

Testimony of

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*“Passenger Screening R&D: Responding to President
Obama’s Call to Develop and Deploy the Next Generation
of Screening Technologies”*

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Chairman Wu, Ranking Member Smith, and Members of the Subcommittee, I am Bert Coursey, the Program Manager, Coordinated National Security Standards Program, at the Department of Commerce's National Institute of Standards and Technology (NIST). Thank you for the opportunity to appear before you today to discuss NIST's work relevant to passenger screening and our relationship with components of the Department of Homeland Security (DHS), including the Transportation Security Administration (TSA), the Science & Technology Directorate (S&T), and the Transportation Security Laboratory (TSL) of S&T.

Since 2003 NIST has had a coordinated relationship with the DHS where NIST's unique capabilities in measurement science have been leveraged to help address critical challenges in multiple areas relevant to homeland security including chemical and biological agent detection, biometrics, first responder communications, and a number of other areas. Today I will focus my remarks on NIST's efforts relevant to passenger screening technologies, but before I get into the specifics of the work I would like to highlight the unique role that the NIST research efforts play in the larger DHS, TSA, and S&T/TSL research, development, testing, and evaluation enterprise.

As a non-regulatory agency of the U.S. Department of Commerce, NIST's mission is to develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life. To fulfill this mission, NIST scientists and engineers continually refine the science of measurement, making possible the ultra-precise engineering and manufacturing required for today's most advanced technologies. They also are directly involved in standards development and testing done by the private sector and government agencies.

It is this focus, and the unique capabilities which result, that make NIST an important partner in DHS's science and technology efforts. The measurement methods, standards reference materials, and new measurement technologies produced by NIST are used to both improve the reliability and effectiveness of current passenger screening systems, as well as support the development of next generation detection technologies. The importance of this work to DHS efforts and the recognized need for close collaboration was formalized in a 5-year MOU between NIST and DHS signed in 2003 and renewed with a follow-up MOU in 2008.

In the remainder of my testimony, I would like to highlight the work that NIST is engaged in relevant to passenger screening in the following areas:

- Trace explosive detection
- X-ray explosives detection
- Canine explosives detection
- Standoff imaging systems
- Reference data for explosives
- Metal detector standards
- Biometrics standards to enhance screening of travelers

- Conformity assessment support for passenger screening equipment

In each of these areas, NIST is working in collaboration with scientists and engineers from DHS components, with our industry and academic partners, end users and the nation's voluntary standards organizations to set the baseline for standards and test methods for explosives detection. Several projects lead to national voluntary consensus standards through ASTM International, IEEE, INCITS and others, and some of these efforts are leading to international standards promulgated by ISO and IEC. However, in many other projects the test data, test materials and new test methods are being provided to DHS (TSA and S&T) and our other federal partners for their immediate use in testing current and future detection systems.

Trace Explosives Detection

Working closely with the Transportation Security Laboratory (TSL), NIST has been involved since 2003 in a multi-year, DHS funded research program that supports standards and measurement needs for trace explosives screening. The research is designed to improve the reliability and effectiveness of current systems as well as support the development of next generation detection technologies. NIST has developed the necessary infrastructure critical to the task by establishing connections with key stakeholders, purchasing an extensive collection of currently deployed trace explosives detection systems, and developing unique measurement capabilities and standard test materials. This infrastructure allows us to understand and test trace detection technology, including the critical front-end sampling process.

Fundamental Measurements and Sampling Studies

Through our ongoing interaction with stakeholders, including the TSA, we identified that a primary limitation in detecting trace explosives in real world scenarios is the inability to efficiently collect the sample. This resulted from a lack of fundamental understanding of the physical and chemical nature of the explosive residue, and the best mechanisms to collect the explosive particles. We have conducted intensive research in this area with the goal of understanding and improving the sampling process. This work encompasses explosive sample collection by physical swiping, aerodynamics (puffer systems) and direct vapor sniffing. We have developed new measurement science tools to understand these processes and test their efficiency. Working with other standards organizations, such as the American Society for Testing and Materials (ASTM), we are developing methods that allow both manufacturers and instrument users to determine the sample collection efficiency of their systems. In addition, we have developed prototype sampling training aids that can be used to test screeners in the field and that provide useful feedback to improve the process. These standard protocols and materials allow for unbiased determination of the effectiveness of the sampling process. Because the standards are developed from a fundamental understanding of the sampling process, they serve as benchmarks for continual improvement in instrument and sampling design.

Some examples of NIST's outputs in this area have been 1) development of a method to determine sampling efficiencies of sample wipes used for trace detectors, 2) development of a prototype training kit to test and improve screener abilities, 3) research articles on the physical nature of explosives residues, identifying specific sample characteristics to target when designing collection strategies.

Optimization of Trace Explosives Detection Equipment Performance

In addition to improvements in the sampling process, further improvements can be made in the trace explosive instruments themselves. Systems can be optimized for detection of current threats, and modifications can begin for detection of emerging threats. NIST has worked to develop a series of unique measurement tools that allow us to study the operational characteristics and fundamental physics that underpin the operation of commercially deployed explosive trace detectors. By understanding each step of the analysis process in detail we are able to make recommendations for improvements in procedures and instrument setup for optimized detection performance.

For several years, NIST has been studying the fundamental science of detecting trace explosives by aerodynamic, non-contact sampling. Typical implementations of this approach include portal-based (puffer) systems. Methods that we have used to study these systems include laser imaging, high-speed videography, and bulk flow tracking, all of which allow real-time visualization of how the air moves around a person's body. These methods, in turn, give NIST researchers insight into how to sample explosive material from a person's shoes, hands, and body. Results typically lead to a better understanding of how these systems work, and may offer valuable information on how to improve the current technology. NIST has also been actively pursuing advanced sampling research with the TSL, developing technologies capable of evaluating sampling systems that may be five to ten years in the future. Aerodynamic particle sampling is a key concept for these future technologies and likely to be implemented in shoe and cargo sampling which is gaining importance because of the potential for non-contact high-throughput sampling. We have a prototype shoe screening system in our laboratory provided by the TSL.

Standard Test Materials for Tabletop Swipe Based Detectors

Our standards development activities include new types of standard test materials and sampling test methods. The NIST test materials are being developed to test not only the performance of the detection technology but also screener performance. A series of NIST Standard Reference Materials (SRM's) have been produced that allow evaluation of bench-top explosives detectors. We have also developed a novel approach for making explosive test materials using inkjet printing to dispense a known and well-characterized amount of explosives onto special test coupons. This is a cost-effective way of producing a large number of well-characterized and field deployable test materials. We currently produce test materials of the major explosives including RDX, TNT, PETN, and AN. These materials could be used in a variety of scenarios including covert testing, predeployment equipment verification as well as

validation and calibration of already deployed systems. Our goal is to make inkjet printing technology readily available to any other federal agencies that may desire to produce their own test materials. Transferring the technology to end users has been greatly facilitated by the commercialization of all of the inkjet systems currently developed and in use at NIST.

NIST has a long history of working with industry and other government agencies through need-based efforts to develop standard test and reference materials and to work closely in voluntary standards organizations such as ASTM and ISO (International Organization for Standards) where standard methods are written. Standard methods and standard reference materials go hand-in-hand in assuring accuracy and reproducibility across technical communities; in this case verification and calibration of trace detection instrumentation. To document the use of the NIST standard test materials, an ASTM standard method has been developed: ASTM E2520-07 *Standard Practice for Verifying Minimum Acceptable Performance of Trace Explosive Detectors*.

Particle-Based Standard Test Materials

Due to the low vapor pressure of most explosives, the majority of deployed trace explosive detection systems utilize sampling of particle residues. Because sampling of these particles is highly dependent on screener performance, testing of sampling efficiencies and procedures requires the use of standard test particles with known chemical and physical properties. Over the last several years we have also developed a robust protocol for fabricating polymer encapsulated explosive test materials that can be used to test both aerodynamic and swipe based explosives detection systems. These particles are being used in prototype screener testing kits.

Vapor-Based Standard Test Materials

Trace vapor detection is a recent addition to the national strategy and investment in aviation security. Vapor sampling is far easier and less intrusive than particle sampling from surfaces, but suffers from the vanishingly small chemical signals emanating from explosive devices. Trace vapors from explosives are typically mingled with a wide variety of benign compounds in the environment, which can mask or cause false alarms. Reliable vapor-based standard test materials are needed to validate the performance of trace vapor detectors, and to improve the technologies on which they are based.

NIST is developing several systems for performance verification at laboratory and operational sites. We have developed a vapor generator based on inkjet technology, where microdrops containing trace levels of explosives are evaporated and mixed with calibrated air flows. This system, in fact, is capable of reliably generating trace vapors below current detection limits, which provide future validation for next-generation vapor detection technologies.

Field-deployable systems are also being considered and developed. For simple pulsed delivery, there are metered dose inhalers adapted from the health care industry, and encapsulated

scents adapted from the fragrance and flavor industry. For simple continuous delivery, there are vapor permeation and saturation devices (similar to smelling salts and room fresheners).

Next-Generation Trace Explosives Sensors

In an effort that highlights the unique capabilities that can be found at NIST, researchers are adapting frequency comb technology – which originated from Nobel Prize winning research at NIST aimed at producing ultra-precise atomic clocks at NIST—into a sensor that can detect the trace gases of explosives. The detection of trace gases that come from explosives is an extremely challenging problem both because the vapor pressure of many common explosives are extremely low, and because many interferences will also be present in any realistic situation. Through a program funded by DHS S&T, NIST is pursuing a detection technique, known as frequency comb spectroscopy (FCS), with the potential to overcome these challenges, providing high sensitivity AND broad spectral coverage. The challenge posed by the interferences can be met through the broad spectral coverage of the combs; this spectral coverage permits FCS to generate a full spectral fingerprint of the trace gases and therefore achieve the required selectivity. The adaptation of this fundamental measurement science research could ultimately lead to a game-changer detection technology that won't require time consuming sampling methods.

National X-Ray Standards for Bulk Explosives Detection

National X-ray standards are necessary to insure that security screening systems for bulk-explosives detection meet the surveillance challenge while properly handling all radiation safety considerations – i.e., they provide the measurement tools to insure that minimum performance and safety requirements are met.

Through funding from DHS S&T Test & Evaluation and Standards Division, NIST has recently facilitated the development of a suite of national x-ray performance and radiation safety standards that cover the gamut of aviation and transportation venues where explosives are screened: checkpoint, checked luggage, cargo, vehicle, and whole-body imaging. These American standards are finding increasing use in national and international settings through close cooperation between NIST, DHS agencies, industrial partners and foreign partners.

In the area of *security systems for screening of humans using X-rays and/or Gamma rays*, DHS and NIST collaborated in the development of an American National Standard for measuring imaging performance – IEEE ANSI N42.47-2010. This National standard provides standard methods for measuring and reporting imaging quality characteristics and establishes minimally acceptable performance requirements for security-screening systems used to inspect people who are not inside vehicles, containers, or enclosures. Specifically, this National standard applies to systems used to detect objects carried on, or within, the body of the individual being inspected. It covers the use of both, backscatter X-ray systems (i.e., detect the X-rays reflected back from the individual being inspected) and transmission x-ray systems (i.e., detect the X-rays passed through the individual being inspected).

As performance is not the only consideration in the use of these security-screening systems, DHS and NIST have also collaborated on the development of National standards for radiation safety for personnel exposed to them. IEEE ANSI/HPS N43.17-2009 applies to security-screening systems in which people are intentionally exposed to primary beam x rays, gamma radiation, or both. The standard provides guidelines specific to the ionizing radiation safety aspects of the design and operation of these systems. This standard was developed under the sponsorship of IEEE ANSI National Committee on Radiation Instrumentation by a 35-member Working Group with the following Federal representation: 4 NIST employees, 7-DHS (including TSA, DNDO, CBP, USSS, S&T), 1-FBP, 2-OSHA, 2-FDA, 1-NRC, and 2-U.S. Army.

IEEE ANSI/HPS N43.17-2009 was influential in the development of a new international standard on this topic, IEC 62463-2010, which is scheduled for publication in August 2010. This international standard is expected to be more comprehensive covering standard requirements, specify general characteristics, general test procedures, radiation characteristics, electrical characteristics, environmental influences, mechanical characteristics, and safety requirements. It will also provide examples of acceptable methods, in terms of dose to the whole or part of the body, for each screening procedure and their required times. In particular, the standard addresses the design requirements as they relate to the ionizing radiation protection of the people being screened, those in the vicinity of the equipment, and the security-screening systems operators.

In the area of *checkpoint cabinet X-ray imaging*, NIST and DHS have collaborated in the development of an American National standard for the performance and evaluation of checkpoint cabinet X-ray imaging security-screening systems – IEEE ANSI N42.44-2008. This standard describes the criteria, test methods, and test objects used to evaluate the performance of cabinet x-ray imaging systems. The standard addresses systems use to screen items with cross sections smaller than 1 m × 1 m, at security checkpoints and other inspection venues (e.g., entrances to Federal buildings). The standard also establishes minimally acceptable imaging performance values for a specified set of image quality metrics and specifies operational characteristics deemed essential for checkpoint x-ray system performance.

In the area of *X-ray computed tomography (CT) security screening of checked baggage*, DHS and NIST are collaborating on the development of an American National Standard for evaluating the image quality of X-ray CT security-screening systems – IEEE ANSI N42.45-2010. CT security-screening technology is currently been used to screen all checked luggage at US airports and the quality of data for automated analysis is of primary concern. This standard provides standard test-methods and -artifacts for measuring and reporting the image quality of CT security-screening systems. This standard is likely to be considered by TSL as a part of their comprehensive verification and certification of CT security-screening systems.

The above described, and jointly developed, standards and test objects not only guide grants and procurement, but also provide ongoing quality assurance for aging security-screening systems in the field. The uniform application of standard test methods and artifacts allows

comparison of the imaging performance of novel systems and prototypes of competing vendors as well as, provides objective quantitative measures of systems claims for a particular technical implementation of explosives detection.

All of these x-ray performance and safety standards continue to be under spiral development as threats and technical countermeasures evolve.

Canine Explosives Detection

NIST is working to develop test materials and documentary protocols for the reliable evaluation of trace explosives and bomb dog detection. SRMs may be used to evaluate performance prior to procurement and during field service. The goal is to provide a suite of materials for evaluation of both the instrumental trace explosives detectors and bomb dogs. For canine performance materials, advanced metrology has been developed that permits the accurate measurement of the primary odors in numerous explosives. Prototype materials have been prepared that mimic the real explosives odor profile and are about to be tested in certified bomb dogs. These canine SRMs will provide substantial monetary savings as well as greater trainer safety by eliminating the current requirement for training aids based on real explosives. NIST also takes a leading role in the development of consensus standards through organizations such as ASTM and SWGDOG that provide best practice protocols for testing detection systems and canines. This work is funded by the S&T Test & Evaluation and Standards Division, and partners in the standards development activities include scientists in S&T and the NPPD Office of Bombing Prevention.

Standoff imaging systems

NIST research has improved the ability to assess claims on the performance of a wide variety of technologies designed to detect explosives, and other weapons, concealed on persons in high-traffic areas such as airports, railway stations, sports arenas, and similar public venues. The work, which is funded by DHS S&T and DOJ National Institute of Justice, includes studies of the reflectance/transmittance of human skin, fabrics, and threat objects when examined from a distance using ultraviolet, visible, infrared, millimeter wave or microwave radiation. A key performance goal for these standoff technologies is the ability to detect hidden IEDs with high probability under various standard scenarios. NIST scientists are also working with DHS to develop a standard to quantify the body coverage of whole-body imagers, such as x-ray backscatter and millimeter wave systems. These recent efforts leveraged longer-term NIST projects in passive and active millimeter-wave and terahertz sensing for security applications. These projects funded by DHS, DARPA, and DOD, made pioneering contributions to active and passive millimeter-wave imaging security applications. The research led to advanced millimeter-wave and THz imaging systems, calibration targets that have been distributed to some 20-research groups, and a database to guide the development of portal sensors for screening liquids and solids. NIST and DHS, along with other federal agencies and industry partners, are working with standards development organizations to develop standards, test artifacts, and test methods for imaging systems for the detection of explosives and other threats.

Reference data for explosives

NIST Standards Reference Data program is a world-class resource for reference data for thermophysical and spectroscopic properties of materials for the science and engineering communities. NIST has several projects using state of the art systems to acquire new data from physical and chemical measurements, and to provide data sets of critically evaluated data from the literature. Because of the wide range of new technologies under development for explosives detection, there are serious gaps in the reference data. DHS S&T and NIST funding are directed at filling in some of these gaps. One example was driven by the potential of a technique known as *Dielectric spectroscopy* to detect hazardous liquids in containers. NIST work showed that this technique is capable of clearly differentiating dangerous liquids, such as gasoline and bleach, and innocuous liquids, such as water and milk. The results thus far have been limited to special test holders and work is being undertaken to determine the effect of container typically used to hold these liquids. The results of this effort yielded reference data, which can be use by researchers to develop new airport scanning equipment for liquid containers.

A second data project is directed towards thermophysical properties of explosives. Concealed explosives can be detected through the chemical or physical “signatures” that they leave behind. Timely and reliable physical and chemical property information for explosives is therefore essential for the successful development and implementation of new detection techniques. But, the properties of explosives are widely dispersed in the technical literature and are often discordant with poor characterization of data quality (i.e., poor estimates of the uncertainty of the chemical-physical properties of the explosive compound).

With support from DHS S&T, NIST is developing software tools for on-demand, critically-evaluated physical and chemical properties of existing and conceptual explosive compounds. For this project, primary experimental information on the properties of explosives is collected, critically evaluated, and provided to DHS in the form of expert-system software. The NIST expert system includes state-of-the-art property-prediction tools that allow many evaluations for conventional explosives as well as those that have not yet, or cannot yet, be studied experimentally.

Metal detector standards

NIST scientists have developed a world-class reference facility for measuring the performance of metal detectors, both hand-held and walk-through types. This facility uses a computer-controlled robot to reproducibly position and move specially designed test objects through or by a metal detector. The test objects are fabricated using defined metal parameters to ensure consistency from measurement to measurement and between different test facilities. The methods developed to test the pertinent electromagnetic properties of these test objects have been used to support similar test object development for the S&T TSL facility. The NIST facility also uses a human electromagnetic phantom to emulate the effect of a person on metal

detector performance; the materials comprising this phantom were developed in collaboration between NIST and industry scientists. Using this facility, NIST developed rigorous and exacting performance standards, one each for hand-held and walk-through metal detectors, for the National Institute of Justice (NIJ). These NIJ standards are used as a basis for procurement by other agencies, such as the Federal Bureau of Prisons (BOP) and the Transportation Security Administration (TSA). The methods used in these standards have been emulated by other groups developing other checkpoint security standards and/or test and evaluation methods.

Biometric Standards to Enhance Screening of Travelers

NIST helps lead the development of many biometric standards used to support the screening of travelers. For example, NIST serves as the Standards Developing Organization (SDO) for two documentary standards (ANSI/NIST-ITL 1-2007 and ANSI/NIST-ITL 1-2008), which facilitates the interchange of electronic biometric data including fingerprint, and face and iris images. These standards support data sharing and interoperability between points of encounter (e.g., a port of entry) and centralized biometric services provided by DHS US-VISIT/IDENT and other screening partners such as the FBI IAFIS. NIST also participates in the development and deployment of national and international standards, such as INCITS-M1 and ISO/IEC-SC37, which focus on data formats, performance testing, and image quality. With many biometric standards to choose from, NIST also chairs the group that develops the *Registry of USG Recommended Biometric Standards*.

Ensuring the high quality of collected biometric data is key to improving the use of biometrics. To that aim, NIST pioneered a publicly available and interoperable algorithm known as the NIST Fingerprint Image Quality (NFIQ). Building on its expertise, NIST also works to test algorithms for assessing image quality of iris and faces. For example, NIST created the Image Quality Evaluation and Calibration (IQEC) program to evaluate quality factors and metrics that impact iris-recognition accuracy. IQEC is one of a growing list of NIST evaluations for testing and informing biometric standards. Other notable tests include the Minutiae Exchange Test (MINEX) which tested the interoperability between standard fingerprint template generators and matchers; and the first Iris Exchange Test (IREX 1) which tested the matchability of standard compact iris image formats.

When screening travelers, it is important to deploy technology and processes that provide the highest level of security while keeping the traveling public moving efficiently through checkpoints. To facilitate that, NIST conducts biometric usability studies that help ensure that screening systems are easy, efficient, and intuitive for travelers and inspection agents alike. As an example, NIST conducted a positioning study to determine the best installation of fingerprint readers on counters at ports of entry. The results of this study were used by TSA in designing checkpoints and placement of the new 10 finger slap readers. In addition, NIST has developed and tested language-independent, international biometric symbols that will help guide travelers efficiently and effectively through the biometric acquisition process. This work was supported by DHS S&T and products were delivered to US VISIT and TSA.

Conformity assessment support for passenger screening equipment

Non-intrusive Inspection Systems

In collaboration with DHS and standards development committees, NIST has enabled the development of performance standards for non-intrusive inspection systems that cover aviation and transportation venues where explosives are screened to include critical characteristics such as electromagnetic compatibility, fire and electrical safety. These standards facilitate the deployment and use of these technologies in environments where passenger/operator safety and performance degradation from electromagnetic interference are key concerns.

NIST has also assisted the TSA Atlantic City Technical Center in enhancing their technical requirements documents for x-ray inspection equipment by identifying appropriate standards references and testing requirements.

Biometrics

NIST assisted TSA in identifying appropriate standards and conformity assessment procedures for a Qualified Products List (QPL) for Airport Access Control biometrics equipment based on the requirements of the *Intelligence Reform and Terrorism Prevention Act of 2004*.

Following a request and funding from DHS, NIST developed a laboratory accreditation program for testing of biometrics products to support the TSA Airport Access Control QPL program; the NIST National Voluntary Laboratory Accreditation Program (NVLAP) will establish an accredited lab network for third party testing to standards for biometrics equipment. This program is available for use by other DHS and other federal labs - a major step towards providing uniformity of testing for commercial cards, readers and other biometrics equipment purchased by the federal and jurisdictional agencies.

Summary

Members of the Subcommittee, aviation security is an activity of national importance. The scientific and technological tools that will enhance our security are complex, and major investments are being made by DHS to develop and refine these tools for emerging and evolving threats. Measurements and standards are essential - both to the current generation of security technologies and to next generation S&T approaches. NIST scientists and engineers are proud to accept the challenges and opportunities presented by our colleagues in the other federal agencies charged with improving our aviation security.

Thank you for your dedicated efforts to improve the safety of air travel for all Americans. I appreciate the opportunity to meet with you today to discuss the role of national standards in strengthening passenger screening and I look forward to answering your questions.