This Fiscal Year (FY) 2018-2019 Annual Report summarizes completed program and project milestones, collaboration and outreach, mission services, laboratory operations and organizational successes of the National Urban Security Technology Laboratory (NUSTL). As a federal laboratory organized within the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T), NUSTL is the national lab dedicated to helping first responders find the right tools and technologies to do their jobs safely and effectively.

NUSTL provides Research, Development, Test & Evaluation (RDT&E) products and services to help state and local first responders and emergency managers prevent, protect against, respond to and recover from homeland security threats and hazards. NUSTL conducts critical Test and Evaluation (T&E) activities in support of the first responder community, DHS programs and components and the broader Homeland Security Enterprise. This includes the development and review of test plans and protocols on emerging and commercial off-the-shelf (COTS) technologies and executing those test plans in both the laboratory and in the field.

NUSTL’s Research and Development (R&D) efforts bring new tools and guidance for responding to radiological and nuclear emergencies. For example, NUSTL published the “Radiological Dispersal Device (RDD) Response Guidance: Planning for the First 100 Minutes,” to help first responders and emergency managers plan for how to initially respond to a RDD, or “dirty bomb.” Recognizing the technical complexities of RDD emergencies, NUSTL created animations of the scientific principles in the RDD Response Guidance and facilitated planning and preparedness activities across the country by first responders and emergency managers. These tools enhance local-level capabilities to effectively execute health, safety and emergency response decision-making during the initial minutes and hours following a RDD detonation, a critical time period to initiate response activities.

During FY 2018 and FY 2019, some of NUSTL’s most notable achievements included:

- Testing 551 pieces of equipment including personal radiation detectors and radiation isotope identifiers
- Executing five assessments of DHS S&T-funded technologies, including body-worn cameras, a 3D crime scene video mapping tool, and respiratory protection gear for fire overhaul operations
- Performing market research and assessments of 52 different tools and COTS technology products, culminating in the publication of nine new reports
- Providing radiation sources and technical expertise to support 45 days of radiation detection-related training exercises for 11 federal, state and local agencies – trainings which served 960 first responders
- Conducting the second part of the Technical Assessment of Counter Unmanned Aircraft Systems Technologies in Cities (TACTIC) to evaluate technologies available to the Homeland Security Enterprise
- Visiting seven out of eight Department of Energy Radiological Assistance Program Regions in the United States to support the operational transition of RDD Response Guidance among federal subject matter experts, state and local emergency managers, incident commanders and decision-makers
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Focused on providing technology and tools to first responders in support of the homeland security mission, the National Urban Security Technology Laboratory (NUSTL) continued to address a diverse range of threats, hazards and capabilities across the homeland security domain in FY 2018 and FY 2019. NUSTL’s support ranged from conducting tests of personal protective equipment for first responders, and far more complex evaluations of counter-unmanned aircraft systems, to providing actionable guidance on how to respond to emergencies such as an RDD, commonly called a “dirty bomb.” The results of the Lab’s RDT&E activities help first responder agencies better prepare for and respond to homeland security challenges and threats, as well as inform their technology and equipment acquisition and deployment decisions.

Located in New York City, NUSTL is a federal laboratory organized within the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T). NUSTL conducts test and evaluation activities alongside first responder partners from all over the country, with special attention to serving responders in our nation’s cities. Given the many complexities of urban environments, the lab concentrates on addressing unique issues that first responders face in and around American urban centers.

This report details two fiscal years of mission activities and accomplishments made possible through the daily contributions of NUSTL’s dedicated staff and stakeholders.

Meet the Leadership Team
A 73-YEAR HISTORY OF SERVICE THROUGH SCIENCE
The laboratory has supported the nation as a federal resource, prospering through seven decades of remarkable history – from measuring radioactive fallout during the Cold War to conducting operational assessments of first responder technologies today. While much has changed since its establishment, the heart of NUSTL’s mission still focuses on the safety and security of the American people.

The laboratory was formed in 1947 under the Medical Division of the Atomic Energy Commission to serve the massive research effort that led to the development of the atomic bomb. In the 1950s, the newly named Health and Safety Laboratory shifted its focus to a growing national concern of radioactive fallout from nuclear weapons tests and used its network of monitoring stations for fallout assessments. The lab soon earned its reputation as a world leader in environmental radiation measurements. Its network of air monitoring stations expanded to assess soil and water samples; air filter samples at the earth’s surface and in the stratosphere; and biological samples and measurements of wet and dry fallout. In 1977, the laboratory’s name changed to the Environmental Measurements Laboratory (EML) as it realigned under the newly created U.S. Department of Energy (DOE). The laboratory’s primary focus was to support environmental monitoring, decommissioning, decontamination and remediation efforts associated with nuclear tests and incidents worldwide. Following nuclear accidents at Three Mile Island and Chernobyl, EML took immediate measurements that provided the ability to accurately and comprehensively reconstruct the environmental contamination that resulted from these events.

In the aftermath of the September 11, 2001 terrorist attacks, President George W. Bush signed legislation to create DHS. EML became part of DHS S&T in 2003 to support homeland security activities. The name changed later in 2009 when then DHS Secretary Janet Napolitano, approved of EML becoming the National Urban Security Technology Laboratory—often called “Nu-steel”—as it is well known today. Four years later, more than one hundred representatives from DHS, local police and fire departments, other agencies, and longtime friends attended the ribbon-cutting ceremony of the newly renovated laboratory.

Today, NUSTL is home to a vast range of capabilities that serve the first responder community, including the test and evaluation of technologies to better understand and mitigate current and future homeland security threats. Laboratory staff members provide a critical scientific interface with a myriad of first responders and other end users for the accelerated delivery and successful field deployment of technologies and systems, not just in New York City, but across the nation.
NUSTL staff members’ vast range of educational backgrounds, particularly those with science and engineering focus areas, uniquely positions the laboratory to provide support to federal, state and local stakeholders and first responders.

**ACADEMIC DEGREES**

The 40 total staff members of NUSTL collectively hold 68 degrees, including 28 advanced degrees.
EDUCATIONAL BACKGROUNDS

The greatest number of degrees are in Engineering and Physical and Life Sciences, with other degrees including but not limited to: Business, Communications, Information Systems, Economics, Urban Planning, Homeland Security Policy and Management, and Weapons of Mass Destruction Strategic Studies.

ENGINEERING FOCUS AREAS

Students are pursuing degrees in:
- Naval
- Mechanical
- Chemical
- Computer
- Electrical

Staff Fast Facts As of December 2020

SCIENCE FOCUS AREAS

Students are pursuing degrees in:
- Animal Science
- Biology
- Biochemistry
- Chemistry
- Computer
- Environmental Health
- Geochemistry
- Marine Environmental Studies
- Physics

Staff Fast Facts As of December 2020
INTERACTING WITH THE 
HOMELAND SECURITY COMMUNITY

Academia: City University of New York, Columbia University, Stevens Institute of Technology, University of Alabama at Birmingham


Federal: Department of Commerce, Department of Defense, Department of Energy, Department of Health and Human Services, Department of Justice, Environmental Protection Agency, Department of Transportation, General Services Administration, National Aeronautics and Space Administration

International: Defence Research and Development Canada, Hastings-Quinte Paramedic Services, Israel National Police, Toronto University Police, United Kingdom Home Office - Centre for Applied Science and Technology

National Laboratories: Argonne National Laboratory, Brookhaven National Laboratory, Idaho National Laboratory, Lawrence Livermore National Laboratory, Marine Corps Warfighting Laboratory, Oak Ridge National Laboratory, Sandia National Laboratories, Savannah River National Laboratory

Responder Agencies: Alabama Emergency Management Agency, Bernalillo County (NM) Fire Department, Bonney Lake (WA) Police Department, Boston (MA) Police Department, Chantilly (VA) Fire Station 15, Chicago (IL) Police Department, City of Houston (TX) Police Department, Colorado Department of Public Safety, Connecticut State Police Emergency Services Unit, Fairfax County (VA) Police Department, Fire Department of New York, Fredericksburg (VA) Police Department, Golden Gate (CO) Fire Protection District, Harris County (TX) Fire Marshal's Office, Lafayette (IN) Fire Department, Lake Havasu City (AZ) Police Department, Maryland Department of Transportation, Massachusetts State Police, Metropolitan Transportation Authority (NY), Nassau County (NY) Police Department, New Jersey Transit Police Department, New York City Department of Health and Mental Hygiene, New York City Emergency Management, New York City Police Department, New York State Division of Homeland Security & Emergency Services, Orange County (CA) Fire Authority, Orlando (FL) Fire Department, Plano (TX) Police Department, Port Authority of New York and New Jersey, Port of Houston (TX) Authority Emergency Management, Seattle (WA) Fire Department, Suffolk County (NY) Police Department, Washington DC Police Department, Wheeling (IL) Police Department

Stakeholder Groups: Conference on Radiation Control Program Directors, Federal Radiological Preparedness Coordinating Committee, InterAgency Board, First Responder Resource Group, National Council on Radiation Protection and Measurements, White House Office of Science and Technology Policy

Note: This listing is not all inclusive.
NUSTL collaborates with organizations from across the United States to test and evaluate first responder technologies, implement tools and resources for state and local emergency planning and maximize the laboratory's overall mission impact. These collaborations have consistently increased year after year. In FY 2018 and FY 2019, NUSTL interacted with members of approximately 505 different organizations.

Laboratory staff worked with a broad range of representatives from a total of 99 private industry organizations, 13 academic institutions, 190 state and local agencies, 31 international organizations and 172 federal agencies.

NUSTL's broad range of partnerships and collaborations are comprised of first responder customers, project performers and stakeholders and government agency representatives from federal, state and local levels – all of whom contribute to the laboratory's products and services through either direct program or project participation, cooperative research projects, or attendance at laboratory meetings and technology assessments. The collaborator listing (pictured left) illustrates many of the organizations that NUSTL has engaged with while performing mission activities.

Staff members are photographed with the Senior Official Performing the Duties of the Under Secretary for Science and Technology William Bryan, DHS S&T Chief of Staff Kathryn Coulter and state and local partners at NUSTL.
NUSTL leverages partnerships with other federal scientific entities for mutual benefit to our constituents. One example is NUSTL’s collaboration with the Department of Defense (DoD), Rapid Reaction Technology Office (RRTO) Innovation Outreach Program to plan and conduct “Thunderstorm” technology events. Thunderstorm is an ongoing series of demonstrations on commercial and emerging technologies for the DoD and interagency partners in operationally relevant environments. NUSTL has promoted inclusion of its first responder partners – including the New York City Police Department (NYPD), Port Authority of New York and New Jersey (PANYNJ), and Fire Department of New York (FDNY) – to coordinate demonstrations and to represent first responder technology priorities. State and local first responders have the opportunity to participate in demonstrations of technologies relevant to the work that they do, while providing feedback and insight on their specific needs.

“Please allow me to express my appreciation for the exceptional support provided by NUSTL during the Thunderstorm 19-2 technology demonstration event in New York City. Working together with your team, we demonstrated 27 technologies to 107 government participants – an impressive feat. I would particularly like to thank you and your team for hosting our Community of Interest Day at NUSTL.”

—Director, RRTO

NUSTL supported Thunderstorm 18-2: Dense Urban and Subterranean Technologies, a two-week test event led by the Georgia Tech Research Institute (GTRI). A total of 28 technologies in the areas of position, navigation and timing in GPS-denied environments, communications, real-time mapping, multi-hazard detection, and personal protective equipment were demonstrated at the experiment venues of New York City’s East Side Access Tunnel, the World Trade Center, and Fort Hamilton. Approximately 110 stakeholders from 73 organizations participated. NUSTL hosted the Thunderstorm 18-2 Community of Interest Day where NUSTL Director Alice Hong provided opening remarks. Ms. Hong shared her perspectives on the cooperation among DHS operational components, first responders and other federal partners for meeting complex technological problems posed by dense urban environments.

NUSTL also provided technical and logistics support for Thunderstorm 19-2: Multi-Domain Operations, led by GTRI. The two-week event demonstrated 27 technologies including those in the areas of chemical, explosive, radiation and drug detection, facial recognition software, sensors for situational awareness, communications in connectivity-deprived environments and multi-domain transport vehicles. The FDNY’s training academy on Randall’s Island, the World Trade Center and Fort Hamilton served as experiment venues. Participants from 62 different organizations attended. NUSTL provided meeting space and planning support that included involvement from the lab’s first responder partners.

For more information on upcoming Thunderstorm Technology Demonstration and Experimentation events, contact thunderstorm@gtri.gatech.edu, thunderstorm@arl.psu.edu, or NUSTL@hq.dhs.gov.
NEW YORK AREA
SCIENCE AND TECHNOLOGY FORUMS

NUSTL's New York Area Science and Technology (NYAST) Forums provide a platform for cross-collaboration and information exchange focused on first responder applications. NYAST Forums connect first responders and other end-users to advancements in science and technology that can enhance their operations. Topical meetings are held at NUSTL and focus on homeland security projects and capabilities and feature multiple speakers and demonstrations. Informative question and answer sessions and opportunities for one-on-one follow-up conversations with the speakers and other attendees are key aspects of each forum. NUSTL hosted four NYAST forums during FY 2018 and FY 2019, which attracted attendance from 166 members representing 89 unique sub-organizations.

NYAST 42 focused on hurricane emergency response, specifically on recent experiences applying new tools during severe weather. Darren Wilson, Program Manager within DHS S&T, and a Principal Investigator with Massachusetts Institute of Technology Lincoln Laboratory’s National Hurricane Program Technology Modernization provided a live demonstration of S&T’s transitioned storm tracking and decision support platform used throughout the emergency management community, known as HV-X. Following the HV-X demonstration, DHS S&T’s Data Analytics Engine Director Stephen Dennis presented on the social media analytics that monitored critical infrastructure and public health during hurricanes Harvey and Irma.

NYAST 43 focused on helping first responders mitigate illegal jamming. DHS S&T Program Manager Sridhar Kowdley shared information about jamming and interference threats as well as findings and recommendations from DHS S&T’s First Responder Electronic Jamming Exercise (JamX 17). Nearly 100 federal, state and local public safety and private organizations gathered at the exercise to test tactics and technologies to help first responders recognize, respond to, report and resolve illegal jamming and unintentional interference incidents. Kowdley then presented JamX 17 data and results being used to develop training tools and operational guidance for first responders to better identify signal interference and address first responder communication system vulnerabilities.
Additionally, Director and Fire Coordinator for the Warren County, New York Office of Emergency Services presented strategies for basic mitigation, guidance for helping communities build communication resilience and the overall importance of education and awareness from a first responder perspective. The two speakers returned for NUSTL’s first ever Chicago Area Science and Technology Forum webinar that brought their presentation to a wider national audience.

NYAST 44 centered on meeting the demands of critical incidents through technological and tactical training capabilities. Former NUSTL Division Director Lawrence Ruth and NYPD’s Counterterrorism Division Lieutenant presented key takeaways from DHS S&T’s Critical Incident Management Technology Assessment (CIMTA), a large-scale event conducted at Grand Central Terminal. The presentations summarized the technologies used during the exercise to address capabilities such as blue-force tracking, gunshot detection, facial recognition, patient tracking and communications during a critical incident. NYPD’s Counterterrorism Division Lieutenant also spoke about the tactics, techniques and procedures utilized by first responders during a critical incident response or active shooter situation and shared operational perspectives on the technologies used at CIMTA.

NYAST 45 focused on battling the opioid crisis, specifically the role of mail screening and detection technologies. DHS S&T Program Manager Dr. Rosanna (Robertson) Anderson highlighted technologies used to counter illicit opioids that are smuggled into the United States. Her presentation included information about technology-enabled processes for mail inspection operations, such as using computer vision to automate flagging suspicious parcels for inspection and employing rapid chemical sensors for opioid threat identification. A DHS Customs and Border Protection (CBP) Science Officer also shared CBP’s national data and trends related to the issue.

To become a NYAST member, please contact NUSTL@hq.dhs.gov.
FOCUS GROUP TO ASSESS SMALL UAS FOR USE IN FIRST RESPONDER MISSIONS

Small unmanned aircraft systems (sUAS) – those with a gross take-off weight less than 50 pounds – offer tremendous potential for supporting first responders’ public safety missions. NUSTL, in coordination with the National Institute of Standards and Technology and DHS S&T, conducted the First Responder Robotic Operations System Test (FRROST) Focus Group to plan for a future assessment of commercially available sUAS. NUSTL staff members led the focus group with first responders and subject matter experts – each with experience using sUAS during search and rescue operations – to identify evaluation criteria and assessment scenarios.

With advances in technology over the past decade, sUAS have become dramatically more affordable, technically capable and easier to fly. sUAS can carry out aircraft public safety missions at a fraction of the cost of a manned aircraft response—while keeping responders out of personal danger—when combined with a multitude of sensor payload capabilities, including: visible and infrared video, still photography, and lidar and hyperspectral imaging. These systems also offer opportunities to perform missions that are impossible for manned vehicles, such as exploring inside buildings or tunnels.

Recommendations from the focus group were published in a report that will serve as the basis of the operational assessment in FY 2020. Results of the sUAS assessment are intended to provide federal, state and local first responders with information on the affordability, capability, deployability, maintainability and usability of the assessed systems. The assessment will be conducted at the Combined Arms Collective Training Facility at Camp Shelby Joint Forces Training Center near Hattiesburg, Mississippi.
OPERATIONAL ASSESSMENT
AND EXPERIMENTATION OF
FIRST RESPONDER
TECHNOLOGIES
OPERATIONAL FIELD ASSESSMENTS OF
DHS-DEVELOPED TECHNOLOGIES

NUSTL conducts operational field assessments (OFAs) of DHS S&T-developed prototype technologies before they are transitioned to the commercial market. During OFAs, first responders from across the nation use the technology under simulated operational conditions to assess capabilities and usability and to verify that the project requirements were met. OFAs are conducted at test and training venues across the country.

NUSTL conducted five OFAs and one Technology Demonstration intended to address capability gaps identified by the DHS S&T First Responder Resource Group. Members of fire services, emergency medical services and law enforcement served as evaluators at the OFAs for the following S&T projects: Automatic Activation of Body Worn Cameras, Automated Driver and Responder Alert System, Burn Saver, Respiratory Protection for Overhaul Operations, QuickRoute and 3D Crime Scene Video Mapping.

“On behalf of the Israel National Police, I would like to thank you as the program manager and all the U.S team for the efforts of planning, preparing and executing such a fruitful demonstration. I’m sure that it will enhance our, U.S. and IL, abilities to digitally record and analyze crime scenes in the future.”
—Superintendent and R&D Project Manager, Israel National Police in response to the 3D Crime Scene Video Mapping Technology Demonstration

In March 2018, NUSTL conducted the Automatic Activation of Body Worn Cameras (ABWC) OFA at NUSTL. The ABWC intended to provide a means to retrofit existing systems to automatically activate a body-worn camera only when needed. The body worn cameras were activated using signals to start recording from four critical event sensors: unlatching of a holstered weapon’s retaining strap, exiting a police vehicle, elevated ambient sound levels and increased pulse rate of the wearer. ABWC was developed by Hitron Technologies Inc. to reduce the risk of missing footage during rapidly escalating situations, an omission which can occur when solely relying on manually activated systems.

Four law enforcement personnel from Arizona, Illinois, New York and Virginia served as evaluators to test the prototype in simulated operational scenarios. Of the four critical event sensors, the holster sensor received the most positive evaluator feedback. They found that it worked well as a camera activation device, and indicated that an event involving the removal of a weapon from its holster is appropriate to be recorded. The three other critical event sensors performed less reliably in activating the camera. Evaluators also expressed reservations about their practicality for operational use because they require calibration and could lead to the camera being activated in situations where it was not needed. The ABWC without Responder Manipulation OFA Report is available at the DHS website.

One of the camera activation sensors is attached to a holster weapon retention strap (left) and an evaluator is fitted with the audio sensor (right).
In August 2018, NUSTL conducted the Automated Driver and Response Alert System (ADRAS) OFA at the Federal Law Enforcement Training Center in Cheltenham, Maryland. ADRAS is intended to increase safety for first responders tending to roadside incidents by enhancing responder and vehicle visibility and providing multi-modal warnings to both responders and oncoming motorists. The system was developed by Applied Research Associates Inc. and is comprised of two main components: a mast that attaches to an emergency vehicle to sense and provide avoidance warnings for oncoming vehicle threats and an enhanced safety vest that can be worn over a responder’s uniform.

The ADRAS vehicle-mounted mast is comprised of loudspeakers, a radar system, a low frequency tone siren and two cameras. One of the OFA activities involved the use of the system in a curved road.

The ADRAS enhanced safety vest is equipped with LED lights and a small oscillatory motor to provide a tactile alert.

Six evaluators from Maryland, Rhode Island, the Federal Highway Administration and the National Highway Traffic Safety Administration participated in OFA activities to assess the system’s ability to notify responders of an approaching vehicle, the usability of the safety vest, the effectiveness for warning oncoming motorists on four different roadway geometries (straight away, mild curve, large curve, 90-degree turn), the ease of setting up and configuring the system, and how well the video replay system captured scenes for post-incident uses.

Overall, the evaluators found that ADRAS would be beneficial as part of the suite of tools at their disposal for improving the safety of responders on the roadway and offered suggestions for enhancing the technology. They found that the system was easy to deploy and provided sufficient alerts to inform responders about an oncoming vehicle, though some thought that employing the technology could impede response operations. While opinions varied on the usability of the video cameras, the evaluators expected that the enhanced safety vest lighting would increase their conspicuity during night time operations. Evaluators found that the loudspeaker warnings of oncoming vehicles would not be distracting to motorists and were most effective in quiet environments, at slower speeds and in close proximity to the incident scene. They suggested that ADRAS effectiveness would be enhanced if users could select from a menu of options to tailor features based on their existing equipment and operational needs. The Automated Driver and Responder Alert System OFA Report is available at the DHS website.

In October 2018, NUSTL conducted two OFAs focused on firefighter safety technologies, designed by TDA Research Inc., at the Federal Emergency Management Agency’s (FEMA) National Fire Academy in Emmitsburg, Maryland. Burn Saver, a thermal sensor and alarm system, is intended to alert firefighters of dangerously hot conditions in which the face mask of their self-contained breathing apparatus (SCBA) could melt. Respiratory Protection for Overhaul Operations, the second technology assessed, offers a lighter, less bulky alternative to SCBA for use when an SCBA is not required, such as while checking for smoldering hot spots or while searching for evidence after a fire.
Burn Saver is to be worn on a firefighter’s shoulder strap. It measures temperature and heat flux and activates a blue light-emitting diode that glows when the device calculates that only 45 seconds remain before damage and flashes when 15 seconds remain. The developers partnered with Motorola Inc. to send alarms via Bluetooth to advanced SCBA face masks that have heads-up displays and to digital radios to communicate with personnel accountability software at an incident command system.

Five firefighters from Maryland, Colorado, and Virginia served as evaluators to assess comfort and potential interference with operational duties. The scenarios incorporated activities that involved their arms and shoulders, such as carrying a ladder, using a sledge hammer and a pike pole, and carrying a rescue mannequin and high-rise pack fire hose. The OFA also included a search and rescue scenario that involved crawling through a previously burned structure containing soot, debris and scorched remains of household furnishings. To assess the effectiveness of the alarm without exposure to dangerous temperatures, NUSTL asked the developer to create an app that would allow the LED to be manually activated remotely at random times while evaluators were performing the rescue and pike pole operations. This provided an opportunity to assess the visibility of the alert on the device.

Evaluators provided significant feedback and insights. They found wearing the device on the shoulder strap, while noticeable, did not prevent them from accomplishing tasks, but that the blue light alert was not adequate to alert the wearer or the partner. They suggested possible solutions, including a rapid strobe alert, locating the light lower on the body to be situated in their peripheral vision and using an audio tone through the radio microphone. Evaluators found the incident command system display useful. The Burn Saver OFA Report is available at the DHS website.

The Burn Saver device shows a light activated alert after it was transported through a controlled burn.

The Burn Saver was worn on their SCBA shoulder strap while evaluators conducted various tasks.
The Respiratory Protection for Overhaul Operations offers lighter, modulated system consisting of a layered chemical vapor and particulate filter module that is to be attached to passive or powered air-purifying respirators (APRs). It was developed by TDA Research Inc. in collaboration with Avon Protection Systems Inc.

The OFA tested three configurations: a passive device where the filter system attached directly to a face mask and the wearer draws air through inhalation, and two systems where a battery-powered blower, worn on the waist or as a back pack, to supply filtered air via a hose to the responder's face mask. Five firefighters and one fire investigator assessed the breathing resistance, comfort and usability of the filter modules in simulated field conditions. OFA activities included a stair climb, debris removal and evidence search. The evaluators found the alternative respiratory protection designs more comfortable compared to SCBA. The backpack-style powered system was preferred overall as it provided the most comfort and a sufficient amount of air for strenuous, extended overhaul work. They found the passive system acceptable for jobs of less than 30 minutes because the breathing resistance and weight of the filter pulling down on the facemask would be problematic for longer jobs. The optional carbon monoxide module was reported to make it more difficult to breathe and exacerbated the facemask weight problem in the passive configuration. Still, this module was acceptable when used in the powered systems. The Respiratory Protection for Overhaul Operations OFA Report is available at the DHS website.

In April 2019, NUSTL conducted an OFA on QuickRoute at a federal law enforcement training center in Maryland. QuickRoute is a mobile application (app) designed by Azimuth 1, LLC. It enables first responders to take the most efficient route available to them when responding to an emergency situation. This technology leverages existing platforms and databases, while customizing options for first responders by modifying civilian travel restrictions.

Six evaluators with backgrounds in communications, fire services and emergency medical services tested the app in various operational scenarios and provided feedback on its functionality, reliability, usability, routing, and hazard alert features. The evaluators had a range of opinions on the functionality and reliability of QuickRoute; part of this variability could be attributed to connectivity issues at the test site and lack of map data available for the site within the app. All evaluators noted that the app should be integrated with jurisdictional dispatch systems and have audible and visual warnings when it suggests drivers to disobey civilian traffic laws. While evaluators had some recommendations on how to improve the app’s hazard and alert notification capabilities, they found the processes of entering, confirming, and clearing alerts generally easy and intuitive. Ultimately, evaluators found that QuickRoute would help them arrive at incident scenes more efficiently if deficiencies identified were addressed.
The QuickRoute OFA Report is available at the DHS website. In FY 2020, NUSTL will conduct a second OFA to assess the changes made to the QuickRoute Mobile App based on the first responder feedback received during the first OFA. The second OFA will provide first responders with an opportunity to assess the system’s dispatch component, QuickRoute Emergency Command Center.

In addition to conducting five OFAs, NUSTL conducted a three-day technology demonstration on a 3D Crime Scene Video Mapping system at the McConnell Public Safety & Transportation Operations Center in Fairfax, Virginia. The system was designed to complement current investigation procedures to accelerate the removal of evidence from a scene and to improve the accuracy of investigations and evidence collection. This demonstration event differed slightly from NUSTL’s standard OFAs because the technology was developed in Israel through S&T’s bilateral effort with the Israel Ministry of Public Security. It was developed by B-design 3D Ltd. with support from the Israeli National Police Administration for the Development of Weapons and Technological Infrastructure Research and Development Division, who delivered it to the United States and provided training on the system to U.S. counterparts. NUSTL partnered with Fairfax County Police Department (VA) to develop realistic scenarios for responders to use the system under operational conditions. NUSTL collected data on the responders’ impressions of the system and its potential for U.S. operations.

The Three-Dimensional Crime Scene Video Mapping system captures high definition video footage of a crime scene, and then uses the system software to create a three-dimensional model from the video. The software allows the user to revisit and explore the scene from different points of view and provides information that may not be obtained only by watching the video. The system can perform analyses such as measuring sizes and distances, tagging evidence, visualizing line of sight from a given position, calculating vehicle speed based on skid-mark length and road conditions, and placing the scene within a larger context using geo-referenced images.

Six law enforcement officers with crime scene investigation experience from Virginia, Illinois and Ohio participated in the hands-on system demonstration, which involved a simulated car crash scenario. Indoor and outdoor crime scenes were staged and the participants conducted an investigation as part of the simulation. Overall, the participants found this system to be suitable for use by crime scene investigators for recording and analyzing outdoor investigation sites and that it could potentially be applied to indoor crime scenes. Participants found the analysis software easy to use and determined the system applicable to investigation operations, offering features beyond the participants’ current procedures. The 3D Crime Scene Video Mapping Technology Demonstration Data Collection Report (Official Use Only version) is available by request to NUSTL@hq.dhs.gov to a limited law enforcement audience.
SAVER PUBLICATIONS

NUSTL’s System Assessment and Validation for Emergency Responders (SAVER) program was established to assist emergency responders in making informed procurement decisions. Also known as “Consumer Reports for First Responders,” SAVER equips responders with knowledge products including focus group, market survey and assessment reports that enable them to select tools and technologies that best fit their operational needs. Through the SAVER program, NUSTL conducts impartial, practitioner-driven, operationally-representative evaluations of commercial off-the-shelf equipment that are categorized under the DHS Authorized Equipment List\(^1\). SAVER reports are delivered to the responder community through the SAVER Document Library website.

The SAVER program assessed 25 products and conducted market research on an additional 27 products in FY 2018 and FY 2019. During this period, 61 emergency responders from 14 states participated in SAVER focus groups and assessments. The SAVER program published nine knowledge products, including two assessment reports, three focus group reports, two market survey reports and two technotes:

- Ballistic-Resistant Body Armor for Women Market Survey Report
- Field Portable Gas Chromatograph/Mass Spectrometer Focus Group Report
- Fixed-Position Direct Radiation Environmental Monitoring Systems Market Survey Report
- Handheld Radioisotope Identifiers Assessment Report
- In-Suit Communications Equipment Focus Group Report
- In-Suit Communications Equipment TechNote
- Less Lethal Technologies for Law Enforcement TechNote
- Portable Radiation Portal Monitors Assessment Report
- Tactical Eyewear Focus Group Report

The SAVER program is driven by participation from the emergency responder community. To ensure that its knowledge products are relevant, the program solicits input from responders to inform project selection and prioritization and selects responders with subject matter expertise to participate in focus groups and assessments. Through guided discussions, these responders develop the evaluation criteria and operational scenarios that form the basis for assessments.

SAVER works continuously on projects of high importance to the responder community. The publication of reports on handheld explosives trace detectors, handheld Raman spectrometers, in-suit communications systems and vehicle tracking technologies is anticipated in FY 2020.

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\(^{1}\) The Authorized Equipment List (AEL) is a list of equipment types allowed under FEMA’s preparedness grant programs. The intended audience of this tool is emergency managers, first responders and other homeland security professionals. The list consists of 21 equipment categories divided into categories, sub-categories and then individual equipment items. NOTE: The AEL consists only of equipment categories and does not list commercially available products.
In addition to enlisting emergency responders to participate in the SAVER program, NUSTL partners with other laboratories and agencies. These partnerships enable SAVER to access additional subject matter expertise, as well as leverage the specialized assets of its partners. Such collaboration enables the SAVER program to assess a broader range of technology, tools and equipment. These partnerships also help to ensure the geographic diversity of responders participating in the program.

NUSTL partnered with Pacific Northwest National Laboratory (PNNL) to conduct focus groups and assessments of field portable gas chromatographs/mass spectrometers (GC/MS) and in-suit communications equipment. The PNNL team supplemented the NUSTL SAVER team with subject matter expertise in the area of chemical detection and communications measurements such as voice clarity and the impact on non-radio communication equipment.

The lab also enlisted the support of the U.S. Army Combat Capabilities Development Command – Soldier Center in Natick, Massachusetts to conduct a focus group on and assessment of tactical eyewear. Eyewear experts from the U.S. Army Combat Capabilities Development Command – Soldier Center provided information on potential hazards that responders may encounter, varying types of eye protection, the trade-offs between those types, and user-identified testing suggestions for inclusion in the assessment. These reports will be published in FY 2020.

Additionally, NUSTL partnered with DHS S&T’s Transportation Security Laboratory (TSL) to assess handheld explosive trace detectors. In this partnership, NUSTL focused on the operational aspects of assessing the detectors, while TSL conducted laboratory testing focused on detector performance.
New York City Mayor’s Office of the Chief Technology Officer Moonshot Challenge

NUSTL provided test, evaluation, and technical advisory services to aid the New York City Mayor’s Office of the Chief Technology Officer in support of their NYCx program. The NYCx Cybersecurity Moonshot Challenge sought to identify technologies to improve the City of New York for residents, while protecting privacy and security. The New York City Mayor’s Office of the Chief Technology Officer requested guidance from NUSTL to identify technologies best suited for implementation. NUSTL staff members shared best practices and knowledge product templates as well as guidance on interviewing subject matter experts, identifying capability gaps, developing experimental designs, evaluating technology effectiveness, assessing technologies, and capturing lessons learned. NUSTL also participated in a final round of pitches during which seven finalists briefed an evaluation panel on their approach to cybersecurity for small and medium-sized businesses in New York City. During the pitches, companies provided information on their cybersecurity tools, business models and end-user experiences which will be utilized for the NYCx Cybersecurity Moonshot Challenge User Evaluation.

Mobile Device Attribute Validation Technology Demonstration

NUSTL hosted a technology demonstration of the Mobile Device Attribute Validation (MDAV), a mobile application used for authenticating first responders’ credentials. MDAV uses public key encryption on smartphones and aims to give first responders the capability to verify one another’s credentials, permits and certifications quickly and securely during field operations, even in the absence of network connectivity. DHS S&T’s Cyber Security Division (CSD) requested that NUSTL conduct a technology demonstration to share the capabilities of MDAV with first responders and to verify its operational suitability. NUSTL collected data related to the first responder organizations’ credentialing methods, policies, procedures and requirements during a technology familiarization session and the tabletop exercise. Representatives from the technology developer, Lockstep Technologies and CSD were especially interested in the results of the discussions and participants’ feedback that could be leveraged to further refine MDAV for operational use.

Participants from the NYPD, New York City Emergency Management (NYCEM) and observers from DHS Cybersecurity & Infrastructure Security Agency (CISA) attended the technology demonstration. The event provided DHS S&T with an improved understanding of customer requirements and uncovered valuable insights from the participating agencies, including representatives from NYCEM who expressed an interest in the capabilities that were demonstrated. Further feedback suggested the developer integrate the application with existing first responder systems to make it easier for incident commanders to readily view and be aware of the skillsets of those on scene.
TECHNOLOGY INSERTION FOR A LARGE-SCALE CRITICAL INCIDENT

NUSTL conducted the Critical Incident Management Technology Assessment (CIMTA), an event that assessed the performance of emerging technologies in an urban, large-scale critical incident exercise with first responders. Approximately 200 state and local police officers, firefighters, emergency medical technicians and S&T technical experts convened at Grand Central Terminal in New York City to participate in the exercise or observe from the incident command post and operations center inside the terminal.

NUSTL worked with DHS S&T to incorporate technologies in areas including blue-force tracking, communications, gunshot detection, situational awareness and video analytics into the exercise to assess their capabilities. Participating first responders and incident commanders used the technologies with the tactics, techniques and procedures they would employ during a critical incident response. Responders from FDNY, Metropolitan Transportation Authority Police Department (MTA PD), NYPD, New York State Police and the New York National Guard participated in the assessment. The exercise provided a valuable evaluation platform for existing and emerging technologies that could be deployed in the future.

“In the wake of the horrific Las Vegas shooting, this exercise could not be more timely and relevant to our efforts to protect the safety of the American people. We know that having the right technology in the hands of a first responder can save critical minutes or seconds – and reduce injuries and save lives,”

—Senior Official Performing the Duties of the Under Secretary for Science and Technology, William Bryan

NUSTL staff members, who led and supported the execution of CIMTA, with the Senior Official Performing the Duties of the Under Secretary for Science and Technology, William Bryan.
FEDERAL TEST LEAD FOR THE
NEXT GENERATION FIRST
RESPONDER PROGRAM

NUSTL served as the Test Agent to the DHS S&T Next Generation First Responder (NGFR) Apex program, a five-year program that ended in FY 2020 to help tomorrow's first responders be more protected, connected and fully aware. NUSTL's role entailed the development of test strategies and overseeing their implementation. NUSTL held lead roles in many of the test events, and in others acted as federal oversight for test and evaluation activities. NUSTL supported the planning and execution of four NGFR test events: PlugTest, Assistant for Understanding Data through Reasoning, Extraction and Synthesis (AUDREY) Paramedic Experiment, Harris County Operational Experimentation (OpEx) and Shaken Fury.

PLUG TEST

NUSTL supported test efforts and data collection during the NGFR PlugTest at the NASA Jet Propulsion Laboratory located in Pasadena, California. The PlugTest involved four sets of NGFR technologies that were integrated during a series of evaluations to validate the First Responder On-Body NGFR Architecture detailed in the NGFR Integration Handbook. NUSTL supported test plan development and provided technical oversight during the execution of the PlugTest. S&T personnel were able to identify successes and possible gaps within the current NGFR architecture.

AUDREY PARAMEDIC EXPERIMENT

NUSTL supported an operational exercise of AUDREY, an artificial intelligence capability being developed by S&T in collaboration with organizations from the United States and Canada to enhance future communications and decision-making for first responders. The exercise was led by S&T’s NGFR program in coordination with NASA’s Jet Propulsion Laboratory and Hastings Quinte, Canada Paramedic Services. Aimed to help paramedics expedite informed decision-making about patient care during an emergency, AUDREY was programmed to assimilate data and execute the steps a paramedic would take in determining the best course of action in treating a patient complaining of chest pain.

NUSTL developed the test plan and collected data throughout five different use cases during the experiment. The data collected by NUSTL included observations of AUDREY, user interactions and electronic logs of the information exchanged between AUDREY, its handheld interface, and the paramedic’s dispatch system. Paramedics found AUDREY successful as a tool to automate the completion of after-action reports and the overall experiment demonstrated how AUDREY can identify, analyze and convey relevant information to paramedics during an emergency.
HARRIS COUNTY OPEX

NUSTL supported the DHS S&T NGFR program’s Harris County OpEx in Houston, Texas. The OpEx was conducted in partnership with local Houston-area public safety agencies and private industry to evaluate new commercial and emerging first responder technologies and integrate them with technologies already used by Houston-area agencies. NUSTL played an essential role in planning NGFR’s Harris County OpEx, including creating and implementing a data collection plan for the event.

At the Port of Houston, the participating agencies coordinated a multi-jurisdictional response to a hazardous materials scenario. The scenario demonstrated a response to a simulated methyl bromide spill on the U.S. Coast Guard Cutter Hatchet. First Responders worked to rescue “victims” from both the Hatchet and the civilian vessel, the Sam Houston. This demonstration provided DHS S&T with an opportunity to study the integration of sensors into advanced situational awareness platforms and assess the technical requirements of a coordinated response during a disaster. The exercise highlighted how integrated solutions could deliver greater operational impact for public safety agencies nationwide.

NUSTL provided technical, test and evaluation support during the event, which demonstrated various technologies that can provide operational capabilities to first responders such as physiological and environmental monitoring, interoperable communications and technologies for enhanced situational awareness. NUSTL’s involvement included developing test procedures to evaluate each technology and creating a data collection plan to ensure the successful recording of OpEx results. Additionally, a team of staff members from NUSTL and DHS S&T’s Human Systems Integration served as data collectors throughout each vignette; they were teamed with scenario participants to record observations on technology performance and feedback from those first responders. Data collection was a crucial step in the process of measuring outcomes of the NGFR technologies and how they impact first responder capabilities. The data also was used to evaluate the test requirements and pinpoint areas for further technology refinement.

United States Coast Guard personnel participate in a simulated decontamination process at the OpEx.
NUSTL supported the Birmingham Shaken Fury OpEx conducted by DHS S&T’s NGFR program at Legion Field Stadium in Birmingham, Alabama. The OpEx brought together 12 public safety agencies, 110 first responders, 21 emergency response vehicles and 30 technologies from 24 performer and industry partners to evaluate an integrated suite of technologies comprised of physiological and environmental sensors, enhanced communications networks, situational awareness platforms and UAS. Shaken Fury incorporated multiple technologies into response operations in the context of a simulated earthquake at the stadium. Simulated activities included urban search and rescue and hazardous materials response. NUSTL coordinated with the technology developers to enable the integration of all systems and led the overall data collection efforts.

NUSTL team members shadowed the first responders throughout the OpEx, recording their observations on technology performance and the interactions between emergency responders and the technologies. Following the vignettes, NUSTL data collectors also administered surveys, developed with the support of S&T’s Human Systems Integration, to the first responders and contributed survey findings to S&T’s After-Action Report.

Birmingham public safety agency liaisons remarked that this OpEx provided them the opportunity to identify capability gaps in coordinating a multi-agency response prior to their hosting the World Games in July 2021.
ASSESSMENT OF COUNTER UNMANNED AIRCRAFT SYSTEMS

To assess the performance and suitability of commercial Counter-UAS solutions in homeland security settings, NUSTL planned and executed TACTIC Part Two in coordination with S&T’s former Program Executive Office for Unmanned Aircraft Systems (PEO UAS). From 2016-2018, the PEO UAS focused on guiding, advising and providing technical expertise to DHS components and the homeland security community on the steps they could take and the technologies they could use to counter unwanted or malicious UAS.

The second part of TACTIC collected and analyzed data for metrics of performance over six days at the Urban Training Center located at Marine Corps Base Quantico. Nine C-UAS commercial solutions with varying sensor modes for detecting, tracking and identifying small UAS were evaluated. TACTIC allowed DHS S&T to assess the capabilities of these technologies and to gain an understanding of the state of the market. It also provided an opportunity for developers to see their C-UAS technologies put into action under operational settings that are relevant to homeland security and to obtain direct feedback from end-users.

TACTIC brought in approximately 200 attendees, including nearly 100 observers from Federal agencies, state and local law enforcement, industry and S&T’s international partners. Many of the attendees were potential end-users who were able to see firsthand how C-UAS technologies work in a replica urban setting. The demonstration also made visible the logistics and training requirements associated with various technology types, allowing observers to better plan for possible acquisition, concepts of operations and training. Lessons learned from this test and evaluation activity informed how S&T continues to evaluate new C-UAS technologies today.

A UAS flies over the Urban Training Center at TACTIC.

The S-900 takes flight during one of the observer day sessions.
NUSTL’s C-UAS Test Team conducts a grounded test to confirm if the C-UAS is able to detect and locate the UAS and ground controller at Fort Totten, a former active U.S. Army installation in the NYC borough of Queens (NY).

FORT TOTTEN AND U.S. OPEN C-UAS DEMONSTRATIONS

The NYPD requested NUSTL’s support with their demonstration of a C-UAS detection-only based technology that the department was planning to employ during the 2018 U.S. Open at Flushing Meadows Park in New York. In preparation for the event, members of NUSTL’s test team helped the NYPD with planning and executing the demonstration at Fort Totten, a former active U.S. Army installation located in the borough of Queens, New York. The demonstration event brought a comprehensive understanding of the technology’s capabilities and limitations, prior to its use during the U.S. Open Tennis Championships. After the Fort Totten event, NUSTL collected data and conducted daily quality assurance checks to ensure the C-UAS technology performed as intended throughout ten days of the event.

GUIDANCE FOR IMPROVED UNDERSTANDING OF C-UAS TECHNOLOGIES

NUSTL served as co-chairs on the National Science and Technology Council’s (NSTC) “Counter Small Unmanned Aircraft Systems (C-sUAS) Fast Action Test and Evaluation Sub-Working Group.” The group was tasked with developing standard guidelines for C-sUAS Test and Evaluation. NUSTL, along with interagency partners, developed guidelines to promote collaboration and data sharing on C-sUAS. The standard guidelines support a common understanding of test methods to collect dependable test data. They aim to minimize the need for multiple agencies to evaluate the same system, thus decreasing time and costs associated with T&E activities. The NSTC was established by Executive Order to coordinate science and technology policy across the federal interagency and is overseen by the White House Office of Science and Technology Policy.
KNOWLEDGE SHARING WITH FIRST RESPONDERS AND GOVERNMENT PARTNERS

To support the Homeland Security Enterprise in understanding the components of C-UAS technologies and the capabilities and limitations of different sensor types, NUSTL’s C-UAS team developed a “C-UAS 101” briefing. The C-UAS 101 brief walks users through how a sUAS operates and the types of sensors used for detecting, tracking, identifying and/or mitigating UAS. The briefing includes use cases of interest to first responders and DHS components, and presents technical issues to consider when deploying and integrating technologies into various concepts of operations. NUSTL delivered tailored C-UAS 101 briefings and presentations to the following DHS Components, first responder customers and stakeholders:

- DHS CBP and Office of Acquisition
- DHS CISA Region II, including regional representatives from New York, New Jersey, Puerto Rico and the Virgin Islands
- DHS Office of Intelligence and Analysis (I&A)
- DHS Office of I&A – Delaware Information and Analysis Center
- DHS Transportation Security Administration (TSA)
- FDNY and their Special Operations Task Force
- NYPD
- PANYNJ’s Office of the Chief Security Officer and Port Authority Police Department
- United States Army
- United States Coast Guard’s Research and Development Center
- TSA’s Visible Intermodal Prevention and Response (VIPR) Newark Field Office Team
- TSA’s Federal Air Marshall Service at LaGuardia Airport

Representatives from TSA thanked NUSTL for the insightful briefing:

“We learned a lot and the information exchange was very beneficial. We look forward to maintaining contact with you and your team as this situation evolves.”

“The presentation was very informative and we look forward to partnering with you and NUSTL as we move forward in our efforts to effectively address the UAS challenge.”

INTERNATIONAL C-UAS COLLABORATION

Senior Technologist Bhargav Patel participated in a C-UAS Trilateral Workshop for the United States, United Kingdom and Canada, in coordination with DHS S&T. The workshop took place in London, England where trilateral representatives reconvened for their annual meeting to discuss C-UAS T&E efforts led by each country. The agenda focused on mitigation technologies for UAS, which can pose greater technical and regulatory challenges. DHS S&T’s TACTIC was part of the technical discussions, in addition to the T&E events that took place in Bristow, U.K. and Montreal, CA. Following the trilateral workshop, Patel attended the European Union’s (EU) “PIONEER” Meeting in Bordeaux, France to discuss high-level approaches, projects and programs associated with UAS and C-UAS technologies. Participants included government officials from Canada, Denmark, France, Netherlands, Spain, Sweden, United Kingdom, United States and the EU commission.

Senior Technologist Bhargav Patel also presented during a segment titled Homeland Perspective: Countering sUAS at the first annual Pacific Protection Symposium in Honolulu, Hawaii. Patel presented on the different components of UAS (i.e., the controller and the aircraft) and discussed how they communicate with one another, in addition to the continuum of events and the processing chain for detecting, tracking and then mitigating a sUAS. His presentation helped orient operators and attendees in the room to the problem of UAS and technologies for C-UAS.
EQUIPPING FIRST RESPONDERS WITH
TECHNOLOGY
EXPERTISE
AND TRAINING
LABORATORY TESTING OF RADIATION DETECTION EQUIPMENT AT NUSTL

Through the Performance Test and Evaluation at NUSTL (PTEN) program, NUSTL helps first responders to better detect radiological and nuclear threats by conducting functional tests of radiation detection equipment prior to their field deployment. PTEN ensures that equipment supplied to the first responders works as intended, and that all equipment accessories, guides and electronic display devices are accounted for and functional. Since 2009, NUSTL has tested more than 25,000 radiation detectors through PTEN and worked closely with all customers to ensure their equipment is making it to the field as soon as possible and is ready to meet mission needs.

During FY 2018-2019, NUSTL received, tested and transferred 551 pieces of equipment and corresponding accessories purchased under the Securing the Cities (STC) grant program administered by the DHS Countering Weapons of Mass Destruction Office (formerly named the Domestic Nuclear Detection Office). STC aims to prevent radiological or nuclear attacks on high-risk urban areas by helping local and state response agencies to detect and interdict illicit radioactive and nuclear material. This STC-funded equipment included personal radiation detectors (PRDs), a radioisotope identifier (RIID), spectroscopic personal radiation detectors (SPRDs), car adapters, and backpack units, as well as chargers and holsters for the NYPD, NYCEM, New York State Division of Homeland Security and Emergency Services, Westchester County Police, and Connecticut State Police Emergency Services Unit. NUSTL completed testing of SPRDs for the NYPD's Transit Bureau on an expedited timeline in order to meet grant funding deadlines. STC Partner, NYPD Counterterrorism Bureau's Fiscal Affairs Director stated, “You guys are just amazing!” when NUSTL met the tight deadline.

NUSTL continued its partnership with the FDNY’s HazMat Battalion to support their use of PRDs as a part of their personal protective program. This program was developed by FDNY specifically for when the equipment reaches their first-and second-year marks of service. In this capacity, NUSTL tested more than 4,500 units for the FDNY.

Additionally, PTEN delivered a technical analysis report to NYCEM outlining the conformance testing of detection equipment including Canberra Mini-Radiac PRDs and a Ludlum 52-1-1 personnel portal system for their agency.

Images of radiation detection equipment that are tested by NUSTL.
RESPONDER TRAINING AND EXCERCISE SUPPORT

NUSTL established its Responder Training and Exercise (RTE) program in 2009 to support the DHS Countering Weapons of Mass Destruction (CWMD) office's STC program. The RTE program addresses radioactivity-related topics, including radiological dispersal devices (RDDs), improvised nuclear devices (INDs) and the use of radiation detection equipment, and concept of operations and tactics.

NUSTL assists first responder agencies in the New York City metropolitan area with their radiation detection training and exercises by providing radiation sources and associated technical advice. NUSTL also routinely responds to requests from federal, state and local agencies to address technical questions and to provide solutions that enable first responders to better use and maintain their radiation detection equipment. NUSTL's radiological materials license, issued by the U.S. Nuclear Regulatory Commission, enables the laboratory to possess and use a set of radiation sources chosen to match specific needs within the homeland security mission space. Radioactive materials for each exercise are packaged and safely managed at field sites under regulated transport. NUSTL staff members are trained in both ionizing radiation safety and radioactive hazardous materials transportation.

In FY 2018 and FY 2019, NUSTL's RTE program supported trainings and exercises for a combined total of approximately 960 trainees, bringing the total since program inception to almost 3,000 first responders from across federal, state and local organizations. The supported trainings and exercises were carried out over the course of 45 days with 11 federal, state and local agencies including:

- DHS TSA, Federal Air Marshal Service
- Federal Bureau of Investigation
- FDNY
- MTA PD
- Nassau County Police Department
- New York City Department of Health and Mental Hygiene
- New York National Guard 24th Weapons of Mass Destruction Civil Support Team
- New York State Department of Environmental Conservation Police Department
- Port Authority Police Department
- Suffolk County Police Department
- United States Coast Guard’s Research and Development Center

In NUSTL-supported training events, police officers and recruits learn how to use their radiation detection equipment in classroom and interactive settings. This equipment includes PRDs and SPRDs, as well as portable and vehicle-mounted detector systems to detect and identify radiation sources. Radiation sources, which are safely handled and managed by a team of specialized staff members from NUSTL, allow end users to experience how the detectors would actually respond during a nuclear event. Many of the trainings and exercises are focused on the individual agency's mission while some events, especially those with a focus on response, involve multi-agency coordination.

NUSTL provided radiation sources and technical assistance to support the Port Authority Police Department's Special Operations Division, which oversees all police officers in their Emergency Service Unit. Laboratory staff members brought radiation sources to the John F. Kennedy International and Newark Liberty International airports where they were used to test radiation detection systems installed inside four armored vehicles for functionality and alarm response.

NUSTL also provided radiation sources and technical support for the FBI’s Weapons of Mass Destruction Training where public safety bomb technicians went through a simulated IND response exercise.
NUSTL provided subject matter expertise and technical assistance to support the FDNY’s HazMat Training, which focused on the initial stages of measuring and mapping radiological contamination following a radiological incident. During a simulated outdoor explosive radiological dispersal device (RDD) detonation, FDNY personnel utilized the *RDD Response Guidance: Planning for the First 100 Minutes* – guidance that was developed and transitioned through NUSTL’s Radiological/Nuclear Response and Recovery Research and Development program. The guidance tool sets forth missions and tactics to be executed by first responders and local response agencies to save lives, issue protective actions and secure the scene in the initial minutes of an RDD response. The FDNY used “Tactic 8: Measure and Map Radiation Levels” to help train their hazmat operations on how to initially characterize the extent of the radiological contamination by determining radiation levels and then assessing the direction of contamination. Participants also learned how to upload data from the field into FEMA’s RadResponder Network, an application used by responders to manage radiological incident data.

Laboratory staff assisted the New York State Department of Environmental Conservation (NYS DEC) with the testing of a newly acquired radiation detection system located on their marine launch. NUSTL assisted members of the New York National Guard 24th Weapons of Mass Destruction-Civil Support Team with radiation detection and isotope identification using person-carried detection equipment.

NUSTL provided information to the United States Coast Guard Research and Development Center (USCG RDC) about ionizing radiation emitted from a security scan device for their radiation safety evaluation. The lab’s Carl Schopfer analyzed test documentation for the HBI-120 handheld backscatter X-ray imager manufactured by Viken Detection. USCG RDC required information on the potential for operator exposure to X-rays when using this detector and requested NUSTL’s expertise to better understand the radiation safety of X-ray backscatter devices that could be used for at-sea accountability along the southern border.

NUSTL’s committed support and admiration for the first responder community is reciprocated by the agencies that NUSTL supports. The laboratory received words of gratitude from the DHS TSA Federal Air Marshal Service for support that NUSTL provided during two of their VIPR training sessions in Atlantic City, New Jersey. A specialized team of NUSTL staff members set up source scenarios, and safely handled and managed NUSTL’s sealed radiation sources throughout a series of classes, drills and field exercises. The events focused on preventive radiological and nuclear detection (PRND) training for TSA’s VIPR teams, which are comprised of law enforcement officers who receive initial then recurrent training to prepare them for preventing and deterring acts of terrorism against U.S. transportation systems. “Thank you very much for all of your help this week,” wrote a representative from DHS TSA’s Office of Training and Development. “You and your personnel were so helpful, and everything seemed to go very smoothly.”
RESEARCH AND DEVELOPMENT
FOR IMPROVING RESPONSE AND RECOVERY TO RAD/NUC INCIDENTS
NUSTL's Radiological and Nuclear Response and Recovery (RNRR) Research and Development (R&D) program builds tools, knowledge products, and other resources that aid first responders and emergency managers in their preparation for, response to, and recovery from radiological and nuclear emergencies. By focusing on building capacity and capability at the local and state level and bridging gaps between federal and local response, the RNRR R&D program has been impactful in its missions to:

- Increase capability at all levels of government to characterize and manage complex and catastrophic radiological and nuclear incidents
- Improve responder ability to save lives during the initial response operations of a radiological incident
- Minimize impact on a community and its economy through improved methods of incident stabilization, radiological clean-up and recovery

The RNRR R&D program invested in, developed, and transitioned tools and products in support of these goals. The R&D achievements include conducting educational outreach, advancing recovery planning efforts, and expanding responder knowledge of the radiological dispersal device (RDD) hazard through the publication of response guidance and development of planning courses and exercise templates.

RDD DETONATION RESPONSE CAPABILITY DEVELOPMENT

In November 2017, NUSTL, the Department of Energy (DOE) National Nuclear Security Administration (NNSA) and the Federal Emergency Management Administration (FEMA) published the RDD Response Guidance: Planning for the First 100 Minutes. The RDD Guidance is rooted in years of scientific research and experimentation by the DOE and documents how first responders and emergency managers can effectively plan for and respond initially to an RDD detonation in their jurisdiction. The RDD Response Guidance includes five key missions and ten tactics for operational response and is written in plain language that can be easily implemented by first responders. To support the integration of the guidance into the response community, several complimentary products are in development or recently completed.

Operational Transition of Guidance Across the Country

To support understanding of the scientific concepts behind the guidance and acceptance of the operational strategies recommended in the RDD Response Guidance, in 2018-2019, the DOE and NUSTL teams visited seven of eight DOE Radiological Assistance Program (RAP) Regions across the country, providing in-depth training and knowledge transfer to other federal subject matter experts who work directly with state and locals in their regions as well as the state and locals themselves. In each region, two sessions were held: the first session included a more technical, detailed presentation on the research and experimentation that form the science behind the guidance. The second session was open to federal, state and local partners to discuss the hazard, how to implement the guidance into planning, and other tools and products. Over 300 federal, state, and local representatives participated throughout the effort. For some audience participants, these sessions represented their first exposure to the RDD guidance and afforded them the opportunity to meet experts from DOE, FEMA, the FBI, the Environmental Protection Agency (EPA) and other federal agencies in their community who would be part of an integrated response. This outreach effort ensured that first responders and emergency managers across the country know about the resources provided in the RDD guidance and the people in their jurisdictions who can support them before and during a real-world response.
Trainings to Support Jurisdictional Planning

Outreach is not enough to ensure that jurisdictions have the knowledge and tools to effectively respond to an RDD – they require preparation and planning based on a jurisdiction’s specific resources and capabilities. For this reason, NUSTL is working with FEMA’s Chemical Biological Nuclear Response (CBRN) Office and the National Training and Exercise Division (NTED) to develop and offer a “train-the-planner” course at the Counter Terrorism Operations Support (CTOS) Center for Radiological and Nuclear Training. The course under development is intended to educate state and local emergency response planners on the Guidance and provide resources to empower them to integrate the material into their local plans. Once complete, the Train-the-Planner course will be offered through the FEMA training catalog, which is provided at no cost to state and local representatives. The course is expected to be piloted and completed in FY 2021.

Additionally, NUSTL, working with DOE’s Lawrence Livermore National Laboratory, created video animations that capture operationally-focused missions and tactics found in the RDD Response Guidance. These animations provide the national first responder community with a visual learning tool that can be used during RDD trainings to reinforce key actions. The easy-to-use video format is intended to help responders understand complex response activities that can directly influence health and safety decision-making and the actions taken during a radiological emergency. The video animations are publicly accessible from NUSTL’s webpage at the DHS S&T website and on FEMA’s RadResponder platform. State and local agencies are encouraged to use the video animations with their communities and partners.

Resources for Exercising RDD Response

Once a jurisdiction has a local response plan, they must work to exercise it to ensure that it meets its intended objectives. To support exercising RDD concepts, the RNRR program is working with Idaho National Laboratory to build a suite of flexible, scalable exercise templates that can be used by local jurisdictions as well as state and federal partners. Providing standardized training and exercise procedures rooted in sound scientific principles and practices for RDD responses will support local preparedness and encourage interagency coordination for radiological/nuclear response and recovery. The templates use Homeland Security Exercise and Evaluation Program best practices to allow for easy ready integration into existing exercise programs.
RECOVERY PLANNING TOOLS

In any emergency, it is critical for recovery to begin when response begins. This is especially true for a radiological and nuclear incident where the decisions made in the first minutes and hours by local first responders will set the tenor of what is expected to be a lengthy, complicated and expensive recovery. To support early recovery activities, the RNRR program is working closely with interagency partners to build new tools and products that can be leveraged immediately by responders and emergency managers.

Capabilities to Estimate Waste

The EPA’s Center for Environmental Solutions & Emergency Response (formerly called National Homeland Security Research Center) initiated the development of the Waste Estimate Support Tool (WEST) that can be used as a planning tool to estimate the potential volume and radioactivity levels of waste generated by a radiological incident and subsequent cleanup efforts. Working closely with the EPA, the RNRR program invested in WEST to ensure that it meets the needs and requirements of responders and decision makers to effectively analyze and implement an integrated response, that in turn, can minimize economic and health impacts to the affected community in the aftermath of a radiological incident.

Research for Recovery Efforts

The RNRR program also worked with the EPA and Argonne National Laboratory (ANL) to conduct research on understanding how municipal and commercial equipment can support first responders in detecting, containing, removing and eliminating radiological contaminants from roadways and other critical infrastructure. The initial research, published in May 2018, outlines five primary support goals: survey and monitoring of contaminated areas; mitigation of received doses to responders; gross and final decontamination of buildings, vehicles, roadways and other surfaces; solid waste management and containment of wastewater generated from the response and recovery efforts – and equipment, with rankings, that may be leveraged to conduct operations around these missions. To ensure that the research can be appropriately used by emergency responders and logisticians, the RNRR program is now working with ANL, EPA and FEMA to build a Radiological Recovery Logistics Tool that can be used to support the identification of appropriate use of equipment for various radiological response and recovery missions. A proof-of-concept tool will be completed by September 2020 with further work expected through 2022.

Making Completed Tools Accessible to Responders

NUSTL's Radiological Decontamination Application was moved to FEMA's RadResponder platform. The application, known as the RadDecon Tool, was developed by NUSTL in partnership with the EPA, and based on existing guidance provided by the United Kingdom. It is intended to provide end users with decision support in preparing for and responding to large scale radiation incidents by understanding different methods of decontamination and the cost, time and other factors to consider when implementing each method. It allows users to enter basic information about the incident and in return, be provided with prioritized decontamination options that decision makers can incorporate into their overall recovery strategy. Transitioning this Application into FEMA's RadResponder has been opportune for the RNRR program because RadResponder is the national standard for radiological data visualization and a go-to-resource for responders with this mission set. Users must have a RadResponder account to access the RadDecon Tool.
The projects in the RNRR program continue to positively impact the first responder and emergency response community’s ability to respond to radiological/nuclear incidents.

**Continued Support of Radiological Operations Support Specialist (ROSS):** This RNRR program continues to support the development of the ROSS position, a FEMA National Qualification System position that can support incident commanders and emergency managers with subject matter expertise in preparedness for, during and in recovery from a radiological incident. The support includes serving on the ROSS Steering Committee, along with FEMA, DOE and the Conference of Radiation Control Program Directors and providing direction, guidance and research and development support to the program. One advancement made was the development and publication of the ROSS Toolkit on FEMA’s RadResponder. The toolkit enhances the operational effectiveness of the ROSS onsite because it compiles disparate reference information related to radiological incidents and organizes it into a coherent resource alongside handbooks and job aids for easy use.

**Publication of National Council of Radiation Protection and Measurements (NCRP) Commentary No. 28, Implementation Guidance for Emergency Response Dosimetry:** RNRR funded both the underlining Guidance (Report 179) and the operational commentary (28) for implementing emergency response dosimetry. The intention of the commentary is to help responders understand how to track personnel doses using appropriate equipment and to conduct dose reconstruction to emergency scenarios by providing operational implementation information and guidance.

**Deployment of Tools at 2018 Vigilant Guardian Exercise:** The RNRR Team partnered with city planners from the Urban Area Security Initiative San Francisco Bay Area to implement NUSTL-developed tools during Vigilant Guardian. These tools include the skills and capabilities of a ROSS and the RDD Response Guidance: Planning for the First 100 Minutes. Vigilant Guardian is an exercise focused on radiological/nuclear detection, interdiction and consequence management to test regional emergency preparedness, operations, personnel and equipment. Vigilant Guardian provided a realistic setting for the ROSS and the RDD Guidance to be leveraged by first responders, emergency managers and public health and government officials who would rely on these tools in the event of a radiological emergency.
NUSTL is proud to announce that its logo has been granted trademark protection by the United States Patent and Trademark Office (USPTO). NUSTL received the USPTO-issued Certificates of Registration for its logo, which was designed to represent the laboratory’s role as a national resource to the first responder community. NUSTL worked with the DHS Office of the General Counsel to seek trademark protection for the logo after its creation in October 2016.

The logo graphically depicts iconic buildings from across the country to capture the national direction of NUSTL’s mission, while not losing sight of its roots in New York City with the representation of the World Trade Center. The Washington Monument and the 875 North Michigan Avenue building were incorporated into the cityscape to symbolize NUSTL’s location in Chicago and presence at DHS S&T’s headquarters in Washington DC.
MANAGEMENT AND ADMINISTRATION AT NUSTL
DELIVERING QUALITY
IN EVERY PRODUCT AND SERVICE

Our nation’s first responder agencies rely on NUSTL’s test and evaluation products and services when making purchasing decisions on equipment and technology. Equipping first responders with the right equipment and technology helps them to better perform their life and property saving missions. As such, it is critical that NUSTL’s products and services are of the highest quality—that they are informative, substantive, interpretable and delivered in a timely manner. To ensure quality, NUSTL has implemented a quality management system (QMS), a collection of policies, procedures, work instructions, and other planning and operational documents that define how NUSTL conducts business and ensures quality products and interactions. This QMS includes specific procedures for test planning, execution and reporting, which ensure that all plans and reports are rigorously reviewed prior to delivery.

NUSTL’s QMS meets the International Organization for Standardization (ISO) for Quality Management Systems. The Certificate of ISO 9001:2015 (pictured right), as certified by Orion Registrar Inc., recognizes the effective management system and outstanding customer service delivered by NUSTL.

Being ISO 9001 certified also means NUSTL’s customers from federal, state and local first responder agencies, S&T’s divisions and offices, and the broader Homeland Security Enterprise can place their highest confidence in the products and services delivered by NUSTL—from field and laboratory testing, technology assessments and radioactive source handling to knowledge products, reports and guidance tools.

NUSTL’s QMS follows a documented, process-based approach to ensure the laboratory’s ability to continually monitor, manage and achieve a rising standard of quality across all facets of our operations. In 2018 and 2019, Orion audited NUSTL and found that NUSTL continued to meet all requirements for maintaining ISO 9001:2015 certification.
ENSURING SAFETY THROUGHOUT OPERATIONS

NUSTL's Safety Health and Environmental Management System (SHEMS) aids in the management of environmental and safety related activities in accordance with federal, state and local regulations. On an annual basis, SHEMS goes through a rigorous auditing process to ensure that the laboratory operates safely and efficiently; this includes training sessions, annual document reviews, as well as internal and external audits. External auditors determined that SHEMS is a mature program, and both functions and integrates with other management programs at NUSTL. Staff members’ awareness of SHEMS and the benefits of the program are well understood across the organization. This is attributed to quarterly safety inspections, continual improvements throughout the lab as well as annual awareness trainings.

It remains evident that NUSTL operates safely and efficiently based on safety metrics that reflect years without an environmental release, a lost work case, an Occupational Safety and Health Administration-recordable case or a radiation exposure case. NUSTL is also in full compliance with the New York City Department of Environmental Protection's Division of Emergency Response and Technical Assessment Unit’s Community Right-To-Know Law. As such, NUSTL’s Director has deemed NUSTL’s SHEMS as suitable, adequate and effective for its intended purposes. Additionally, DHS S&T Environment Safety, Health and Energy Branch personnel gave accolades to NUSTL for the effectiveness of their SHEMS.

UPGRADING INFORMATION TECHNOLOGY

NUSTL upgraded various aspects of information technology equipment to ensure its collaborative facility remains state-of-the-art. Across the laboratory, new audio/video systems including large display screens (pictured right) with multi-input options were installed to provide NUSTL and our partners with a more effective way to conduct trainings, operational assessments, demonstrations and exercises.
NUSTL continued its efforts in property management and environmental sustainability by donating, selling and recycling excess property valued at more than $33,000. Additionally, NUSTL maintained its vehicle fleet and facilitated property related audits throughout the year.

NUSTL’s participation in the Federal Electronics Challenge program, Earth Day Recycling and the GSAXcess enables the laboratory to meet environmental sustainability goals including the repurpose, reuse and recycling of all legacy electronics and waste material.

Between FY 2018 and FY 2019 NUSTL donated, sold or recycled property in a variety of ways including:

- 48 monitors and 1 printer (*pictured top left*) donated to the U.S. CBP in New York, New York
- 2 monitors donated to CISA in New York, New York
- 2 unmanned aircraft systems donated to another DHS S&T office in Washington DC
- 2 laptops donated to Charles H. Darden Middle School in Wilson, North Carolina through Computers for Learning
- 2 monitors donated to Gates of Heaven Ministries academic enrichment program in Staten Island, New York through Computers for Learning
- 2 television sets sold to a private security company in Bronx, New York
- Various units of scientific equipment (*pictured bottom left*) to measure radiation donated to the Department of the Navy’s Office of Naval Research in Washington DC
- 26 pounds of depleted batteries recycled to Batteries Solutions, Inc. in Lubbock, Texas
- 686 pounds of electronic waste recycled to the U.S. General Services Administration
LOOK AHEAD
NUSTL expects FY 2020 to be another high-impact year as requests for NUSTL's T&E expertise, services and products continue to increase. DHS components, S&T offices and the national first responder community have a high demand for NUSTL's honest and objective assessments of emerging and commercially available technologies that can help guide their investment and acquisition decisions. Meanwhile, the laboratory’s work on C-UAS technology continues to press forward into the air domain of homeland security.

NUSTL’s R&D projects will continue to address state and local preparedness for radiological and nuclear emergencies in coordination with FEMA and interagency partners to ensure R&D reflects the highest priorities of federal, state and local partners.