective from the user's perspective (but some would be expected to be more effective). CSAC provides chemical information that improves prediction, detection and safety in law enforcement operations and policy actions.

The CARD is a CSAC application that delivers a searchable catalog of over 2,000 chemical reaction pathways. The chemistry steps needed to make illicit opioids deliver critical information pertaining to opioid manufacture, detection, safety and seizure to law enforcement and chemical analysts. It is used by the

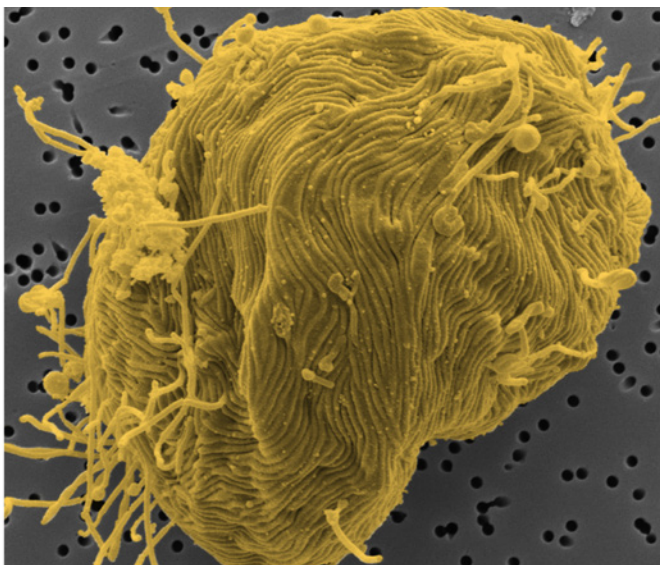
FBI, Coast Guard and others to visualize and predict the chemistry of creating opioids.

CSAC also oversees the interagency Non-Traditional Agent Pharmaceutical Based Agent (NTA/PBA) online virtual data library currently servicing over 300 users. Extracted data from technical documents allows analysts to search for and assess substances by physical properties, chemical structure, toxicology, detection, contamination, medical countermeasures and other technical characteristics. The NTA/PBA Library features over 20,000 data points related to the toxicity, properties and countermeasures for these toxic chemicals. The extensive holdings provide foundational information to researchers and analysts within DHS and the interagency.

### NBACC Pioneers an Improved Method for Quantification of Virus Titers in Dilute Aerosols

Results from NBACC's work with lethal infectious diseases have enabled researchers to gain a better understanding of the potential for airborne transmission of viruses like Ebola and how it may impact healthcare workers.

From 2014 to 2016, infections from the Ebola virus caused more than 11,000 deaths in West Africa and cases of Ebola were diagnosed in other countries, including the U.S. While human-to-human transmission of Ebola occurs primarily through direct contact with the bodily fluids of infected patients, new cases have occurred without direct contact.



*Scanning electron micrograph of Ebolavirus Gueckedou grown in Vero E6 tissue culture cells.*

Researchers believe that, in a small fraction of cases, infection may result from exposure to small droplets or aerosols containing the virus.

Assessing the risk of Ebola transmission via aerosols is complicated, as the minimum amount of virus required to cause infection is undetermined because commonly used testing methods are often not sensitive enough to measure the amount of infectious virus in the air.

NBACC researchers designed and conducted a study to optimize methods for collecting and measuring very small amounts of Ebola virus in aerosols. They compared multiple devices, concluding that filters made of gelatin were the most effective and safest type of sampling device for collecting Ebola virus from the air. They used a cell line, developed by the CDC, in an assay designed to measure the amount of infectious Ebola virus present in a sample. The cell line glows green when infected by the virus, which enables them to differentiate Ebola virus infection from other causes of cell death. NBACC researchers found that the combination of the gelatin filter samplers and improved assay was easier to use, more reliable and nearly ten times more sensitive than the previous methods utilized to measure the amount of Ebola virus in air samples.

NBACC's new methodologies can be employed in other studies to determine the amount of inhaled Ebola virus that causes infection or death in an animal model and whether infected animals produce aerosols containing Ebola virus when they breathe. Methods and lessons-learned from this work have informed NBACC's research in support of COVID-19 response.

## NUSTL Produces Innovations in Radiological Emergency Management

Shortly after the tragic events of 9/11, the concept of a citywide response and recovery system for a radiological emergency was created and deployed. NUSTL developed the initial concept for the Radiological Emergency Management System (REMS), a post-event gamma radiation sensor network designed for response and recovery after a release of radiation in an urban area, whether accidental or deliberate. The system consists of radiation sensors distributed throughout New York City that transmit real-time data to the police department's central command center.

NUSTL developed the REMS through a CRADA with a major instrument manufacturer and later turned the concept into a commercial product. Following a six-year pilot project, the REMS sensors were

manufactured and installed on buildings throughout New York City, including Grand Central Terminal, where an average of 750,000 people pass through every day. NUSTL supported the REMS installation at Grand Central Terminal to ensure its integration with existing security monitoring systems. The installation was the first of its kind to take place at a major indoor transportation facility in the U.S.



*NUSTL completed the physical installation of the REMS (pictured) inside New York City's Grand Central Terminal to monitor and detect abnormally elevated radiation levels.*

Today the REMS provides real-time data to emergency management officials so they can quickly determine a threat in the earliest moments of a radiological incident. Access to this data provides several benefits, including:

- Critical information about radiation levels before responders enter the affected area
- Guidance on which areas to evacuate and which to shelter-in-place
- Timely and accurate information for the public about potential radiation exposure to reduce panic and prevent unnecessary evacuations
- Predictions of the path of the radioactive plume and advance warnings for affected areas when integrated with an atmospheric dispersion model

Since its citywide implementation, NUSTL has used data from the REMS sensors to develop a Concept of Operations for the RadHalo™, a newer technology originating from the REMS concept. The RadHalo™ is currently operational at several tunnel locations around New York City to protect millions of commuters daily. The REMS can also serve as a model for radiological response and recovery in other cities. NUSTL developed a detailed lessons-learned report to transfer the technology to other cities interested in a post-event radiation detection and monitoring network.



## PIADC ASF Task Force Responds to a New Disease Threat

ASF is a high-threat FAD that originated in Africa and spread through Russia and Eastern Europe. In August 2018, outbreaks of ASF occurred in China for the first time. China is the global leader in pork production with 500 million pigs, half the world's population of pork. ASF has rapidly spread throughout China, resulting in the death of approximately 40 percent of its swine. The disease is now in over 50 countries, which significantly increases the risk of spread to disease-free countries, including the U.S. On an annual basis, more than 115 million hogs go to market in the U.S. with a market value of \$24 billion. The U.S. is also the largest pork exporter in the world and is currently free from the disease. There is currently no vaccine to protect swine in the event of an ASF outbreak.



*Scientist at PIADC conducting a health examination of pigs (in compliance with the PIADC animal welfare plan).*

Due to the potential threat of ASF being introduced to the U.S., PIADC's interagency senior leadership group formed the PIADC ASF Task Force, aimed at interagency coordination of ASF applied research, diagnostics and collaboration with industry, academia and international partners working on ASF countermeasures. This Task Force is comprised of members from DHS S&T and USDA. The PIADC ASF Task Force promotes actions that support the timely exchange of relevant stakeholder information and will be of service to USDA and DHS for subject matter expertise and emergency response.

The PIADC ASF Task Force's primary goal is to develop an emergency use vaccine that could be used in an outbreak. Additional priorities include identifying key gaps in ASF diagnostics, transmission, vaccine candidates and ASF disinfection and decontamination.

The PIADC ASF Task Force conducted a tabletop exercise in August 2019 to simulate multiagency response efforts during the first 60 days of a multisite ASF outbreak. The exercise included more than 60 U.S. participants with representatives from 32 state and academic laboratories.

## TSL Invention Keeps Detection Systems in Check

Faced with the formidable task of screening nearly two million airline passengers every day, Transportation Security Officers (TSOs) are determined to find indications of a potential safety or security threat. TSOs rely on Explosives Trace Detectors (ETDs) to detect the telltale signs of an improvised explosive device (IED). Microscopic particles of explosive compounds can adhere to skin, clothing and carried items despite a terrorist's best efforts to conceal their presence. When maintained correctly ETDs are highly sensitive and will identify trace amounts of prohibited materials, alerting the TSO to the possible presence of an IED or other prohibited items.

ETDs require periodic testing on actual explosives to ensure they are continuing to operate reliably in the field. Currently, this is done by providing skilled field testers with kits containing carefully prepared test solutions and specimens. Recently, TSL developed a more efficient and reliable method to verify the operation of the ETDs. The TSL invention repurposes the metered dose inhalers (MDIs) used to treat asthma and other respiratory diseases. In the TSL version, the asthma inhalers are filled with solutions of explosives rather than pharmaceutical solutions. When the substance inside the MDI is dispensed onto the ETD swab, it deposits a calibrated amount of a known explosive. The ETD operator can then simply insert the swab into the ETD and verify that it detects the explosive correctly.

TSL delivered MDI-based test kits to TSA and U.S. Secret Service for use in operational environments.



*TSL scientist loading metered dose dispensers with explosives solution to be used in ETD field test kits.*



## NATIONAL BIO AND AGRO-DEFENSE FACILITY (NBAF)



*Architectural rendering of the completed NBAF looking to the northeast.*

The NBAF is a new federal laboratory site located in Manhattan, Kansas. The \$1.25 billion facility is a major investment in the future of agricultural defense. A modernized laboratory capability is necessary to detect, treat and prevent animal disease impacts to human health, livestock producers and the broader agricultural industry.

The NBAF design features are state-of-the-art and include a unique BSL-4 laboratory space as well as other capabilities that allow the U.S. to conduct comprehensive research, develop vaccines and antivirals and provide enhanced diagnostic capabilities. Once complete, the facility will be leveraged by DHS and others as a national security asset, existing as a global resource for the study of FADs and zoonotic diseases.

### DID YOU KNOW?

70 percent of emerging diseases are zoonotic, meaning they can transfer from animals to humans.

### Its Purpose

The NBAF program fulfills the requirements of Homeland Security Presidential Directive 9, released in 2004. It directed DHS and USDA to work together and provide for safe, secure and state-of-the-art agriculture biocontainment laboratories that research and develop diagnostic capabilities for foreign animal and zoonotic diseases.

### Our Role

Within DHS S&T, ONL is responsible for NBAF construction and commissioning activities. DHS is building the facility to standards that fulfill the mission needs of USDA which assumes ownership, management and operations of NBAF once construction and commissioning activities are complete.

DHS has an ongoing need for access to enhanced biodefense capabilities and is dedicated to the mission of protecting U.S. agriculture. It will leverage an enduring collaborative relationship with NBAF as a national and international laboratory asset for this purpose.



*Architectural rendering of NBAF entrance, looking to the east.*

## Design

The NBAF site encompasses over 48 acres with over 700,000 square feet of facility space, including the main laboratory, the central utility plant (CUP), visitors' center, transshipping building and wastewater treatment plant. Its main laboratory building provides over 574,000 square feet of integrated laboratory space, support areas and required safety systems that meet or exceed all modern design principles and biocontainment standards for research, as well as space for the development of vaccines, diagnostics and training.

The NBAF will include BSL-2, 3 and 4 spaces with capabilities above and beyond those currently offered at PIADC. Approximately ten percent of NBAF's laboratory space will be used for BSL-4 research. The NBAF will be the first laboratory in the U.S. to provide maximum biocontainment laboratory space capable of studying cattle and other livestock. The inclusion of these spaces and a dedicated biologics development module will ensure there is a domestic capability to develop promising biological and agricultural defense countermeasures safely, effectively and rapidly.

Safety is a primary feature of NBAF's design. All crucial systems throughout the facility have backup and redundancy, including those pertaining to the general facility, the laboratory itself, waste management and utility infrastructure.

## Enduring Interagency Partnership

DHS and USDA have worked closely together to ensure the facility's science capabilities reflect the latest available technology to meet current program requirements. In January 2020, DHS S&T and USDA entered into a Memorandum of Understanding (MOU) for collaboration at NBAF. The MOU outlines a mechanism for engagement involving national security-related RDT&E needs at NBAF. Since 2004, USDA and DHS have developed a strong and enduring partnership for a coordinated biological countermeasures research program in response to the threat of agricultural terrorism.

DHS and USDA remain committed to ensuring a process remains in place at NBAF to address national security priorities through research and development on for foreign, emerging and zoonotic diseases. This partnership and collaboration will continue beyond the transfer of PIADC's mission to NBAF.





# Science and Technology Directorate Office of National Laboratories



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