THE SCIENCE OF SECURITY, PARTS I AND II

HEARINGS

BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

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THE SCIENCE OF SECURITY, PART I: LESSONS LEARNED IN DEVELOPING, TESTING, AND OPERATING ADVANCED RADIATION MONITORS

THURSDAY, JUNE 25, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brad Miller [Chairman of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

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Subcommittee on Investigations and Oversight

Hearing on

The Science of Security, Part I: Lessons Learned in Developing, Testing and Operating Advanced Radiation Monitors

Thursday, June 25, 2009
10:00 am. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Panel I

Mr. Gene Aloise
Director, Natural Resources and Environment
Government Accountability Office

Dr. Micah Lowenthal
Division on Earth and Life Studies
Nuclear and Radiation Studies Board
National Research Council
The National Academy of Sciences

Panel II

Dr. William Hagan
Acting Deputy Director
Domestic Nuclear Detection Office
Department of Homeland Security

Mr. Todd C. Owen
Acting Deputy Assistant Commissioner
Office of Field Operations
U.S. Customs and Border Protection
Department of Homeland Security

HEARING CHARTER

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

The Science of Security, Part I: Lessons Learned in Developing, Testing, and Operating Advanced Radiation Monitors

THURSDAY, JUNE 25, 2009
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

The Subcommittee on Investigations and Oversight meets on June 25, 2009 to examine problems with the Department of Homeland Security's (DHS) efforts to acquire its next generation radiation monitors known as Advanced Spectroscopic Portals (ASPs). The ASP program has been under scrutiny since 2006 for failing to have clear-cut program requirements, an adequate test plan, sufficient timelines and development milestones or a transparent and comprehensive cost benefit analysis. Since the Domestic Nuclear Detection Office (DNDO), a DHS component, was created in 2005, they have been responsible for researching, developing, testing and managing the program.

The hearing will examine two new independent reports—one by the Government Accountability Office (GAO) and the other by the National Academy of Sciences—that identify ongoing and systematic problems in the testing and development of the ASP program. With an estimated program cost of $2-to-$3 billion the Subcommittee will evaluate the rigor of the overall test program, the technical abilities of the ASPs compared to existing radiation portal monitors and search for lessons from the ASP program that can be applied to future DHS acquisitions.

Background

Since the terrorist attacks of September 11, 2001, protecting the Nation from a nuclear or radiological attack has been a top national security priority. In 2002, to help address this potential threat, the U.S. Customs and Border Protection (CBP) agency began deploying radiation monitors at U.S. border sites and ports of entry so its officers could screen the more than 23 million containers of cargo that enter the country every year for radiological and nuclear materials.

The equipment used to screen this cargo both then and now are polyvinyl toluene (PVT) or "plastic" portal monitors able to detect the presence of radioactive sources, but unable to *identify* the type of radiation present. The PVT monitors, while relatively inexpensive, robust and highly reliable, are unable to distinguish between radioactive sources that might be used to construct a nuclear bomb, such as Highly Enriched Uranium (HEU), and non-threatening naturally occurring radiological materials (NORM) contained in ceramic tiles, zirconium sand or kitty liter, for instance. As a result, any time a PVT monitor detects a radioactive source the cargo is sent to "secondary" screening where CBP agents verify the detection of the radioactive source with a second PVT monitor and use hand-held Radioactive Isotope Identification Devices called RIIDs to help *identify* the source of radiation.

This method of operation leads to many "secondary" inspections for naturally occurring radioactive material or radioactive material intended for benign purposes, such as radioactive medical isotopes. At the Los Angeles/Long Beach port of entry, for instance, PVT monitors routinely send up to 600 conveyances of cargo to secondary inspection each day. The RIIDs, used in secondary inspections however, are limited in their abilities to locate and identify potential threat material in large cargo containers. As a result, CBP officers can consult with scientists in CBP's Laboratories and Scientific Services (LSS) unit who can often help them enhance the ability to correctly identify the radioactive material of concern. As a last resort, CBP officers may physically search a cargo container by emptying its contents and closely scrutinizing it for potentially dangerous radioactive material.

If terrorists were to try to smuggle nuclear or radiological materials in containerized cargo—and there are ample other pathways for such smuggling—they would likely try to shield or "mask" those materials in an attempt to make it more difficult to detect, identify and locate the material of concern. Shielding requires that lead or steal or other types of metal enclose the radioisotopes to hide its radioactive signature. Potential terrorists may also attempt to "mask" threatening radioactive material by placing it together with or alongside other non-threatening material that has a natural radioactive signature, such as ceramic material, kitty litter or even bananas. Most nuclear security experts believe smuggled radioactive or nuclear material would be both shielded and masked in order to conceal it from being located and properly identified. Obviously, these efforts would make it harder to detect.

In order to help both improve the flow of commerce by eliminating many of the false alarms that send cargo for secondary screening and to more accurately identify radioactive or nuclear material, the Department of Homeland Security (DHS) began developing Advanced Spectroscopic Portals (ASPs) in 2004. The ASPs were intended to both *detect* and *identify* radioactive material. In April 2005, the Domestic Nuclear Detection Office was created by National Security Presidential Directive–43/Homeland Security Presidential Directive–14 to, among other things, research, develop, test and acquire radiation detection equipment to be used by CBP and other federal agencies. The office was not formally established until October 2006 under the *SAFE Port Act.*

From the very start of the ASP program, DNDO seemed to push for acquisition decisions well before the technology had demonstrated that it could live up to its promise. On July 14, 2006, Secretary of Homeland Security Michael Chertoff and the Director of DNDO, Vayl Oxford, announced contract awards to three companies worth an estimated $1.2 billion to develop the ASPs, including the Raytheon Company, from Massachusetts, the Thermo Electron Company from Santa Fe, New Mexico and Canberra Industries from Connecticut. Both Chertoff and Oxford held a press conference to announce the billion dollar contract awards just a few months after highly critical reviews of the ASPs' abilities by the GAO and the National Institute of Standards and Technology (NIST).

In March 2006, GAO said: "it is not clear that the benefits of the new portals would be worth any increased cost to the program." In June 2006, NIST submitted a report to DHS on results of side-by-side testing the previous year at the Nevada Test Site of both ASP and PVT systems. The DNDO had assumed that the ASPs would correctly identify HEU 95 percent of the time for both bare or unmasked HEU and HEU masked in a container with more benign radiological material. Yet, NIST found that the three best ASP systems tested identified HEU only 70 to 88 percent of the time. Their ability to identify "masked" HEU was much worse. The three ASP manufacturers did this only 53 percent of the time (Raytheon), 45 percent of the time (Thermo) and 17 percent of the time (Canberra). "Despite these results," the GAO found, "DNDO did not use the information from these tests in its cost-benefit analysis." DNDO claimed that they assumed they would meet the 95 percent performance level at some point in the future but provided no data on why they reached this conclusion, said GAO.

At the Chertoff-Oxford press conference in July 2006, then Secretary of Homeland Security, Michael Chertoff, said one of the key reasons for developing the ASPs and replacing the existing radiation monitors was to "have fewer false positives." In September 2007, Vayl Oxford, the Director of DNDO reiterated that point in testimony to Congress where he emphasized that the ASPs would reduce the number of false alarms from the nearly 600 experienced each day by the PVTs at the port of Long Beach in California, for instance, to 20 to 25 per day with the new ASP monitors.

That was the hope, anyway. One of the criteria for ASP primary screening prior to certification of the new radiation monitors by the Secretary of Homeland Security, which is required by the appropriations committees, is that the ASPs must refer at least 80 percent fewer conveyances for further inspection than the PVTs. But in "field validation tests" earlier this year, by one of the two remaining contractors, the ASPs being tested sent more innocent radioactive shipments to secondary screening than the older PVT monitors. The cause of the high false positives was apparently due to a software glitch. This was a serious concern to the Customs and Border Protection personnel who will have to operate and maintain the ASPs if and when they are certified and deployed. The contractor has reportedly corrected the software issue and intends to return the ASPs to field validation testing next month.

Last fall, "integration" testing of the ASPs by the second remaining contractor was halted because of different technical troubles with its own software. The contractor corrected the problem and its ASP machines re-entered integration testing late last year. The contractor hopes to finish integration testing and begin field validation testing in early August. Still, both contractors are now many months behind schedule because technical issues have forced delays.

Virtually any high-technology research and development program experiences bumps in the road, technical troubles and occasional set-backs. However, well managed programs have clear technical requirements and strategic goals. They ensure that the new technology being developed is thoroughly tested and adequately integrated into the operational plans and procedures of those who must operate them in the field. When these vital components are short changed, when the test plan is insufficient and the program's research, development and testing methods are marred by scanty scientific rigor, the technical tools being developed are bound to suffer as a result. Cutting critical corners in the development process serves no one's interests. Yet, from the start many of the leaders of the ASP program at DHS seemed more interested in fielding this technology then in vigilantly validating its performance and effectiveness. At the July 2006 press conference unveiling the contractors on the ASP program, for instance, Vayl Oxford said: "the priority for the first year . . . is to get units out immediately." Three years later, none of these units have yet cleared field validation tests.

The policy governing the ASP program and the disproportionate focus on getting the ASP units into the field quickly never matched the multiple independent technical assessments of the technology being developed and tested. Over the past three years the Government Accountability Office has issued six reports on the ASP program and testified before Congress multiple times on this matter. Last year the Homeland Security Institute, a Federally Funded Research and Development Center for DHS, issued a report on the ASPs that also criticized the ASP test program, saying it provided insufficient data. The National Academy's of Science, which will release an interim report on the ASPs that they have just concluded this week, will provide testimony at the Subcommittee hearing that echoes many of the concerns raised by GAO over the years.

History of Problems

In 2006, the GAO issued a harsh critique of the DNDO's cost-benefit-analysis (CBA) of the ASPs. The DNDO analysis omitted critical test data that identified major technical problems with the ASPs and they drastically increased the procurement costs of the PVTs. In short, the GAO found DNDO's cost-benefit analysis was "incomplete," based on "unreliable" data and used "inflated cost estimates for PVT equipment."

In 2007, GAO concluded that tests of the ASPs conducted by DNDO were "biased" and "were not an objective and rigorous assessment of the ASPs' capabilities." The tests, for instance, used insufficient amounts of materials likely to mask or shield radioactive threat sources that terrorists might attempt to smuggle into the country. The tests, said GAO, did not attempt to test the limitations of the ASPs and "did not objectively test the performance" of currently used hand-held radiation detectors or RIIDs.

Last year, in their own independent cost estimate of the ASP program, GAO found that the ASPs could cost about $3.1 billion, $1 billion more than the DNDO's estimate. The GAO also found that the DNDO had often changed its deployment strategy, eliminating plans to develop ASP portals for rail, airport and seaport cargo screening terminals, for instance. As a result, GAO estimated the newest scaled back plan reduced the potential costs of the program to about $2 billion from 2008 to 2017. The only documentation that DNDO provided to GAO for this major change in the ASP program was a one-page spread-sheet and DNDO has still not released an updated cost-benefit analysis of the program.

In addition, GAO criticized DNDO's decision not to complete computerized simulations or "injection studies" of the ASPs prior to certification by the Secretary of Homeland Security. The National Academy of Sciences has also found that computer modeling is critically important to the ASP program since running every potential radioactive smuggling scenario in live tests is unrealistic. Computer simulations would help provide a clearer assessment of the potential performance of the ASPs in actual smuggling incidents and effectiveness at identifying threatening radioactive material. DNDO, however, does not plan to complete the studies prior to the Secretary of Homeland Security's decision on certification, which DNDO expects to occur in October.

Problems Remain

While DNDO's past tests have been characterized as being unsound, incomplete and limited in scope, the GAO's most recent work on the ASP program does point to some improvements in the integrity of the latest round of tests. However, they also pinpointed significant technical limitations which have not yet been resolved.

The ASP portals did prove more effective than the PVTs in detecting HEU materials concealed by "light shielding." However, differences between the ASPs and PVTs became less notable when shielding was slightly increased or decreased. In past tests there was virtually no difference in the performance of the two machines with regard to detecting other kinds of radioactive isotopes, such as those used for medical or industrial purposes, according to the GAO, except in one case where the ASPs performed worse than the PVTs. Whether these other forms of radioactive sources are sensed by a PVT or ASP machine they all require secondary inspection to determine why a payload contains radioactive material. In detecting HEU, the ASPs performed better only in one narrowly defined scenario, which many experts see as an unrealistic portrayal of a true attempted nuclear smuggling incident. None of the tests run by DNDO, for instance, included scenarios that utilized both "shielding" and "masking" as a means of attempting to smuggle radioactive or nuclear material.

In addition, GAO and others have faulted DNDO for not focusing enough on attempting to improve the current radiation portal monitor program. Instead, DNDO has been nearly single-mindedly focused on developing Advanced Spectroscopic Portals at the expense of other far simpler alternatives. Surprisingly, for instance, DNDO has not completed efforts to improve the performance of PVTs by a method called Energy Windowing that could provide them with some limited, but enhanced, performance. Energy Windowing efforts are controversial and are believed to only provide modest enhancements to the performance of PVTs. But both GAO and CBP has been pushing DNDO to do more on this front for years. In addition, DNDO has not made efforts to upgrade the software in the hand-held radiation detection units known as RIIDs that could also provide a far less expensive alternative to enhancing the operational effectiveness of radiation monitors.

Because both remaining ASP contractors suffered from serious technical problems in their last round of testing, Customs and Border Protection (CBP) agency personnel fear that if the ASPs are certified, procured and deployed that they will encounter many problems in the field that will negatively impact their day-to-day operations and perhaps the technical effectiveness of the current radiation monitoring program to actually detect illicit nuclear or radiological material coming into the country. The GAO, National Academy of Sciences and others have also criticized DNDO for not seeking input from CBP officials on the ASP program from the start. The relationship has improved and DNDO does attempt to include CBP in critical decisions regarding the ASP program today. But many critics say perhaps one of DNDO's biggest failures was the fact that they did not do this from the beginning, seeking input from the operational users of the technology that DNDO was tasked to research, test and develop.

As a result of all of these issues, the ASPs continue to suffer from key questions about their ability to provide significant improved performance over existing radiation detection equipment currently fielded at U.S. ports. The Department of Homeland Security has already spent more than $235 million on the ASP program. But if the Secretary of Homeland Security certifies that the ASP monitors are worth investing in this fall—just three to four months from now—then $2 billion more may be invested to procure ASP radiation monitors. Yet, given the continued criticism of the narrowly focused and inadequate ASP test program, the limited technical improvements they may offer over current radiation monitors and significant increased costs to maintain and operate the ASPs compared to the PVTs, the success of the program remains in doubt.

Key Issues

- **Go Slow.** Uncovering and resolving technical problems once newly developed radiation monitors are fielded may hinder the ability to detect and identify radioactive or nuclear material that poses a potential threat. It could disrupt operations at U.S. borders and ports of entry curtailing the flow of commerce and it will cost more to rectify these problems in the field, rather than in the laboratory or at the test range. Yet, rather than carefully testing and validating the performance and effectiveness of the ASP monitors before a major procurement decision is made DHS has continually sought to get the ASPs into the field in spite of critical technical flaws identified during testing.

- **Cost Benefit Analysis.** Even if the technical abilities of the ASPs are proven, their relative technical capabilities and increased costs must be carefully weighed in comparison to the existing radiation monitoring system in place today. Replacing a proven, less-costly system that has the confidence of its operators, must be given careful consideration. The DNDO has not yet provided an updated cost-benefit-analysis that would validate a decision to procure the multi-billion dollar ASP equipment.

- **Judging Performance.** As the House Committee on Appropriations has said in the past, procurement of the Advanced Spectroscopic Portal monitors should not proceed until they are deemed to add a "significant increase in operational effectiveness" over the current PVT system already in place. Last July, CBP, DNDO and the DHS management directorate jointly issued criteria for determining this increase in effectiveness in both "primary" and "secondary" screening. In primary screening the criteria requires ASPs to detect potential threats as well as or better than PVTs, show improved detection of Highly Enriched Uranium and reduce innocent alarms. In secondary screening the criteria requires ASPs to reduce the probability of misidentifying special nuclear material (HEU or plutonium) and reduce the average time to conduct secondary screenings. The Secretary of Homeland Security must certify to Congress that the ASPs have met these criteria before funding for full-scale procurement of the ASPs goes forward. However, the criteria to measure this improvement are weak and rather vague.
- **Lessons Learned.** The Department of Homeland Security must make greater efforts to avoid rushing to acquisition decisions when the R&D is incomplete. With ASPs, the research and development program itself has been hindered by a lack of rigorous scientific evaluations, and undemanding testing protocols. Moving to acquire systems plagued by such problems may endanger security and significantly increase the costs of the program. A review of DHS's major programs by GAO last November found that 45 of 48 major programs did not adhere to the agency's own investment review process that helps provide appropriate oversight to address cost, schedule and performance problems. In FY 2008, the review found, DHS spent $147.5 million on the ASP program despite the fact it did not have a mission needs statement. The program also lacked operational requirements documents and an acquisition program baseline.

Witnesses

Panel I:

Mr. Gene Aloise, Director, Natural Resources and Environment, Government Accountability Office

Dr. Micah Lowenthal, Division on Earth and Life Studies, Nuclear and Radiation Studies Board, National Research Council, The National Academy of Sciences

Panel II:

Dr. William Hagan, Acting Deputy Director, Domestic Nuclear Detection Office (DNDO), Department of Homeland Security (DHS)

Mr. Todd C. Owen, Acting Deputy Assistant Commissioner, Office of Field Operations, U.S. Customs & Border Protection (CBP), Department of Homeland Security (DHS).

Chairman **Miller**. The hearing will now come to order. Good morning. Welcome to today's hearing, *The Science of Security: Lessons Learned in Developing, Testing, and Operating Advanced Radiation Monitors.*

In the wake of the terrorist attacks on September 11, 2001, preventing the detonation of a nuclear or radiologic device—a 'dirty bomb'—in the United States has become a top national security objective. We have invested billions of dollars since 9/11 to develop the means to prevent, detect and respond to any attack by weapons of mass destruction. We developed radiation monitors at our port and border crossings to screen millions of cargo containers entering the United States every year, hunting for radiological material that could be used for terrorist purposes. Since 2004, the Department of Homeland Security has spent more than $230 million on a program to develop a new radiation detection system called an Advanced Spectroscopic Portal, or ASP, that can both detect and identify nuclear material.

Congress expects that the funding federal agencies receive will be well spent. When it comes to scientifically challenging or technically demanding programs, it pays to have well-prepared program requirements, demanding testing protocols and an independent and comprehensive cost-benefit analysis. Those vital steps, those vital program components help managers make informed decisions about whether to move forward with a technology development program or to replace a proven technology with a new technology. Unfortunately, despite recent progress, the ASP program has suffered because it lacked all the preparatory steps of a well-managed program. We will hear about some of those problems today from the Government Accountability Office and the National Academies of Science.

Over the years, the GAO has released six reports on the ASP program. The GAO found that some of the Domestic Nuclear Detection Office's tests were biased and did not provide a rigorous assessment of ASP's capabilities. The Agency relied on incomplete and unreliable data in their cost-benefit analysis, omitting critical test data, inflating the cost of current radiation detectors and underestimating the cost of ASP monitors. The Department failed to produce a requirements document or adequate documentation regarding major changes to the planned ASP deployment strategy. DNDO never considered the option of investigating improvements of the existing radiation portal monitoring program, both the PVT monitors and the hand-held detectors that Customs and Border Protection agents rely upon.

The National Academy of Science's interim report on the ASP program, released yesterday, reflects many of the same concerns. The Academy calls for significant restructuring of DHS testing procedures for the ASP program. They question the criteria being used to judge the ASPs' performance and they recommend that DHS not proceed with further ASP procurement until they address all the findings and recommendations in their report.

GAO's reports have provided a regular accounting of how the ASP program was going wrong. The Academy report provides a roadmap to how the program can be put back on track, assuming that the Department determines that it is worth the cost and effort.

Radioactive materials have become a normal part of commerce. They are used for medical procedures and industrial applications. Bananas have radiation. Technology can help us detect and identify radioactive sources in cargo containers but no technology can sort out good radioactive material intended for legitimate purposes from the bad radioactive materials intended to do us harm. As a result, human operators will still need to make important decisions often informed by intelligence efforts to keep the Nation secure. Well-trained, well-equipped people, law enforcement officers and Customs and Border Protection inspectors will always be critical to the equation.

This hearing addresses our responsibility to the technological part of that equation. Before we move forward with a $2 billion or $3 billion program, we must ensure that we get our money's worth from the new technology. Put another way, if we have $2 billion or $3 billion to spend to enhance our security, is this technology really how we should spend it?

I look forward to hearing from all of our witnesses today.

And now I recognize Dr. Broun, the Ranking Member from Georgia, for an opening statement.

[The prepared statement of Chairman Miller follows:]

PREPARED STATEMENT OF CHAIRMAN BRAD MILLER

In the wake of the terrorist attacks of September 11, 2001, preventing the detonation of a nuclear or radiological device in the U.S. has become a top national security objective.

We have invested billions of dollars since 9/11 to develop the means to prevent, detect and respond to any attack by weapons of mass destruction. We have deployed radiation monitors at our ports and border crossings to screen millions of cargo containers entering the U.S. every year, hunting for radiological material that could be used for terrorist purposes. Since 2004, the Department of Homeland Security (DHS) has spent more than $230 million on a program to develop a new radiation detection system called an Advanced Spectroscopic Portal or ASP that can both detect and identify nuclear material.

Congress expects that the funding federal agencies receive will be well spent. When it comes to scientifically challenging or technically demanding programs, studies have shown that it pays to have well-prepared program requirements, demanding testing protocols and an independent and comprehensive cost benefit analysis. These vital program components help managers make informed decisions about whether to move forward with a technology development program, or to replace a proven technology with a new technology. Unfortunately, despite some recent progress, the ASP program has suffered because it lacked all the preparatory steps of a well managed program. We will hear about some of those problems today from both Government Accountability Office (GAO) and the National Academies of Science.

Over the past three years the GAO has released six reports on the ASP program. The GAO found that some of the Domestic Nuclear Detection Office's (DNDO) tests were "biased" and did not provide a rigorous assessment of the ASP's capabilities. The agency relied on "incomplete" and "unreliable" data in their cost-benefit analysis—omitting critical test data, inflating the costs of the current radiation detectors, and underestimating the costs of ASP monitors. The Department failed to produce a requirements document or adequate documentation regarding major changes to their planned ASP deployment strategy. DNDO never considered the option of investing in improvements to the existing radiation portal monitoring program—both the current polyvinyl toluene (PVT) monitors and the hand-held detectors Customs and Border Protection agents rely upon.

The National Academy of Sciences' interim report on the ASP program, released yesterday, reflects many of the same concerns. The Academy calls for a significant restructuring of DHS testing procedures for the ASP program, they question the criteria being used to judge the ASP's performance and they recommend that DHS not proceed with further ASP procurement until they address all of the findings and recommendations in their report.

GAO's reports have provided a regular accounting of how the ASP program was going wrong; the Academy's report provides a roadmap to how the program could be put back on track—assuming that the Department determines that is worth the cost and effort.

Radioactive materials have become a normal part of commerce. They are used for medical procedures and industrial applications. Technology can help us detect and identify radioactive sources in cargo containers, but no technology can sort out "good" radioactive material intended for legitimate purposes from the "bad" radioactive material intended to do us harm. As a result, human operators will need to make important decisions, often informed by intelligence efforts, to keep the Nation secure. Well trained, well equipped people—law enforcement officers and customs and border protection inspectors—will always be critical to the equation.

This hearing addresses our responsibility to the technological part of that equation. Before we move forward with a two to three billion dollar program we must ensure that we get our money's worth from the new technology. Put another way, if we have two or three billion dollars to spend to enhance our security, is this technology really how we should spend it?

I look forward to hearing from all of our witnesses today.

Mr. BROUN. Thank you, Mr. Chairman. I want to welcome our witnesses here today and to thank you for participating in this important hearing on the Department of Homeland Security's Advanced Spectroscopic Portal program. I know it is hard to say, particularly for the non-scientist, but I am a scientist—I am a physician.

Yesterday the House took up consideration of the DHS appropriations bill, and later today the Science Committee's Technology and Innovation Subcommittee, which I am also a Member of, will hold a hearing on cyber security. I also sit on the Homeland Security Committee's Subcommittee on Emerging Threats, Cyber Security, Science and Technology as well. Needless to say, DHS has kept me busy this week.

This morning we will look into the status of the Department's ongoing development of the next-generation radiation portal monitors, get an update from GAO on their continued work, and receive a report from the National Research Council. It goes without saying that this program has been followed closely for some time now and thankfully many of the testing issues that GAO has brought up in previous reports seem to have been mitigated, at least somewhat. However, this program is far from out of the woods. In their most recent analysis, GAO and the Academy raised new issues relating to the rigor of the testing and the certification process and offer paths forward for potential acquisition in the future. I hope DHS takes these recommendations seriously, and I look forward to ensuring that they are not summarily dismissed for the sake of arbitrary timetables. We see that frequently here in government.

Looking forward, DHS should conduct a rigorous cost-benefit analysis that takes into account updated threat assessments, a review of all variations of concepts of operations, potential upgrades to existing technologies and independent cost estimates. It also needs to weigh the pros and cons not just of ASP versus Polyvinyl Toluene (PVT) and Radio-Isotope Identification Devices (RIID), but also whether the additional capability gained outweighs the needs of other aspects of the global nuclear detection architecture. Unfortunately, this may be hard to do at this point considering GAO indicated earlier this year that the Domestic Nuclear Detection Office had, to quote GAO, “not developed an overarching strategic plan to guide its development of a more comprehensive global strategy for nuclear detection.”

All of these factors need to be taken into consideration as DHS moves toward an acquisition. Even then I will remain cautious, given the Department’s track record with past acquisitions. Many of the issues we are dealing with today could have been prevented by engaging the end-users early on in the process and also by clearly defining the requirements and simply following existing Department acquisition processes.

Last week this subcommittee held a hearing on issues plaguing NPOESS. The AST program exhibits eerie similarities to that program in that it attempted to link research and development activities with the acquisition of an operational system and had unclear architectural priorities. Let us hope other federal programs can learn from these lessons and protect taxpayers from future inefficiencies and waste.

Mr. Chairman, I yield back the balance of my time and I look forward to our witnesses’ testimony. Thank you.

[The prepared statement of Mr. Broun follows:]

PREPARED STATEMENT OF REPRESENTATIVE PAUL C. BROUN

Thank you, Mr. Chairman. I want to welcome the witnesses here today, and thank them for participating in this important hearing on the Department of Homeland Security’s (DHS) Advanced Spectroscopic Portal (ASP) program.

Yesterday the House took up consideration of the DHS Appropriation bill, and later today the Science Committee’s Technology and Innovation Subcommittee, which I also sit on, will hold a hearing on cyber security. I also sit on the Homeland Security Committee’s Subcommittee on Emerging Threats, Cyber Security, Science and Technology, as well. Needless to say, DHS has kept me busy this week.

This morning we will look into the status of the Department’s ongoing development of next-generation Radiation Portal Monitors, get an update from General Accountability Office (GAO) on their continuing work, and receive a report from the National Academy of Sciences. It goes without saying that this program has been followed closely for some time now, and thankfully many of the testing issues that GAO brought up in previous reports seem to be mitigated. However, this program is far from “out of the woods.” In their most recent analysis, GAO and the Academy raise new issues relating to the rigor of the testing and certification process, and offer paths forward for a potential acquisition in the future. I hope DHS takes these recommendations seriously, and I look forward to ensuring that they are not summarily dismissed for the sake of arbitrary timetables.

Looking forward, DHS should conduct a rigorous Cost-Benefit Analysis (CBA) that takes into account updated threat assessments, a review of all variations of Concepts of Operations (CONOPS), potential upgrades for existing technologies, and independent cost estimates. It also needs to weigh the pros and cons of not just ASP versus Polyvinyl Toluene (PVT) and Radio-isotope Identification Devices (RIID), but also whether the additional capability gained outweighs the needs of other aspects of the Global Nuclear Detection Architecture. Unfortunately, this may be hard to do at this point considering GAO indicated earlier this year that the Domestic Nuclear Detection Office (DNDO) had “not developed an overarching strategic plan to guide its development of a more comprehensive global strategy for nuclear detection.”

All of these factors need to be taken into consideration as DHS moves toward an acquisition. Even then, I will remain cautious given the Department’s track record with past acquisitions. Many of the issues we are dealing with today could have been prevented by engaging the end-users early in the process, clearly defining requirements, and simply following existing Department acquisition processes.

Last week this subcommittee held a hearing on issues plaguing the National Polar-Orbiting Environmental Satellite System (NPOESS). The ASP program exhibits eerie similarities to that program in that it attempted to link research and development activities with the acquisition of an operational system, and had unclear architectural priorities. Let's hope other federal programs can learn from these lessons and protect taxpayers from future inefficiencies and waste.

With that, Mr. Chairman, I yield back my time.

Thank you.

Chairman MILLER. Thank you, Dr. Broun.

Panel I:

Chairman MILLER. I am now pleased to introduce our panel of witnesses. Mr. Gene Aloise is the Director of Natural Resources and Environment at the Government Accountability Office, GAO, and Dr. Micah Lowenthal is the Director of the Nuclear Security and Nuclear Facility Safety Program in the Nuclear and Radiation Studies Board at the National Research Council of the National Academy of Sciences. Is that how you describe your job at a cocktail party?

As our witnesses should know, you each have five minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When you have all completed your spoken testimony, we will begin with questions and each Member will have five minutes to question the panel. It is the practice of this subcommittee to receive testimony under oath. Do either of you have any objection to taking an oath? Okay. You also have the right to be represented by counsel. Do either of you have counsel here? If you would please stand and raise your right hand? Do you swear to tell the truth and nothing but the truth?

The record will reflect that both Mr. Aloise and Dr. Lowenthal took the oath. Mr. Aloise, you may begin.

STATEMENT OF MR. GENE ALOISE, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE (GAO)

Mr. ALOISE. Thank you, Mr. Chairman.

Mr. Chairman and Members of the Subcommittee, I am pleased to be here today to discuss DHS's plans to develop and test advanced portal monitors for use at the Nation's borders to prevent nuclear materials from being smuggled into the United States. According to DHS, the current system of radiation detection equipment is effective and does not impede the flow of commerce. However, DHS wants to improve the capabilities of the existing equipment with new equipment.

One of the major drawbacks of the new equipment is the substantially higher cost compared to the existing equipment. We estimated in September 2008 that the life cycle cost of each standard cargo version of the ASP to be about $823,000 compared to about $308,000 for the PVT standard cargo portal and that the total program cost for the Domestic Nuclear Detection Office's (DNDO) latest deployment plan would be about $2 billion.

Since 2006, we have issued six reports, and including today, four testimonies, and have made 19 recommendations for improving DNDO's efforts to develop and test portal monitors. Our concerns have focused on the need for realistic and objective testing of ASPs, full disclosure and reporting of testing limitations, development of cost estimates that consider the full cost to deploy the new equipment, and development of a sound cost-benefit analysis which determines whether the marginal increase in security from the ASPs is worth its very high cost.

My testimony today is based on our recent report, which assessed the most recent round of ASP testing. I will also discuss the lessons learned from ASP testing. Our work on the latest round of ASP testing found that DHS increased the rigor in comparison with previous tests, and thereby added credibility to the test results. However, we still question whether the benefits of the ASP justify the high cost. In particular, DHS's criteria for significant increase in operational effectiveness require only marginal improvement in the detection of certain weapons-usable nuclear material. The marginal improvement required of ASPs is particularly notable given that DNDO has not completed efforts to enhance the performance of the current generation of equipment. Customs and Border Protection (CBP) officials have told us that they have repeatedly urged DNDO to investigate improving the performance of the equipment through what is known as energy windowing. DNDO has collected the data necessary to do this, but has not yet completed efforts to analyze the data and further improve the technique.

Our analysis of the new test results shows that ASPs detected certain nuclear materials better than PVTs when shielding approximated DOE threat guidance, which is based on light shielding. However, differences between the two systems were hard to recognize when shielding was slightly increased or decreased. Both systems had difficulty in detecting nuclear materials when shielding was somewhat greater than threat guidance, which is set to match the extent of the detection limits of the PVTs. Importantly, the threat guidance is not a realistic approximation of how a terrorist might shield nuclear material to successfully smuggle it undetected through a border crossing.

In addition, DNDO underestimated the time needed for ASP testing, which was originally supposed to be finished by September 2008. DHS's most recent schedule anticipated ASP certification around May 2009, but testing has been delayed even further, and DHS has not updated its schedule. As far as we know, certification is scheduled for some time this fall.

Of concern to us is the fact that DNDO does not plan to complete simulations that could provide additional insights into ASP capabilities and limitations prior to certification. On this point, DNDO does not seem to have learned from past mistakes. A rush to deploy ASPs before all testing is complete leads to shortcuts in testing and raises questions among stakeholders about the equipment's effectiveness and reliability. Furthermore, DNDO has not yet updated its cost-benefit analysis, which might show that DNDO's plan to replace existing equipment is not justified.

One of the primary lessons to be learned from our work is to avoid the pitfalls in testing that stem from a rush to procure new technologies. In the case of the ASP, a push to rush to replace existing equipment led to a testing program which lacked scientific rigor. Even for the new round of testing, DNDO consistently underestimated the time necessary to conduct tests and resolve problems, and testing is still not completed.

In closing, we believe that given the importance of this new equipment to our national security, that Congress and the American taxpayer still need to know three things: does the equipment work, how much will it cost; and does the marginal increase in security justify its very high cost.

Mr. Chairman, that concludes my remarks and I would be happy to respond to any questions you and the Ranking Member may have.

[The prepared statement of Mr. Aloise follows:]

PREPARED STATEMENT OF GENE ALOISE

Combating Nuclear Smuggling: Lessons Learned From DHS Testing of Advanced Radiation Detection Portal Monitors

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss GAO's work on the Department of Homeland Security's (DHS) testing of advanced spectroscopic portal (ASP) radiation detection monitors. As you are aware, the national security mission of U.S. Customs and Border Protection (CBP), an agency within DHS, includes screening for smuggled nuclear or radiological material that could be used in a nuclear weapon or radiological dispersal device (a "dirty bomb"). To screen cargo at ports of entry, CBP conducts primary inspections with radiation detection equipment called portal monitors—large stationary detectors through which cargo containers and vehicles pass as they enter the United States. When radiation is detected, CBP conducts secondary inspections using a second portal monitor to confirm the original alarm and a hand-held radioactive isotope identification device to identify the radiation's source and determine whether it constitutes a threat.

The polyvinyl toluene (PVT) portal monitors currently in use can detect radiation but cannot identify the type of material causing an alarm. As a result, the monitors' radiation alarms can be set off even by benign, naturally occurring radioactive material. One way to reduce the rate of such innocent alarms—and thereby minimize unnecessary secondary inspections and enhance the flow of commerce—is to adjust the operational thresholds (i.e., operate the PVTs at a reduced level of sensitivity). However, reducing the sensitivity may make it more difficult to detect certain nuclear materials.

To address the limitations of current-generation portal monitors, DHS's Domestic Nuclear Detection Office (DNDO) in 2005 began to develop and test ASPs, which are designed to both detect radiation and identify the source.[1] DNDO hopes to use the new portal monitors to replace at least some PVTs currently used for primary screening, as well as PVTs and hand-held identification devices currently used for secondary screening. However, in September 2008, we estimated the life cycle cost of each standard cargo version of the ASP (including deployment costs) to be about $822,000, compared with about $308,000 for the PVT standard cargo portal, and the total program cost for DNDO's latest plan for deploying radiation portal monitors—which relies on a combination of ASPs and PVTs and does not deploy radiation portal monitors at all border crossings—to be about $2 billion.[2]

Concerned about the performance and cost of the ASP monitors, Congress required the Secretary of Homeland Security to certify that the monitors will provide a "significant increase in operational effectiveness" before DNDO obligates funds for full-scale ASP procurement.[3] The Secretary must submit separate certifications for

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[1] DNDO was established within DHS in 2005; its mission includes developing, testing, acquiring, and supporting the deployment of radiation detection equipment at U.S. ports of entry. CBP began deploying portal monitors in 2002, prior to DNDO's creation, under the radiation portal monitor project.

[2] GAO, *Combating Nuclear Smuggling: DHS's Program to Procure and Deploy Advanced Radiation Detection Portal Monitors Is Likely to Exceed the Department's Previous Cost Estimates,* GAO–08–1108R (Washington, D.C.: Sept. 22, 2008).

[3] *Consolidated Appropriations Act,* 2008, Pub. L. No. 110–161, 121 Stat. 1844, 2069 (2007); *Consolidated Security, Disaster Assistance, and Continuing Appropriations Act,* 2009, Pub. L. No. 110–329, 121 Stat. 3574, 3679 (2008).

primary and secondary inspection. In response, CBP, DNDO, and the DHS management directorate jointly issued criteria in July 2008 for determining whether the new technology provides a significant increase in operational effectiveness. The primary screening criteria require that the new portal monitors detect potential threats as well as or better than PVTs, show improved performance in detection of highly enriched uranium (HEU), and reduce innocent alarms. To meet the secondary screening criteria, the new portal monitors must reduce the probability of misidentifying special nuclear material (e.g., HEU and plutonium) and the average time to conduct secondary screenings.

DNDO designed and coordinated a new series of tests, originally scheduled to run from April 2008 through September 2008, to determine whether the new portal monitors meet the certification criteria for primary and secondary screening and are ready for deployment. Key phases of this testing program include concurrent testing led by DNDO of the new and current equipment's ability to detect and identify threats and of ASPs' readiness to be integrated into operations for both primary and secondary screening at ports of entry; field validation led by CBP at four northern and southern border crossings and two seaports; and an independent evaluation, led by the DHS Science and Technology Directorate at one of the seaports, of the new portal monitors' effectiveness and suitability.

Since 2006, we have issued six reports and four testimonies on development of radiation detection portal monitors, including today's testimony, and have made 19 recommendations for improving DNDO's efforts to develop and test portal monitors. Our concerns have focused on key areas in which DNDO's efforts have lacked the necessary rigor given ASPs' high cost and the importance of the radiation portal monitor project to our national security. These areas include objective and realistic testing of ASPs' performance in comparison with the performance of current-generation equipment; full disclosure and reporting of the limitations of tests used to support a decision by the Secretary of Homeland Security on ASP certification; development of a cost estimate that considers the full costs of the plan for deploying radiation detection portal monitors; and development of a cost-benefit analysis based on ASPs' demonstrated performance and a complete accounting of the portal monitor project's costs. (App. I presents a summary of our key findings and recommendations related to ASPs.) As I will discuss today, DNDO has improved the rigor of testing but has not yet updated the cost-benefit analysis that is critical to a decision on whether to replace radiation detection equipment already deployed at ports of entry with the significantly more expensive ASPs.

Specifically, my testimony discusses (1) our key findings on the most recent round of ASP testing and (2) lessons from ASP testing that can be applied to other DHS technology investments. These findings are based on our report released this week and other related GAO reports.[4] We conducted this performance audit work in June 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to produce a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our statement today.

The Latest Round of Testing Highlights the Limitations of ASPs

Our report on the latest round of ASP testing found that DHS increased the rigor of ASP testing in comparison with previous tests and that a particular area of improvement was in the performance testing at the Nevada Test Site, where DNDO compared the capability of ASP and current-generation equipment to detect and identify nuclear and radiological materials. For example, unlike in prior tests, the plan for the 2008 performance test stipulated that there would be no system contractor involvement in test execution. Such improvements addressed concerns we previously raised about the potential for bias and provided credibility to the results.

Nevertheless, based on the following factors, we continue to question whether the benefits of the new portal monitors justify the high cost:

- *The DHS criteria for a significant increase in operational effectiveness.* Our chief concern with the criteria is that they require a marginal improvement over current-generation portal monitors in the detection of certain weapons-usable nuclear materials when ASPs are deployed for primary screening. DNDO considers detection of such materials to be a key limitation of current-generation portal monitors. We are particularly concerned about the marginal

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[4] GAO, *Combating Nuclear Smuggling: DHS Improved Testing of Advanced Radiation Detection Portal Monitors, but Preliminary Results Show Limits of the New Technology,* GAO–09–655 (Washington, D.C.: May 21, 2009).

improvement required of ASPs because the detection threshold for the current-generation portal monitors does not specify a level of radiation shielding that smugglers could realistically use. DOE and national laboratory officials told us that DOE's threat guidance used to set the current detection threshold is based not on an analysis of the capabilities of potential smugglers to take effective shielding measures but rather on the limited sensitivity of PVTs to detect anything more than certain lightly shielded nuclear materials. DNDO officials acknowledge that both the new and current-generation portal monitors are capable of detecting certain nuclear materials only when unshielded or lightly shielded. The marginal improvement in detection of such materials required of ASPs is particularly notable given that DNDO has not completed efforts to fine-tune PVTs' software and thereby improve sensitivity to nuclear materials. DNDO officials expect they can achieve small improvements in sensitivity, but DNDO has not yet funded efforts to fine-tune PVTs' software. In contrast to the marginal improvement required in detection of certain nuclear materials, the primary screening requirement to reduce the rate of innocent alarms could result in hundreds of fewer secondary screenings per day, thereby reducing CBP's workload and delays to commerce. In addition, the secondary screening criteria, which require ASPs to reduce the probability of misidentifying special nuclear material by one-half, address the inability of relatively small hand-held devices to consistently locate and identify potential threats in large cargo containers.

- *Preliminary results of performance testing and field validation.* The preliminary results presented to us by DNDO are mixed, particularly in the capability of ASPs used for primary screening to detect certain shielded nuclear materials. Preliminary results show that the new portal monitors detected certain nuclear materials better than PVTs when shielding approximated DOE threat guidance, which is based on light shielding. In contrast, differences in system performance were less notable when shielding was slightly increased or decreased: Both the PVTs and ASPs were frequently able to detect certain nuclear materials when shielding was below threat guidance, and both systems had difficulty detecting such materials when shielding was somewhat greater than threat guidance. With regard to secondary screening, ASPs performed better than hand-held devices in identification of threats when masked by naturally occurring radioactive material. However, differences in the ability to identify certain shielded nuclear materials depended on the level of shielding, with increasing levels appearing to reduce any ASP advantages over the hand-held identification devices. Other phases of testing uncovered multiple problems in meeting requirements for successfully integrating the new technology into operations at ports of entry. Of the two ASP vendors participating in the 2008 round of testing, one has fallen behind due to severe problems encountered during testing of ASPs' readiness to be integrated into operations at ports of entry ("integration testing"); the problems may require that the vendor redo previous test phases to be considered for certification. The other vendor's system completed integration testing, but CBP suspended field validation after two weeks because of serious performance problems resulting in an overall increase in the number of referrals for secondary screening compared with existing equipment.
- *DNDO's plans for computer simulations.* DNDO does not plan to complete injection studies—computer simulations for testing the response of ASPs and PVTs to simulated threat objects concealed in cargo containers—prior to the Secretary of Homeland Security's decision on certification even though delays to the ASP test schedule have allowed more time to conduct the studies. According to DNDO officials, injection studies address the inability of performance testing to replicate the wide variety of cargo coming into the United States and the inability to place special nuclear material and other threat objects in cargo during field validation. DNDO had earlier indicated that injection studies could provide information comparing the performance of the two systems as part of the certification process for both primary and secondary screening. However, DNDO subsequently decided that performance testing would provide sufficient information to support a decision on ASP certification. DNDO officials said they would instead use injection studies to support effective deployment of the new portal monitors.
- *Lack of an updated cost-benefit analysis.* DNDO has not yet updated its cost-benefit analysis to take into account the results of the latest round of ASP testing. An updated analysis that takes into account the results from the latest round of testing, including injection studies, might show that DNDO's

> plan to replace existing equipment with ASPs is not justified, particularly given the marginal improvement in detection of certain nuclear materials required of ASPs and the potential to improve the current-generation portal monitors' sensitivity to nuclear materials, most likely at a lower cost. DNDO officials said they are currently updating the ASP cost-benefit analysis and plan to complete it prior to a decision on certification by the Secretary of Homeland Security.

Our report recommended that the Secretary of Homeland Security direct DNDO to (1) assess whether ASPs meet the criteria for a significant increase in operational effectiveness based on a valid comparison with PVTs' full performance potential and (2) revise the schedule for ASP testing and certification to allow sufficient time for review and analysis of results from the final phases of testing and completion of all tests, including injection studies. We further recommended that, if ASPs are certified, the Secretary direct DNDO to develop an initial deployment plan that allows CBP to uncover and resolve any additional problems not identified through testing before proceeding to full-scale deployment. DHS agreed to a phased deployment that should allow time to uncover ASP problems but disagreed with GAO's other recommendations, which we continue to believe remain valid.

Procurement Decisions for New Technologies Require Rigorous Testing and Thorough Analysis of Results

The challenges DNDO has faced in developing and testing ASPs illustrate the importance of following existing DHS policies as well as best practices for investments in complex homeland security acquisitions and for testing of new technologies. The DHS investment review process calls for executive decision-making at key points in an investment's life cycle and includes many acquisition best practices that, if applied consistently, could help increase the chances for successful outcomes. However, we reported in November 2008 that, for the period from fiscal year 2004 through the second quarter of fiscal year 2008, DHS had not effectively implemented or adhered to its investment review process due to a lack of senior management officials' involvement as well as limited monitoring and resources.[5] In particular, of DHS's 48 major investments requiring milestone and annual reviews under the Department's investment review policy, 45 were not assessed in accordance with this policy. In addition, many major investments, including DNDO's ASP program, had not met the Department's requirements for basic acquisition documents necessary to inform the investment review process. As a result, DHS had not consistently provided the oversight needed to identify and address cost, schedule, and performance problems in its major investments. Among other things, our November 2008 report recommended that the Secretary of Homeland Security direct component heads, such as the Director of DNDO, to ensure that the components have established processes to manage major investments consistent with departmental policies. DHS generally concurred with our recommendations, and we noted that DHS had begun several efforts to address shortcomings in the investment review process identified in our report, including issuing an interim directive requiring DHS components to align their internal policies and procedures by the end of the third quarter of fiscal year 2009. In January 2009, DHS issued a memorandum instructing component heads to create acquisition executives in their organizations to be responsible for management and oversight of component acquisition processes. If fully implemented, these steps should help ensure that DHS components have established processes to manage major investments.

Based on our body of work on ASP testing, one of the primary lessons to be learned is to avoid the pitfalls in testing that stem from a rush to procure new technologies. GAO has previously reported on the negative consequences of pressures imposed by closely linking testing and development programs with decisions to procure and deploy new technologies, including the creation of incentives to postpone difficult tests and limit open communication about test results.[6] We found that testing programs designed to validate a product's performance against increasing standards for different stages in product development are a best practice for acquisition strategies for new technologies. In the case of ASPs, the push to replace existing equipment with the new portal monitors led to a testing program that until recently lacked the necessary rigor. Even for the most recent round of testing, DNDO's schedule consistently underestimated the time required to conduct tests, resolve

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[5] GAO, *Department of Homeland Security: Billions Invested in Major Programs Lack Appropriate Oversight,* GAO–09–29 (Washington, D.C.: Nov. 18, 2008).

[6] GAO, *Best Practices: A More Constructive Test Approach Is Key to Better Weapon System Outcomes,* GAO/NSIAD–00–199 (Washington, D.C.: July 31, 2000).

problems uncovered during testing, and complete key documents, including final test reports. In addition, DNDO's original working schedule did not anticipate the time required to update its cost-benefit analysis to take into account the latest test results. The schedule anticipated completion of testing in mid-September 2008 and the DHS Secretary's decision on ASP certification between September and November 2008. However, testing is still not completed, and DNDO took months longer than anticipated to complete the final report on performance testing.

As previously mentioned, a number of aspects of the latest round of ASP testing increased the rigor in comparison with earlier rounds and, if properly implemented, could improve the rigor in DHS's testing of other advanced technologies. Key aspects included the following:

- *Criteria for ensuring test requirements are met.* The test and evaluation master plan established criteria requiring that the ASPs meet certain requirements before starting or completing any test phase. For example, the plan required that ASPs have no critical or severe issues rendering them completely unusable or impairing their function. The criteria provided a formal means to ensure that ASPs met certain basic requirements prior to the start of each phase of testing. DNDO and CBP adhered to the criteria even though doing so resulted in integration testing taking longer than anticipated and delaying the start of field validation.
- *Participation of the technology end-user.* The participation of CBP (the end-user of the new portal monitors) provided an independent check, within DHS, of DNDO's efforts to develop and test the new portal monitors. For example, CBP added a final requirement to integration testing before proceeding to field validation to demonstrate ASPs' ability to operate for 40 hours without additional problems and thereby provide for a productive field validation. In addition, the participation of CBP officers in the 2008 round of performance testing allowed DNDO to adhere more closely than in previous tests to CBP's standard operating procedure for conducting a secondary inspection using the hand-held identification devices, thereby providing for an objective test.
- *Participation of an independent test authority.* The DHS Science and Technology Directorate, which is responsible for developing and implementing the Department's test and evaluation policies and standards, will have the lead role in the final phase of ASP testing and thereby provide an additional independent check on testing efforts. The Science and Technology Directorate identified two critical questions, related to ASPs' operational effectiveness (i.e., detection and identification of threats) and suitability (e.g., reliability, maintainability, and supportability), and drafted its own test plan to address those questions.

Mr. Chairman, this completes my prepared statement. I would be happy to respond to any questions that you or other Members of the Subcommittee may have at this time.

GAO Staff Acknowledgments

Ned Woodward (Assistant Director), Joseph Cook, and Kevin Tarmann made key contributions to this testimony. Dr. Timothy Persons (Chief Scientist), James Ashley, Steve Caldwell, John Hutton, Omari Norman, Alison O'Neill, Amelia Shachoy, and Rebecca Shea also made important contributions.

Appendix I:

Key Findings and Recommendations from Related GAO Products on Testing and Development of ASPs

Combating Nuclear Smuggling: DHS Has Made Progress Deploying Radiation Detection Equipment at U.S. Ports-of-Entry, But Concerns Remain. GAO–06–389. Washington, D.C.: March 22, 2006.

- *Key findings.* Prototypes of advanced spectroscopic portals (ASP) were expected to be significantly more expensive than current-generation portal monitors but had not been shown to be more effective. For example, Domestic Nuclear Detection Office (DNDO) officials' preliminary analysis of 10 ASPs tested at the Nevada Test Site found that the new portal monitors outperformed current-generation equipment in detecting numerous small, medium-size, and threat-like radioactive objects and were able to identify and dismiss most naturally occurring radioactive material. However, the detection capabilities of both types of portal monitors converged as the amount of source material decreased.
- *Recommendations.* We recommended that the Secretary of Homeland Security work with the Director of DNDO to analyze the benefits and costs of deploying ASPs before any of the new equipment is purchased to determine whether any additional detection capability is worth the additional cost. We also recommended that the total program cost estimate for the radiation portal monitor project be revised after completion of the cost-benefit analysis.

Combating Nuclear Smuggling: DHS's Cost-Benefit Analysis to Support the Purchase of New Radiation Detection Portal Monitors Was Not Based on Available Performance Data and Did Not Fully Evaluate All the Monitors' Costs and Benefits. GAO–07–133R. Washington, D.C.: October 17, 2006.

Combating Nuclear Smuggling: DHS's Decision to Procure and Deploy the Next Generation of Radiation Detection Equipment Is Not Supported by Its Cost-Benefit Analysis. GAO–07–581T. Washington, D.C.: March 14, 2007.

- *Key findings.* DNDO's cost-benefit analysis issued in response to our March 2006 recommendation did not provide a sound analytical basis for DNDO's decision to purchase and deploy ASPs. We identified a number of problems with the analysis of both the performance of the new portal monitors and the costs. With regard to performance, DNDO did not use the results of its own tests and instead relied on assumptions of the new technology's anticipated performance level. In addition, the analysis focused on identifying highly enriched uranium (HEU) and did not consider how well the new portal monitors can correctly detect or identify other dangerous radiological or nuclear materials. With regard to costs, DNDO did not follow the DHS guidelines for performing cost-benefit analyses and used questionable assumptions about the procurement costs of portal monitor technology.
- *Recommendations.* We recommended that DHS and DNDO conduct a new cost-benefit analysis using sound analytical methods, including actual performance data and a complete accounting of all major costs and benefits as required by DHS guidelines, and that DNDO conduct realistic testing for both ASPs and current-generation portal monitors.

Combating Nuclear Smuggling: DNDO Has Not Yet Collected Most of the National Laboratories' Test Results on Radiation Portal Monitors in Support of DNDO's Testing and Development Program. GAO–07–347R. Washington, D.C.: March 9, 2007.

- *Key findings.* DNDO had not collected a comprehensive inventory of testing information on current-generation portal monitors. Such information, if collected and used, could improve DNDO's understanding of how well portal monitors detect different radiological and nuclear materials under varying conditions. In turn, this understanding would assist DNDO's future testing, development, deployment, and purchases of portal monitors.
- *Recommendations.* We recommended that the Secretary of Homeland Security, working with the Director of DNDO, collect reports concerning all of the testing of current-generation portal monitors and review the test reports in

order to develop an information database on how the portal monitors perform in both laboratory and field tests on a variety of indicators, such as their ability to detect specific radiological and nuclear materials.

Combating Nuclear Smuggling: Additional Actions Needed to Ensure Adequate Testing of Next Generation Radiation Detection Equipment. GAO–07–1247T. Washington, D.C.: September 18, 2007.

- *Key findings.* We found that tests conducted by DNDO in early 2007 were not an objective and rigorous assessment of the ASPs' capabilities. Specifically, we raised concerns about DNDO using biased test methods that enhanced the apparent performance of ASPs; not testing the limitations of ASPs' detection capabilities-for example, by not using a sufficient amount of the type of materials that would mask or hide dangerous sources and that ASPs would likely encounter at ports of entry; and not using a critical Customs and Border Protection (CBP) standard operating procedure that is fundamental to the performance of hand-held radiation detectors in the field.
- *Recommendations.* We recommended that the Secretary of Homeland Security delay Secretarial certification and full-scale production decisions on ASPs until all relevant tests and studies had been completed and limitations to tests and studies had been identified and addressed. We further recommended that DHS determine the need for additional testing in cooperation with CBP and other stakeholders and, if additional testing was needed, that the Secretary of DHS appoint an independent group within DHS to conduct objective, comprehensive, and transparent testing that realistically demonstrates the capabilities and limitations of ASPs.

Combating Nuclear Smuggling: DHS's Program to Procure and Deploy Advanced Radiation Detection Portal Monitors Is Likely to Exceed the Department's Previous Cost Estimates. GAO–08–1108R. Washington, D.C.: September 22, 2008.

- *Key findings.* Our independent cost estimate suggested that from 2007 through 2017 the total cost of DNDO's 2006 project execution plan (the most recent official documentation of the program to equip U.S. ports of entry with radiation detection equipment) would likely be about $3.1 billion but could range from $2.6 billion to $3.8 billion. In contrast, we found that DNDO's cost estimate of $2.1 billion was unreliable because it omitted major project costs, such as elements of the ASPs' life cycle, and relied on a flawed methodology. DNDO officials told us that the agency was no longer following the 2006 project execution plan and that the scope of the agency's ASP deployment strategy had been reduced to only the standard cargo portal monitor. Our analysis of DNDO's summary information outlining its scaled-back plan indicated the total cost to deploy standard cargo portals over the period 2008 through 2017 would be about $2 billion but could range from $1.7 billion to $2.3 billion. Agency officials acknowledged the program requirements that would have been fulfilled by the discontinued ASPs remained valid, including screening rail cars and airport cargo, but the agency had no plans for how such screening would be accomplished.
- *Recommendations.* We recommended that the Secretary of Homeland Security direct the Director of DNDO to work with CBP to update the projection execution plan to guide the entire radiation detection program at U.S. ports of entry, revise the estimate of the program's cost and ensure that the estimate considers all of the costs associated with its project execution plan, and communicate the revised estimate to Congress so that it is fully apprised of the program's scope and funding requirements.

Combating Nuclear Smuggling: DHS Needs to Consider the Full Costs and Complete All Tests Prior to Making a Decision on Whether to Purchase Advanced Portal Monitors. GAO–08–1178T. Washington, D.C.: September 25, 2008.

- *Key findings.* In preliminary observations of the 2008 round of ASP testing, we found that DNDO had made progress in addressing a number of problems we identified in previous rounds of ASP testing. However, the DHS criteria for significant increase in operational effectiveness appeared to set a low bar for improvement—for example, by requiring ASPs to perform at least as well as current-generation equipment when nuclear material is present in cargo but not specifying an actual improvement. In addition, the ASP certification schedule did not allow for completion of computer simulations that could provide useful data on ASP capabilities prior to the Secretary's decision on certification. Finally, we questioned the replacement of current-generation equipment with ASPs until DNDO demonstrates that any additional increase in security would be worth the ASPs' much higher cost.[1]

Combating Nuclear Smuggling: DHS's Phase 3 Test Report on Advanced Portal Monitors Does Not Fully Disclose the Limitations of the Test Results. GAO–08–979. Washington, D.C.: September 30, 2008.

- *Key findings.* DNDO's report on the second group of ASP tests in 2007 (the Phase 3 tests) did not appropriately state test limitations. As a result, the report did not accurately depict the results and could potentially be misleading. The purpose of the Phase 3 tests was to conduct a limited number of test runs in order to identify areas in which the ASP software needed improvement. While aspects of the Phase 3 report addressed this purpose, the preponderance of the report went beyond the test's original purpose and made comparisons of the performance of the ASPs with one another or with currently deployed portal monitors. We found that it would not be appropriate to use the Phase 3 test report in determining whether the ASPs represent a significant improvement over currently deployed radiation equipment because the limited number of test runs did not support many of the comparisons of ASP performance made in the report.
- *Recommendations.* We recommended that the Secretary of DHS use the results of the Phase 3 tests solely for the purposes for which they were intended—to identify areas needing improvement—and not as a justification for certifying whether the ASPs warrant full-scale production. If the Secretary intends to consider the results of the Phase 3 tests in making a certification decision regarding ASPs, we further recommended that the Secretary direct the Director of DNDO to revise and clarify the Phase 3 test report to more fully disclose and articulate the limitations present in the Phase 3 tests and clearly state which insights from the Phase 3 report are factored into any decision regarding the certification that ASPs demonstrate a significant increase in operational effectiveness. Finally, we recommended that the Secretary direct the Director of DNDO to take steps to ensure that any limitations associated with the 2008 round of testing are properly disclosed when the results are reported.

Combating Nuclear Smuggling: DHS Improved Testing of Advanced Radiation Detection Portal Monitors, but Preliminary Results Show Limits of the New Technology. GAO–09–655. Washington, D.C.: May 21, 2009.

- *Key findings.* We reported that the DHS criteria for a significant increase in operational effectiveness require a large reduction in innocent alarms but a marginal improvement in the detection of certain weapons—usable nuclear materials. In addition, the criteria do not take the current-generation portal monitors' full potential into account because DNDO has not completed efforts to improve their performance. With regard to ASP testing, we found that DHS increased the rigor in comparison with previous tests, thereby adding credibility to the test results, but that preliminary results were mixed. The results showed that the new portal monitors performed better than current-generation portal monitors in detection of certain nuclear materials concealed by light shielding approximating the threat guidance for setting detection thresholds, but differences in sensitivity were less notable when shielding was slightly below or above that level. Testing also uncovered multiple problems in ASPs meeting the requirements for successful integration into operations at ports of entry. Finally, we found that DNDO did not plan to complete computer simulations that could provide additional insight into ASP capabilities and limitations prior to certification even though delays to testing allowed more time to conduct the simulations.
- *Recommendations.* We recommended that the Secretary of Homeland Security direct the Director of DNDO to assess whether ASPs meet the criteria for a significant increase in operational effectiveness based on a valid comparison with current-generation portal monitors' full performance potential and revise the schedule for ASP testing and certification to allow sufficient time for review and analysis of results from the final phases of testing and completion of all tests, including computer simulations. If ASPs are certified, we further recommended that the Secretary of Homeland Security direct the Director of DNDO to develop an initial deployment plan that allows CBP to uncover and

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[1] This testimony also summarized our September 2008 report on the life cycle cost estimate to deploy ASPs (GAO–08–1108R).

resolve any additional problems not identified through testing before proceeding to full-scale deployment.

BIOGRAPHY FOR GENE ALOISE

Gene Aloise is a Director in the Natural Resources and Environment team at GAO. He is GAO's recognized expert in international nuclear nonproliferation and safety issues and completed training on these subjects at the University of Virginia and Princeton University. His work for GAO has taken him to some of Russia's closed nuclear cities and the Chernobyl reactor in Ukraine as well as numerous nuclear facilities around the world and in the United States. Mr. Aloise has had years of experience developing, leading, and managing GAO domestic and international engagements. His diverse experience includes assignments with congressional committees as well as various offices within GAO. He has received numerous awards for his leadership and expertise including GAO's Meritorious Service Award. Mr. Aloise received his Bachelor's degree in political science/economics from Rowan University and holds a Master of Public Administration from Temple University. Mr. Aloise is also a graduate of the Senior Executive Fellows Program, John F. Kennedy School of Government, Harvard University.

Chairman MILLER. Thank you, Mr. Aloise.

Dr. Lowenthal.

STATEMENT OF DR. MICAH D. LOWENTHAL, DIRECTOR, NUCLEAR SECURITY AND NUCLEAR FACILITY SAFETY PROGRAM, NUCLEAR AND RADIATION STUDIES BOARD, NATIONAL RESEARCH COUNCIL, THE NATIONAL ACADEMIES

Dr. LOWENTHAL. Good morning, and thank you, Chairman Miller, Ranking Member Broun, Members of the Committee. My name is Micah Lowenthal. As you said, I am the Director of the Nuclear Security and Nuclear Facility Safety Program at the National Research Council's Nuclear and Radiation Studies Board. I am here to describe a recently issued interim report from a Congressionally mandated National Research Council study on Advanced Spectroscopic Portals.

I am the study director supporting the authoring committee of that report, and I will begin by providing background on the request for this study and then I will summarize the main messages of the report.

The Department of Homeland Security, or DHS, wants to deploy new radiation detector systems called Advanced Spectroscopic Portals, or ASPs, to improve scrutiny of containerized cargo for nuclear and radiological material. The ASPs are intended to replace some or all of the radiation portal monitors (RPMs) and hand-held radioisotope identifiers (RIIDs) currently used at ports and border crossings across the United States. Congress required that the Secretary of Homeland Security certify that the ASPs provide a significant increase in operational effectiveness over the old systems. Congress also directed DHS to ask the National Research Council to advise the Secretary on testing, analysis, costs and benefits of the ASPs before the certification decision.

I want to point out that the appropriations committees who made these requirements said they appreciate that certification will be difficult. The study committee agrees with that, that these are hard problems, both for the testing and the cost-benefit analysis, so it is not surprising that DHS's work has been challenging.

Here are the main findings and recommendations from the interim report. The study committee found that the ASP performance tests prior to 2008 had serious flaws. The Domestic Nuclear Detection Office, DNDO, acknowledged problems with the tests and addressed a number of those flaws in later testing. The 2008 performance tests were indeed improved, but shortcomings remain. DNDO's current approach to performance testing involves physically testing detector performance against a small number of configurations of threat objects and cargo in one environment. The set of possible combinations of threats, cargo and environments is so large and multidimensional that DNDO needs an analytical basis for understanding the performance of its detector systems, not just an empirical basis. Our study committee recommended that DHS use a more rigorous approach in which scientists use computer models to simulate configurations and detector performance, use physical tests to validate and refine the models and use the models to select key new physical tests that advance our understanding of the detector systems. This iterative modeling and testing approach is standard in the development of some high-technology equipment and is essential for building scientific confidence in detector performance.

The idea of an iterative approach also extends to deployment. The study committee recommends a process for incremental deployment and continuous improvement of the ASPs with experience in the field leading to refinement in both the technologies and the operations for the next deployment. As a first step in this process, DHS should deploy the unused ASPs it already has, to assess the ASPs' performance in multiple environments without investing in a much larger acquisition at the outset.

The ASP cost-benefit analysis was not complete when our interim report was written. Preliminary estimates by DNDO indicate that the cost increases from replacing the currently deployed systems with ASPs outweigh the cost reduction or savings from operational efficiencies. Therefore, a careful cost-benefit analysis will need to reveal the security advantages, if any, of the ASPs over the current systems and possible alternatives. Such a cost-benefit analysis should include three key elements: a clear statement of the objectives of the program, an assessment of meaningful alternatives; and a comprehensive, credible and transparent analysis of benefits and costs.

DHS should consider tradeoffs among different options for allocating its efforts and funds, looking at the overall system for ways to improve defense against nuclear smuggling. The study committee recommended that DHS not proceed with further procurement of ASPs until it has addressed the findings and recommendations from the report, and the ASP has been shown to be a favored option in the cost-benefit analysis.

Now, those are the main messages from the report. For this hearing I was also asked to comment on any lessons learned regarding processes by which the ASPs have been researched, developed and tested to date. Although the study committee only examined the testing of ASPs, not a broader portfolio, I think there are three lessons to be learned based on the study. First, the process of modeling and testing iteratively can be applied more broadly to other complex technology development programs. Second, incremental deployment with continuous improvement is a good strategy for deployments of systems that have not fully matured, especially if they are envisioned to have an ongoing mission. And third, the systems-level approach that is examining how to optimize choices within the overall system, rather than focusing narrowly on one tradeoff decision, is applicable to almost every use of equipment in security applications.

Thank you for the opportunity to testify. I would be glad to elaborate my testimony in response to questions.

[The prepared statement of Dr. Lowenthal follows:]

PREPARED STATEMENT OF MICAH D. LOWENTHAL

Good morning Chairman Miller, Ranking Member Broun, and Members of the Committee. My name is Micah Lowenthal and I am the Director of the program on Nuclear Security and Nuclear Facility Safety in the National Research Council's Nuclear and Radiation Studies Board.[1] I am here to describe the recently issued interim report from a congressionally mandated National Research Council study on advanced spectroscopic portals (ASPs). I am the study director supporting the authoring committee of that report.[2] The full report is classified, but an abbreviated version was also produced for unrestricted public release.[3] My testimony is based on the abbreviated version. I will begin by providing background on the request for this study. I will then summarize the main messages of the report and discuss some of the points most relevant to this hearing.

BACKGROUND ON THE REQUEST FOR THE STUDY

Containerized cargo entering the United States at sea ports and land-border crossings for trucks is currently screened for radiation using detectors, called radiation portal monitors (RPMs), in conjunction with hand-held radioisotope identifiers (RIIDs). The Department of Homeland Security (DHS) is seeking to deploy new radiation detectors, called advanced spectroscopic portals (ASPs), to replace the current RPM and RIID combination, which has known deficiencies. The ASPs consist of new detector equipment and new software, including algorithms for isotope identification.

Following some controversy over the testing and evaluation of the new ASPs, Congress required in Title IV of Division E of the *Consolidated Appropriations Act,* 2008 (Public Law 110–161) that the Secretary of Homeland Security submit to Congress a report certifying that ASPs would provide a "significant increase in operational effectiveness" over continued use of existing screening devices. This certification is a precondition for proceeding with full-scale procurement of ASPs. Congress also directed DHS to request that the National Academies advise the Secretary on the certification decision by helping to validate testing completed to date, providing support for future testing, assessing the costs and benefits of this technology, and bringing robustness and scientific rigor to the procurement process. Due to delays in the test and evaluation program, the Academies and DHS agreed that the study committee would issue an interim report that provides (1) the committee's evaluation of testing plans and execution it has seen, and (2) advice on how the Domestic Nuclear Detection Office (DNDO) can complete and make more rigorous its ASP evaluation for the Secretary and the Nation.

This interim report is based on testing done before 2008 (referred to as past tests), plans for and preliminary results from performance tests carried out in 2008, and the agency's draft cost-benefit analysis as of October 2008. The committee received briefings on the performance test results and analysis and on the cost-benefit analysis but it did not receive any written reports on those topics by February 2009, when the interim report entered the Academies peer review process.

I will now discuss each element of the study task below.

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[1] The National Research Council is the operating arm of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine of the National Academies, chartered by Congress in 1863 to advise the government on matters of science and technology. The Nuclear and Radiation Studies Board is responsible for oversight of National Research Council studies on safety and security of nuclear materials and waste.

[2] Dr. Robert Dynes, a physicist at the University of California, member of the National Academy of Sciences, and former President of the University of California, chaired this study.

[3] The report is titled *Evaluating Testing, Costs, and Benefits of Advanced Spectroscopic Portals for Screening Cargo at Ports of Entry: Interim Report.* The abbreviated version of the report is available online at *http://www.nap.edu/catalog.php?record_id=XXXX*

SUMMARY OF THE MAIN MESSAGES OF THE REPORT

First, I want to note that the committee focused much of its attention on performance testing. This is not because the other tests are unimportant—the portals will be of little use if they are incompatible with CBP's computer systems, for example—but the design, execution, and evaluation of these tests are comparatively routine, even if solutions to problems revealed by the tests are not. The design, execution, and evaluation of performance tests for the ASPs is more challenging and involves more of the science and engineering principles on which the committee has advice to offer.

Past Performance Testing

Performance tests prior to 2008 had serious flaws that were identified by the Government Accountability Office and the Secretary's ASP Independent Review Team. All truck-conveyed containers at ports and border crossings currently pass through primary screening, which is conducted with a radiation portal monitor (RPM). Containers that trigger an alarm are sent to secondary screening, which is conducted with an RPM and a RIID. The tests prior to 2008 did not adequately assess the capabilities of the ASP systems in primary and secondary screening compared with the currently deployed RPM and RIID screening systems, nor whether the ASP systems met performance criteria for procurement.

There were serious flaws in the testing protocol. Notably, DNDO utilized the same radiation sources in performance testing that were used to set up and calibrate this testing. Device setup and any calibration must use separate radiation sources from those used for testing. Also, standard operating procedures for the use of RIIDs in secondary screening were not followed in the performance tests, which disadvantaged the RIIDs in comparisons with ASPs.

2008 Performance Testing

DNDO staff acknowledged several pre-2008 deficiencies and designed its 2008 test plan to correct them. The study committee examined the revised test plan, observed tests, and questioned test personnel, and the committee concluded that DNDO did address those problems.

Because of the ASP configurations and the size of their detectors, ASPs would be expected to improve isotope identification, provide greater consistency and coverage in screening, , and increase speed of screening compared to the current RPM–RIID combination when used in secondary screening. Consequently, DNDO's 2008 performance tests of ASPs in secondary screening focused on confirming and quantifying that advantage for several threat objects, cargoes, and configurations.

When used for primary screening, an ASP system must be compared to the existing RPM–RIID combination for primary and secondary screening. This is because ASPs perform an isotope identification function in primary screening. Isotope identification is only possible in secondary screening with the current RPM–RIID system. DNDO's preliminary analysis did account for this difference.

The study committee found that the 2008 performance tests were an improvement over previous tests. They enabled DNDO to identify and physically test some of the performance limits of ASP systems. However, the committee identified several shortcomings of these tests: (1) The selected test configurations were too limited to assess the performance of ASP systems against the range of threat objects, cargoes, and configurations that could be encountered during cargo screening operations at ports without modeling to complement the physical experiments; (2) the sample sizes (the number of test runs of each case) are small and limit the confidence that can be placed in comparing ASP and RPM–RIID performance; and (3) in its analysis, some of the performance metrics are not the correct ones for comparing operational performance of cargo screening systems. These shortcomings are described in greater detail in our report. In the committee's judgment, DHS cannot determine whether ASPs can consistently outperform current RPM–RIID systems in routine practice until these shortcomings are addressed. Better physical measurement and characterization of the performance of the systems are a necessary first step but may not be sufficient to enable DHS to conclude that the ASPs meet the criteria it has defined for achieving a "significant increase in operational effectiveness."

The committee recommends modifications to the testing procedures that are being used by DHS. These modifications would influence subsequent procurement steps, as described in the recommendations for the procurement process.

Recommended Approach for Testing and Evaluation

To make the testing and evaluation more scientifically rigorous, the committee recommends an iterative approach involving modeling and physical testing. The threat space that is, the set of possible threat objects, configurations, surrounding cargoes, and conditions of transport—is so large and multi-dimensional that DNDO needs an analytical basis for understanding the capabilities of ASP detectors for screening cargo. DNDO's current approach is to physically test small portions of the threat space and to use other experimental data to interpolate and extrapolate to other important parts of the threat space to test the identification algorithms in ASP systems.

The committee recommends that DNDO use computer models of threat objects, radiation transport, and detector response to simulate ASP performance. Then DNDO can use physical experiments to validate these computer models, which would allow a critique of the models' fidelity to reality and show where model refinements were needed. Physical testing and model refinement would proceed iteratively until the model provided an acceptably accurate depiction of reality. With validated models, DNDO could evaluate the performance of ASP systems over a larger, more meaningful range of the threat space than is feasible with physical tests alone.

This kind of interaction between computer models and physical tests is standard in the development and deployment of some high-technology equipment and is essential for building scientific confidence in technology performance. The performance tests conducted in 2008, and even prior to 2008, can be used to help refine and validate models. The committee also notes the skills required to proceed exist in the National Laboratories.

Recommended Approach for the Procurement Process

The idea of an iterative approach also extends to deployment of ASP systems at ports of entry. The committee noted that DHS' testing philosophy is oriented toward a one-time certification decision in the near future. However, the mandate for passive radiation screening of cargo at ports of entry is expected to continue indefinitely. Rather than focusing on a one-time decision about the deployment of ASPs, the committee suggests that current testing be viewed as a first step in a continuous process of system improvement and adaptation to changes in the threat environment, composition of container cargo, technological and analytical capabilities, and the nature of commerce at ports of entry. These factors have changed significantly over the last decade and can be expected to evolve—in both predictable and unpredictable ways—in the future. The committee recommends that DHS should develop a process for incremental deployment and continuous improvement, with experience leading to refinements in both technologies and operations over time, rather than a single product purchase to replace current screening technologies. The ASP deployment process should be developed to address and exploit changes. This would enable DNDO to adapt and continually update its screening systems so that they do not become outdated as they would after a one-time deployment.

As the first step in this process, the committee recommends that DHS deploy its currently unused low-rate initial production ASPs for primary and secondary inspection at various sites under a program of extended operational testing. Such deployment, even on a limited scale, would provide valuable data concerning ASP operation, reliability, and performance, and would allow DHS to better assess ASP capabilities in multiple environments without investing in a much larger acquisition at the outset.

The development of the hardware for radiation detection and the software for analyzing detector signals is separable. The current DHS procurement process is a competition among vendors to provide the combined systems, which has been useful. However, as DHS moves forward, the committee recommends that it match the best hardware to the best software (particularly the algorithms), drawing on tools developed by the competing companies and others, such as the national laboratories.

The deployment of ASPs will not eliminate the need for hand-held detectors with spectroscopic capabilities. Because some of the improvement in isotope identification offered by the ASPs over the RIIDs is a result of software improvements, the committee recommends that these improvements be incorporated into hand-held detectors. Improved software might significantly improve RIID performance and expand the range of deployment options available to Customs and Border Protection for cargo screening.

By separating the hardware and software elements of the system and engaging the broader science and engineering community, DHS would have increased confidence in its procurement of the best product available with current technology, and simultaneously could advance the state-of-the-art.

Recommended Approach for Cost-Benefit Analysis

The preliminary analysis presented to the committee suggests that benefits of deploying the ASPs may not be clearly greater than the costs. Because DNDO's preliminary estimates indicate that the cost increases from replacing the RPM–RIID combination with ASPs exceed the cost reductions from operational efficiencies, it is important to consider carefully the conditions under which the benefits of deploying ASPs justify the program costs. A cost-benefit analysis (CBA) can provide a structure for evaluating whether a proposed program (such as the ASP program) is reasonable and justified.

The Secretary's decision on ASP certification is based, at least in part, on whether the ASPs meet the objectives in DHS' definition of "significant increase in operational effectiveness" (SIOE); however, other factors relating to the costs and benefits of the proposed ASP program will also need to be taken into account. DHS' definition of SIOE is a modest set of goals: As noted above, the increases in operational efficiency do not by themselves appear to outweigh the cost increases from replacing the RPM/RIID combination with ASPs, based on DNDO's preliminary estimates, and the criteria do not require a significantly improved ability to detect special nuclear material (an ingredient of a nuclear weapon) in primary screening. If the ASPs meet the defined goals and are able to detect the minimum quantities of nuclear threat material recommended by the "DOE guidance," DHS still will not know whether the benefits of the ASPs outweigh the additional costs associated with them, or whether the funds are more effectively spent on other elements of the Global Architecture.

A CBA can provide insight about alternative choices—for example, whether the benefits of a given program exceed its costs, and which choices are most cost-effective. To be effective, the CBA must include three key elements: (1) a clear statement of the objectives of the screening program; (2) an assessment of meaningful alternatives to deploying ASPs; and (3) a comprehensive, credible and transparent analysis of in-scope benefits and costs.

The CBA should begin with a clear statement of what operational problem the ASPs are intended to address. This statement will define the role that the system plays in providing a layer in the defense against the importation of nuclear or radiological materials. The CBA should also include a narrative that clarifies how improving detection for containers at ports of entry to the United States fits into a larger effort to improve detection capabilities, in recognition of the many ways that materials could be brought into the United States through ports of entry that are not already screened, or across uncontrolled stretches of border. Furthermore, to be useful in a procurement decision, a CBA must address whether funds are better spent to replace the currently deployed equipment rather than to expand coverage for other material pathways that currently have no radiation screening. DHS should consider tradeoffs among different options for allocating efforts and funds, looking at the overall system for ways to improve defenses against nuclear smuggling. Such an analysis is needed in the CBA for ASP systems because it is not evident that it has been provided elsewhere.

The CBA also needs to account for meaningful alternatives (including non-ASP systems) to reveal the scale of the benefits of ASPs for radiation screening and determine whether these benefits outweigh the additional costs for procurement and deployment. The complexity of the container screening task suggests that there could be many different options worthy of consideration. These options include variations on ASP deployment configurations and operational processes, and application of technologies beyond the current RPM–RIID and ASP systems such as deploying hand-held passive detectors with state-of-the-art software and advanced methods for detecting nuclear materials. Considerations should include active interrogation, improved imaging systems, and integration of these existing technologies. These alternatives need to be compared to a baseline that reflects as realistically as possible the screening capability that DHS currently has in place. This baseline should reflect the number and placement of current RPM and RIID detectors, sensitivity of these detectors based on how they are operated at each port, and performance of existing hand-held detectors in the manner they are used in the field. The CBA must indicate what capability an investment in ASPs will provide beyond the existing systems as they are currently deployed and operated, or beyond alternative radiation detection technologies that could be developed and deployed at ports of entry.

In comparing alternatives, it is important that the CBA treat benefits and costs in a comprehensive, credible, and transparent manner. The benefit assessment should show how the ASP system would contribute to improving security with respect to prevention of the detonation of a nuclear device or radiological weapon in the United States. Because this is the primary objective of the ASP program, a CBA that is silent on this subject would be incomplete. Such an assessment is difficult and no assessment of such benefits will be definitive or unassailable. The cost assessment should cover all phases of the acquisition life cycle in a manner that is independent of contractor or program office biases, and it should also assess the risk of cost escalation associated with the estimate.

The committee recommends that DHS not proceed with further procurement until it has addressed the findings and recommendations in this report, and then only if the ASP is shown to be a favored option in the CBA.

“Lessons Learned”

For this hearing I was also asked to comment on “lessons learned” regarding the processes by which the ASPs have been researched, developed, and tested. Although the study committee only examined the testing of ASPs, my personal view is that three lessons that could be learned:

First, the process of iterative modeling and testing can be applied more broadly to other complex technology development programs. Modeling coupled to validating experiments is a necessity for some technology applications because of the complex conditions in which these technologies must operate.

Second, incremental deployment with continuous improvement is a good strategy for deploying systems that have not fully matured, especially if they are envisioned to have an ongoing mission.

Third, a systems-level approach—that is, examining how to optimize choices within the overall system rather than narrowly focusing on one tradeoff decision—is applicable to almost every use of equipment in security applications.

This concludes my testimony to the Committee. Thank you for the opportunity to testify on this important topic. I would be happy to elaborate on any of my comments during the question and answer period.

BIOGRAPHY FOR MICAH D. LOWENTHAL

Micah Lowenthal is the Director of the Nuclear Security and Nuclear Facility Safety Program in the Nuclear and Radiation Studies Board at the National Research Council of the National Academies. At the Academies, he has directed domestic and international studies on nuclear and radiological safety and security, nuclear nonproliferation, nuclear fuel cycles, radioactive waste, and management of contaminated environments. Before joining the National Academies’ staff in 2001, Dr. Lowenthal was a researcher and lecturer at the University of California at Berkeley. In 1996 he was an American Association for the Advancement of Science Environmental Science and Engineering Fellow. Dr. Lowenthal received an A.B. degree in physics and a Ph.D. degree in nuclear engineering, both from the U.C.–Berkeley.

Chairman MILLER. Thank you, Dr. Lowenthal. Unfortunately, you all probably know that our days here are somewhat scattered, and I need to go to the Floor. We have tried to arrange another Member of the Majority who is a Member of the Subcommittee to preside in my absence. Ms. Dahlkemper has been an especially conscientious Member and she may arrive between now and 11:00, which is when I expect to come back, and if that is the case, we will come out of recess and she will preside or any other Member of the Majority who is a Member of the Subcommittee.

Mr. BROUN. Mr. Chairman, I would be glad to preside if you would like me to.

Chairman MILLER. Well, I thank Dr. Broun for that generous offer but I think we will do it the way that every other committee and subcommittee in Congress does it. So with that, we will need to stand in recess. I apologize again for the inconvenience. Believe me, it is more inconvenient for me than it is for you, and we will be back in session but I appreciate your being here and I thank you for your indulgence.

[Recess.]

DISCUSSION

Chairman MILLER. We are now out of recess. Floor colloquies are undoubtedly one of the most peculiar stylized aspects of Congressional service. I have heard of political campaigns that 80 percent of all the effort is wasted, the problem is, no one knows what the 20 percent is that is not. I suspect that there is at least that ratio of wasted effort in Congressional service and I very much suspect Floor colloquies are in the wasted effort category. But it was something I had to do.

Mr. BROUN. Floor debate, isn't it?

Chairman MILLER. I will resist temptation to point out other aspects of Congressional service that may be wasted efforts. If we may now begin our rounds of questioning, Mr. Aloise, Dr. Lowenthal, Dr. Broun, I now recognize myself for five minutes.

PRIORITIZING SECURITY NEEDS

Dr. Broun raised the point that there are other priorities that we have to decide between, priorities even within security, so it is not security versus other things government does. In October of 2007, this committee held a hearing on an exercise on a scenario of a terrorist attack assuming that a dirty bomb was detonated in two American cities, and what we found was that we were probably better prepared, certainly better prepared for Katrina than we were for dirty-bomb attacks, despite the fact that if there is one punch that has obviously been telegraphed by terrorists, by al-Qaeda in particular, it is a dirty-bomb attack. We did not have the capacity to conduct the test to see what the level of contamination was, to let our people know that they can go back into offices, office buildings—that we might shut down, indefinitely, 10, 15, 20 square blocks of an American city, the midtown of an American city or perhaps two—that would probably take six years to complete the necessary environmental tests for an attack in one city, nor testing on individuals to see if they had been exposed to radiation. That might take a couple years. We would have to tell parents that we could not test their children to see if they had been exposed to radiation for a couple years. But, you know, if the child's hair started falling out, call us and maybe we can move them up in line. And the failing there seemed to be simply one of funding. We are not prepared to respond to a radiological attack, and here we see we are spending $2 or $3 billion to develop a technology that those who will use it really question whether it does much if any good at all, certainly not enough to justify $2 or $3 billion. DNDO expects the Secretary of Homeland Security to make a decision this October, four months from now, about whether to certify that it is worth investing the $2 billion in the ASPs. Do either of you believe that there will be enough information available this fall for DHS to make that decision, and how confident are you that the costs of the ASPs justify the investment? Mr. Aloise.

Mr. ALOISE. Well, that is the question. In our view, until integration testing is done, field validation is done, operational testing is done, the injection studies are complete, an analysis of energy windowing versus the ASPs is done, until all the testing is done and we know whether or not this marginal increase in security is justified through a sound, independent cost-benefit analysis, it is our belief that we shouldn't spend any money on this program or go forward with it.

Chairman MILLER. And do you think there is any realistic chance those preconditions may be satisfied between now and October?

Mr. ALOISE. At this point it does not look that way.

Chairman MILLER. Dr. Lowenthal.

Dr. LOWENTHAL. We agree that these are the preconditions for going ahead with certification, that there is a great deal of information that is needed. I am not really in a position to tell you how much time it will take them to get that information together. There is some information that they presumably have already put together, some analysis that they have already done that we haven't seen. We will be happy to look at it when they provide it. But in terms of timelines, we would not be inclined to guess when they will be ready.

DECISION-MAKING: PROCESSES AND TIMELINES

Chairman MILLER. Both of you appear to disagree with DHS's view that they will be able to obtain the data they need from field evaluation tests that are to begin next month. Why do you not believe that those tests will be good enough for DHS to base a decision on? Mr. Aloise.

Mr. ALOISE. Well, that is only part of, as I just said, what they need to base their decision on. You know, field validation testing has not gone well so far. They suspended it after two weeks because they were actually sending more—the ASPs were actually sending more to secondary than the PVTs so they had to work out a number of those problems and I am assuming they have. It has been a while since the initial testing. We just have to see how it goes, and we are going to be looking to CBP for a lot of the answers because they are the agency that has to live with this equipment, and I—we feel fairly confident that they are not going to go forward until they are satisfied that the testing has gone right at this point.

Chairman MILLER. Dr. Lowenthal.

Dr. LOWENTHAL. The testing that they are going to do for field validation is going to tell them something that they need to know but it won't tell them everything that they need to know, and the committee—the study committee's recommendations were to enhance what they are going to be able to learn from these sorts of tests with modeling and simulations. The range of environments that they are going to be operating in is very limited. They are only doing field validation testing in four different sites, and there are a lot of other conditions, a lot of other kinds of cargo and so on that are worth learning about. Some of that can be done with simulation and some of it can be done with the deployment that the committee recommended.

Chairman MILLER. Thank you. My time has expired.

Dr. Broun for five minutes.

Mr. BROUN. Thank you, Chairman.

ASP IN CONTEXT: THE GLOBAL NUCLEAR DETECTION ARCHITECTURE

How would y'all—"y'all" is a southern word. How would you all prioritize the upgrade from the PVT RIID system to the ASP system within the entire global nuclear detection architecture? Let us start with Dr. Lowenthal.

Dr. LOWENTHAL. I should point out that the committee really only looked at the testing of the ASPs and talked about what kinds of information a decision-maker would want to have; and so the committee recommended that they (DHS) consider these other components of the global architecture—and there are gaps that are known and have been pointed out by others within that architecture—but the committee did not study that question, itself. What the committee did say is that if you look at this from the perspective of an adversary who is trying to sneak something into the United States, if you can—if you reinforce the places where you already are screening but you leave other avenues totally open, you may not be gaining much improvement in security.

Mr. BROUN. Mr. Aloise.

Mr. ALOISE. We agree. As I mentioned to Dr. Lowenthal a minute ago, we are spending a lot of money upgrading locks on the front door but the windows and the back door are wide open. Does that make sense to do with limited resources, so——

Mr. BROUN. I agree wholeheartedly. Are there other areas that would benefit greater from the same level of investment, Mr. Aloise?

Mr. ALOISE. Well, there are a lot of vulnerabilities that need to be looked at that have not been properly addressed in the architecture. The border crossing is really not the greatest threat, so I would—we believe that we should be looking equally hard at all the other vulnerabilities in the architecture because as it was just said, that is probably not where they are going to come through. If they have taken the time and trouble to get this material, it is unlikely they are going to stick it in a cargo container and drive it across through a portal monitor.

Mr. BROUN. And with open borders, they can just carry it in wherever they want to carry it.

Dr. Lowenthal, particular—and let me ask you to answer your question in view of comments you made in your testimony about that we have ASPs sitting there now, if you would include that discussion?

Dr. LOWENTHAL. Well, given the scope of our study, I wouldn't be comfortable to try to identify what the most promising area is. What the committee recommended is that DHS do that analysis, look at the entire system. We have some concerns that that hasn't been done, and—I will separate this into two parts. One is that the committee recommended that DHS look at that whole system in addition to just the tradeoff between the ASPs and the PVTs, because as a decision-maker, the people in the Administration and in Congress will want to know whether the money is well spent. The analysis does not appear to have been done elsewhere and so the committee recommends that it be included in this ASP decision. Now, the other component of that is the deployment of the ones that they already own. That is more for a learning exercise. This is something where they can learn more about the performance of the systems in the field and improve them as they go forward. I think these are directed at slightly different points.

Mr. BROUN. Thank you. My time disappeared, so I guess I am out of time. I am not sure where we stand. Thank you, Mr. Chairman.

Chairman MILLER. Well, you will have time for a second round because I was planning to ask at least one more question. I now recognize myself for a second round of questions.

MANAGEMENT OF ASP TESTING AND DEPLOYMENT

Your criticism, for both of you, the criticism appears to be as much that the problems with the ASPs was not the technical challenges but that the whole program was just poorly managed. This is a recurring theme for this committee, you know, how could management—how could programs be managed better. But if you think the whole testing program has been troubled from the start, and that the management more than anything else is a problem, what lessons should we learn? How should this program be managed differently? How can it be managed differently in the future, this and other similar programs?

Mr. ALOISE. Well, I will take a shot at that. Back in 2006 when we issued our first report on the deployment of PVTs, we learned about the ASPs and we knew then that there would only be a marginal improvement in security. That is why we called for a cost-benefit analysis before anything went further; is it worth the marginal increase in security you are going to get from the ASPs? Do that first, then go talk to the Congress and the decision-makers can decide whether it is worth it or not, and we know the story. It was poorly done, and it was based on assumptions and not data, and that leads us to where we are today. It was a rush to push technology through that was immature, and that has got to be the true lesson of this, is that without proper and scientifically rigorous testing, without a technology that is mature, it should not be generally rushed to deployment—especially when you have a system already there that is working.

Chairman MILLER. Right. Dr. Lowenthal.

Dr. LOWENTHAL. I should point out that our study committee was silent on the matter of whether this was managed well or not, but I think that the report highlights many of the points that you made in your opening remarks about what should be done in the future. I think you hit on all of those—a well-planned-out testing program with criteria established in advance and an idea as you go in for what you are going to learn from each stage of this, making sure that it matches up with what the customer is looking for, as Mr. Aloise mentioned. All of those components lead to having a testing and evaluation program that will lead to procurement that gives the customer what he needs and the Nation what it needs.

Chairman MILLER. Would it be a fair summary to say that the problem is that we began with the conclusion and then found the analysis to support it, rather than beginning with the analysis, and then finding what conclusions would come from the analysis?

Mr. ALOISE. I think so, Mr. Chairman. I think we had a solution in search of a problem.

Chairman MILLER. There is a problem but there may have been another solution. Our clock is not working, so each Member needs to show self-restraint. I will now go to Dr. Broun for a second round. Ms. Dahlkemper has arrived and I think is now collecting herself.

Dr. Broun for five minutes, however that might be measured. Five minutes based on the honor system.

Mr. BROUN. I hope Ms. Dahlkemper can collect herself. I trust that she can. She is very good at doing that.

I am very interested to hear Dr. Lowenthal's comments about whether we can take the ASP units that are available now, put them in a parallel screening process out there in the field, as the appropriators evidently are preventing us from doing. Would you recommend that we do so, and is that something that you could put in your report to us, so that we can look at that possibility and maybe even make that recommendation?

Dr. LOWENTHAL. Yes. Our study committee recommended that they take the—they procured a number of these low rate initial production [units] so that they can test and evaluate them. They have a number of them that have been sitting moth-balled. I understand that some of them have been cannibalized for parts for other ones, and we don't have an exact number of how many they have, but they have some number of them that they already own that they could deploy in the field. Our study committee's recommendation, explicitly in the report, is that these should be deployed at selected sites, and the experience gained from those will contribute to both their understanding of how they perform, but also how they might be able to modify the operations at the sites, and also the technology, what improvements they might want to put in there. So that is explicitly in the report.

Mr. BROUN. Mr. Aloise, any comments?

Mr. ALOISE. Just that we would agree with that. We think that is a smart idea.

Mr. BROUN. Thank you. I hope that the CBP people can be consulted because I think the end-user has not been consulted enough in this process, and with that, Mr. Chairman, I will yield back.

Chairman MILLER. Thank you. You may or may not have had time to yield back. You probably did.

Ms. Dahlkemper for more or less five minutes.

Ms. DAHLKEMPER. Thank you very much, and I apologize for being late. I had a markup in another committee, but I appreciate the opportunity to ask a question of both of you if you could just address this.

JUSTIFYING THE COST OF THE ADVANCED SPECTROSCOPIC PORTAL PROGRAM

Can either of you provide some insight into whether improving portal radiation detection is worth $2 billion to $3 billion? Assuming that ASPs prove to be robust enough to use, and they deliver real improvement in detection in commercial flow, would that still be enough to justify deploying them, given all the other needs out there and our limited resources?

Mr. ALOISE. I have to go back to, and I know I sound like a broken record on this, a cost-benefit analysis that we have been calling for a couple years, although those factors that you mentioned need to be in there so that the decision-makers can look at and see whether the marginal improvement is worth it, considering all the vulnerabilities we have in the architecture already that we need to address.

Ms. DAHLKEMPER. Dr. Lowenthal.

Dr. LOWENTHAL. We agree entirely that a cost-benefit analysis will be needed to show that. We are not in a position to judge whether they are going to be worth it, partly because our study didn't examine the results of their tests for this interim report. It looked at the approach. Once they have the results and they can factor those into their cost-benefit analysis, then a judgment can be made as to whether they are worth it.

Ms. DAHLKEMPER. Mr. Aloise, the GAO has done a lot of work on how agencies should do a cost-benefit analysis. Can you lay out some principles that should be guiding DHS as they begin their own cost-benefit analysis on whether to acquire ASPs or not?

Mr. ALOISE. Yes. In fact, we just developed this about a year ago on how to develop a cost-benefit analysis. It was based on working with 90 representatives from all the federal agencies including DHS and it lays out exactly what the best practices are. But some of the things must be based on fact, must be fact based, based on data, not assumptions, must have proper documentation all along the way, and those are the kinds of things that we are missing from the ones we looked at for DNDO.

Ms. DAHLKEMPER. Anything specific to this particular——

Mr. ALOISE. In particular, test results, what do the test results show.

Ms. DAHLKEMPER. All right. Dr. Lowenthal, do you want to comment on that?

Dr. LOWENTHAL. If I can just add one point, we give some advice on how to complete the cost-benefit analysis but one of the things that is pointed out in our report is that no cost-benefit analysis at the end that deals with security matters is going to be totally unassailable. They are going to have to produce something that they can defend, but you are always going to be able to pick at some part of it. This is a difficult problem. This is not an easy issue to work through.

Ms. DAHLKEMPER. Thank you. I yield back.

Chairman MILLER. Thank you, Ms. Dahlkemper. You still had five minutes.

That concludes the questioning of this first panel. Again, we thank both Mr. Aloise and Dr. Lowenthal, and we will stand at ease for a second while this panel can step down and the next panel can come up.

Panel II:

At this time I would like to introduce our second panel. Dr. William Hagan is the Acting Deputy Director of the Domestic Nuclear Detection Office at the Department of Homeland Security. That is also a mouthful of a title. Mr. Todd C. Owen is the Acting Deputy

Assistant Commissioner of the Office of Field Operations at the U.S. Customs and Border Protection, Department of Homeland Security. You each have five minutes for your spoken testimony. Your written testimony will be included in the record. When we have completed your spoken testimony, we will begin with questions. Each Member will have five minutes to question the panel. It is the practice of this subcommittee to receive testimony under oath. Do either of you have any objection to taking an oath? Both witnesses indicated that they do not. If not, you also have the right to be represented by counsel. Do either of you have counsel here? And both indicated they do not have counsel present. Please stand and raise your right hand. Do you swear to tell the truth and nothing but the truth?

The record should reflect that both witnesses took the oath. We will begin with Dr. Hagan.

STATEMENT OF DR. WILLIAM K. HAGAN, ACTING DEPUTY DIRECTOR, DOMESTIC NUCLEAR DETECTION OFFICE, DEPARTMENT OF HOMELAND SECURITY

Dr. HAGAN. Good morning, Chairman Miller, Ranking Member Broun and distinguished Members of the Subcommittee. As Acting Deputy Director of the Domestic Nuclear Detection Office, DNDO, at the Department of Homeland Security, I am honored to be here with my colleague from U.S. Customs and Border Protection (CBP), Mr. Todd Owen. I would like to thank the Committee for the opportunity to share lessons learned and progress to date on our Advanced Spectroscopic Portal Program. I would also like to thank the Committee for its support of DNDO's mission to reduce the risk of radiological and nuclear terrorism to the Nation.

Over the past three years, we have made substantial investments in the development of the next generation of radiation portal monitor known as the Advanced Spectroscopic Portal, or ASP. The goal of the ASP program is to advance passive detection for cargo inspection. ASP is expected to automatically discriminate threat from non-threat materials for unshielded to lightly shielded threats in primary inspection while improving identification capability in secondary inspection. To ensure that ASP systems achieve the necessary technical and operational performance, we are in the midst of putting them through a rigorous test campaign. ASP has already advanced through several rounds of performance testing, and will face field validation at ports of entry, as well as independent operational testing and evaluation conducted by the DHS Science and Technology Directorate's operational test authority. The successful completion of these tests, along with other analyses in consultation with the National Academy of Sciences, will then inform the Secretary's certification decisions for ASP this fall.

In addition, during the execution of our test campaigns, we have cooperated with the Government Accountability Office and the National Academy of Sciences to provide both groups with information and visibility into our testing and analysis processes. The resulting review as issued by the GAO and the NAS provide a valuable external assessment of the ASP program.

The 2008–2009 set of ongoing tests reflect a number of steps DNDO has taken to reform test processes. For example, one of our most fundamental improvements has been to standardize test event planning. We now utilize detailed instructions with a six-milestone process to ensure that test planning is done openly, that partner inputs are included, and that test events are designed to provide the data required to meet the objectives of the test and to help make programmatic decisions. Additionally, some improvements in the ASP program have been the result of DHS-wide enhancements to program management. The changes put in place within DHS further ensure that any eventual certification or acquisition decisions are consistent with DHS priorities and made with a strong acquisition management foundation.

Specifically, we are implementing DHS's new management directive 102–01 for large acquisition programs which requires a complete set of analysis, testing and documentation as input for an acquisition decision. This set includes, for example, analysis of alternatives, concept of operations, operational requirements, mission need statements, cost-benefit analysis and others. We are acutely aware that we must integrate end-user requirements and conduct tests and evaluation campaigns. We recognize that the development and deployment of new systems can be expensive and the cost to taxpayers must be justified by the increased capabilities of the equipment. We feel that the plans and procedures now in place for the ASP program provide a sound foundation for future certification and acquisition decisions. ASP systems have been under review and evaluation for over three years, and further improvements will always be possible, but I believe that after the plan testing and analysis is complete and the requirements of MD 102–01 have been fulfilled, DHS will be in a position to make an informed decision.

As a final note, I would like to emphasize that while we are diligently working to characterize and evaluate the performance of ASP to ensure that operators receive appropriate equipment for their mission, the ASP program is only one piece of the multi-layered solution we call the global nuclear detection architecture through which we seek to integrate efforts across the government into an overarching strategy to improve the Nation's nuclear detection capabilities. Accordingly, we plan to continue deployments of detection systems at our official ports of entry while also dedicating increased time and effort to a wider range of pathways. In addition, we have been working to strengthen the architecture by filling gaps, improving technologies, building necessary infrastructure and raising awareness about radiological and nuclear threats and the role of detection systems.

I look forward to continuing to work with our partners within DHS, other federal departments and State and local agencies and the Members of this subcommittee and the Congress to help keep the Nation safe from radiological and nuclear terrorism.

This concludes my statement. I thank you for your attention. I am happy to answer any questions.

[The prepared statement of Dr. Hagan follows:]

PREPARED STATEMENT OF WILLIAM K. HAGAN

Introduction:

Good morning Chairman Miller, Ranking Member Broun, and distinguished Members of the Subcommittee. As Acting Deputy Director of the Domestic Nuclear Detection Office (DNDO) at the Department of Homeland Security (DHS), I would like to thank the Committee for the opportunity to share lessons learned and progress to date on our Advanced Spectroscopic Portal (ASP) program. I would also like to thank the Committee for its support of DNDO's mission to reduce the risk of radiological and nuclear terrorism to the Nation.

DNDO was established to improve the Nation's capability to detect and report attempts to import, possess, store, develop, or transport nuclear or radiological material for use against the Nation, and to further enhance this capability over time. To that end, our work is guided by our development of a global nuclear detection architecture (GNDA). DNDO has developed a time-phased, multi-layered, defense-in-depth GNDA that is predicated on the understanding that no single layer of defense can detect all radiological or and nuclear (rad/nuc) threats. For this reason, the GNDA provides multiple detection and interdiction opportunities overseas, at our borders, and within the United States to effectively increase the overall probability of system success. DNDO has worked with intra- and interagency partners to develop time-phased strategies and plans for improving the probability of detecting and interdicting nuclear threats. DNDO will continue to enhance the GNDA over time by developing better detection technologies, working with our operational partners to improve concepts of operations (CONOPs), enabling real-time reporting of detection events, and supporting effective response to real threats.

My testimony today will include a status update and lessons learned in DNDO's efforts to address one aspect of the GNDA—scanning cargo containers at ports of entry. Specifically, I will focus on the ASP program—a program to improve the detectors used to perform this task.

Role of Container Scanning and ASP in the GNDA:

The United States border is the first layer within the GNDA where the United States has full control over detection and interdiction. As such, considerable effort and resources have been placed at this layer to provide comprehensive radiological and nuclear detection capabilities, particularly at ports of entry (POEs). After 9/11, considerable concern was raised about the possibility that terrorists could use the enormous volume of cargo flowing into the United States as a pathway for bringing in nuclear material or a nuclear weapon. By far, the largest mode for incoming cargo is maritime shipping containers, with approximately 11 million containers coming into the country every year. Additionally, in the *Security and Accountability for Every* (SAFE) *Port Act of 2006,* Congress mandated that all containers coming in through the top 22 ports, by volume, be scanned for radiation by the end of 2007.

A key consideration in rad/nuc detection is the ability to effectively detect threats without impeding the flow of legitimate trade and travel across the border. United States Customs and Border Protection (CBP) currently scans cargo entering at our nation's POEs using polyvinyl toluene (PVT)-based radiation portal monitors (RPMs) that can detect radiation, but cannot distinguish between threat materials and naturally occurring radioactive material (NORM), such as kitty litter and ceramic tiles. Narrowing down alarms to just those for dangerous materials is especially important for POEs that have a high volume of containers, or those that see a high rate of NORM. To address this limitation, DNDO is developing next-generation technology—the ASP program. The ASPs have shown significantly improved capability to distinguish rad/nuc threats from non-threats over the hand-held instruments currently used in secondary screening. Thus, the introduction of ASP systems is expected to not only reduce the number of unnecessary referrals and false positives in primary but increase the probability of detecting dangerous materials in secondary.

As you know, DNDO initiated the ASP program in 2006, building on previous work within CBP and the Science and Technology Directorate. ASP systems are the next generation of radiation portal monitors. ASP units are now being developed by two separate vendors. These units have been subjected to rigorous tests and both systems will complete several rounds of performance testing and field validation at POEs. Following these performance tests, both systems will complete independent operational testing and evaluation conducted by the DHS Science and Technology Directorate's Operational Testing Authority. Test data will be analyzed and provided in support of the Secretary's Certification decision. DNDO is also engaged with the National Academy of Sciences (NAS) to allow them to review ASP testing and inform the certification process, as required in the FY 2008 and 2009 Homeland

Security Appropriations bills. Indeed, in its most recent report on ASP testing, the Government Accountability Office (GAO) acknowledged the many enhancements and lessons that DNDO has incorporated into its testing programs.

Reviews to date and lessons learned:

Since 2006, the ASP program has undergone extensive review from outside agencies, including the GAO, an Independent Review Team (IRT) established by the previous DHS Secretary, and, most recently, the National Academy of Sciences. We have taken each review seriously, valued the recommendations that have been provided, and, where we felt appropriate, we have incorporated their recommendations into the next stages of the program.

The first reviews conducted by the GAO of the ASP program focused on testing conducted in 2005 as part of the original ASP vendor selection and the initial cost-benefit analysis used to evaluate potential deployment options for ASP systems. In its report, released in September 2006, GAO questioned the methods used by DNDO to quantify performance capabilities of new systems, and insisted that ASP performance be evaluated against system requirements prior to full scale deployment. DNDO concurred with the need for additional testing prior to full scale deployments, which were underway prior to the release of GAO's report. These tests were conducted throughout 2007 and focused specifically on evaluating the performance of ASP systems in a number of testing environments.

In September 2007, GAO recommended that DHS establish an independent body to conduct additional testing of ASP systems, which DNDO agreed to, launching the ASP-Independent Review Team (IRT), a team of independent experts, drawn from a wide range of institutions and backgrounds. The ASP–IRT Report, delivered in February 2008, provides a valuable independent assessment of the ASP program, and served as an important source of information, albeit based on the data that was available at the time.

In addition to the reviews of 2007 testing, at the conclusion of initial "field validation" testing in 2007, CBP identified a number of functional improvements, unrelated to detector performance, that required modifications to ASP systems prior to deployment. DNDO postponed efforts to seek certification at that time, initiated new efforts to develop these requested changes , and conducted a new series of tests in 2008 and early 2009 to ensure that these changes did not detract from detector performance.

The 2008–2009 test campaign transitions the program from developmental to functionality and performance testing, culminating in full operational tests. This testing includes:

1. System Qualification Testing, designed to demonstrate that ASP units are manufactured in accordance with processes and controls that meet the specified design requirements;
2. Performance Testing at the Nevada Test Site (NTS), designed to evaluate ASP, PVT, and radioisotope identification devices (RIID) detection and identification performance against controlled, realistic threat materials, shielding and masking scenarios;
3. Integration Testing, designed to determine whether the ASP systems are capable of operating and interfacing with the other equipment found in operational settings;
4. Field Validation Testing, designed to exercise the ASP in a stream of commerce environment at POEs;
5. Operational Test and Evaluation (OT&E), designed to measure the operational effectiveness and suitability of ASP. The OT&E will be independently conducted by the DHS Science and Technology Directorate (S&T).

Recently, the GAO released its latest report, focusing on the testing conducted in 2008 and 2009. GAO acknowledged improvements in ASP testing, but raised some concerns. DNDO agrees that analysis and review of test data is necessary. DNDO plans to continue study the results of testing as the ASP program progresses. However, DNDO believes that the data analysis performed to date and the anticipated data from ongoing testing will be sufficient to inform an ASP certification decision in the future.

In addition to the GAO's reviews, DNDO and CBP have provided NAS with regular testing updates. Recently, the NAS delivered an interim report to the Department and the Appropriations Committees. Like the NAS, DNDO sees the intrinsic value of continued testing and incremental deployment of ASP systems. However, DNDO must balance the need to better understand a complex system like ASP and the need to further reduce the risk of certain significant vulnerabilities and operational burdens. DNDO believes that the criteria outlined for certification are a sufficient threshold for determining when we have reached the point where deployment should begin.

Ultimately, these reviews provide for a valuable external assessment of the ASP program. It is only through initial deployments that we will continue to learn more about the performance of these systems, and most rapidly bring about the improvements that are needed to address current limitations. ASP systems have been under review and evaluation for over three years now, and, while further improvements will always be possible, we should not delay the implementation of substantially improved capabilities.

Acquisition lessons learned and changes made in response:

DNDO has taken a number of steps to reform processes to ensure the success of ASP, as well as other development and acquisition programs. At the same time, these reforms are accompanied by a number of similar improvements to DHS-wide program management processes.

With regard to testing, DNDO has taken a number of steps to improve internal procedures based on lessons learned from earlier tests.

One of our most fundamental improvements has been through the standardized implementation of DNDO Operating Instruction 1, "Test Event Planning." This detailed instruction lays out a six-milestone process that ensures that test planning is done openly, that partner inputs are included, and that test events are designed to provide the data required to meet the objectives of the test, and ultimately to help make programmatic decisions.

We have also taken considerable steps to ensure that any ASP testing is responsive not just to DNDO requirements and objectives, but to all DHS partners. Prior to the 2008–2009 testing, DHS created a test planning working group that included DNDO, CBP, the DHS Operational Testing Authority (OTA), the Office of the Under Secretary for Management (USM), and the National Laboratories. Collectively, this group laid out the test campaign and assigned responsibilities for each test event to respective components.

Finally, in the 2008–2009 ASP test campaign, based on lessons learned in the 2007 test campaign series, we instituted strict entrance and exit criteria for each of the test events. These criteria were developed long before testing began, and were developed jointly with our operational partner, CBP. This has given us confidence that as the ASP systems have continued through this series of test events, requirements are met prior to completion.

DNDO has also made a number of program management changes based on lessons learned throughout the program. In late 2008, DHS decided against exercising the next contract option for one of three ASP vendors. This decision reduced costs for carrying forward multiple, parallel development efforts.

Finally, DNDO and the ASP program have benefited from a number of DHS-wide improvements to program management. DNDO has adopted Management Directive (MD) 102–01, which outlines the acquisition management process for DHS programs. ASP program plans have been adapted to be consistent with the rigorous process outlined in the directive. This will further ensure that any eventual certification and acquisition decisions are consistent with DHS priorities and made with a strong acquisition management foundation.

There is an important distinction between two key milestones for the ASP program—Secretarial certification and the MD 102–01 milestone decision for purchase and deployment of ASP. The former is a rather loosely defined milestone, which we have clarified by defining a "significant increase in operational effectiveness," requiring that the Secretary formally state that she believes the ASP system is "better than" the current system. The latter is a very well defined milestone that was developed for all large programs within the Department of Homeland Security. Items such as mission needs, operational requirements, analysis of alternatives, etc., are part of the MD 102–01 process. No ASP production units can be purchased and deployed without successfully navigating the MD 102–01 process. The Secretarial certification requirement is in addition to and in advance of the MD 102–01 deployment decision.

Together, the lessons learned in testing and program management, along with the introduction and adherence to MD 102–01 have significantly improved the ASP program. At the same time, it is important to note that these lessons learned have not only benefited the ASP program; they are being applied across DHS.

ASP Path Forward:

The plans and procedures in place for the ASP program provide a sound path forward for ASP certification and future acquisition decisions. The current path to certification includes testing, accompanied by the analysis of results, to ensure that Secretary Napolitano has sufficient information for ASP certification. ASP systems have been under review and evaluation for over three years now, and, while further improvements will always be possible, a certification decision will determine whether or not the systems address increase the probability of detecting dangerous materials while minimizing the operational burdens.

ASP was designed to improve capabilities in both primary and secondary inspections. For primary applications, we have defined a "significant increase in operational effectiveness" as being a quantified reduction in unwanted referrals to secondary inspection, while maintaining similar or better sensitivity in detecting materials of concern. Ultimately, the degree to which ASP systems meet this objective is driven by sensitivity thresholds at which the systems will be operated, similar to the threshold used for current PVT systems. Therefore, the advantage in primary can be viewed as an improvement in efficiency of operations (less unwanted referrals), while maintaining the same or better detection efficiency. The relative degree to which we realize these benefits with respect to the current systems will vary by port, depending on the operational thresholds at which the current PVT systems are set.

The evaluation of ASP systems in secondary inspection is more direct. The ability of ASP systems to identify and resolve the source of radiation is directly compared to the ability of current capabilities to perform the same functions. In this instance, a "significant increase in operational effectiveness" is defined as a quantified improvement in the ability to identify materials of concern.

Both of these definitions were developed through coordination between DNDO, CBP, and USM. This definition has been approved by DHS senior leaders and has served as the guide for developing test campaigns to meet these test objectives. Again, because of the rigor that has gone in to developing and quantifying these improvements, we are seeking to remove ambiguity in the evaluation process, and ensure that any certification and acquisition decisions are made consistent with DHS priorities and objectives.

Conclusion:

DNDO will continue to work with CBP and other partners within and beyond DHS to improve the Nation's ability to detect radiological and nuclear threats at our ports and borders. DHS is facing a challenge at our ports and borders as the Department balances facilitating the flow of goods and commerce with the need to sufficiently scan cargo for radiological or nuclear threats as it enters our nation. As both the President and Secretary have said, the Nation will need more technology to meet its security challenges and the technologies that DNDO is pursuing, of which ASP is but one example, are a critical component in addressing that challenge.

Our efforts to develop and evaluate ASP systems are sound. Current test results are capturing the benefits of ASP systems, and the reviews to date have provided a valuable assessment of the program and identified a number of key lessons learned.

I welcome and appreciate the Committee's active engagement with this program, and look forward to continuing our cooperation as we move forward together. Chairman Miller, Ranking Member Broun, and Members of the Subcommittee, I thank you for your attention and will be happy to answer any questions that you may have.

BIOGRAPHY FOR WILLIAM K. HAGAN

Dr. William Hagan serves as Acting Deputy Director of the Department of Homeland Security's (DHS) Domestic Nuclear Detection Office (DNDO). Prior to that, he was Assistant Director for the Transformational Research and Development (R&D) Directorate at DNDO. In that role Dr. Hagan was responsible for long-term R&D seeking technologies that can make a significant or dramatic positive impact on the performance, cost, or operational burden of detection components and systems.

Prior to DNDO, he was a Senior Vice President at Science Applications International Corporation (SAIC). Business areas included nuclear technology (analysis, detection, and applications), telecommunications, optics, transportation, system integration, and technology assessments during his thirty years at SAIC.

Dr. Hagan earned a Bachelor of Science in Engineering Physics in 1974, Master of Science in Physics in 1975, and Master of Science in Nuclear Engineering in 1977 from the University of Illinois at Urbana. He received his Ph.D. in Physics from the University of California–San Diego in 1986. He holds three patents. Dr. Hagan was appointed to Senior Executive Service in 2006.

Chairman MILLER. Thank you, Dr. Hagan.

Mr. Owen for five minutes.

STATEMENT OF MR. TODD C. OWEN, ACTING DEPUTY ASSISTANT COMMISSIONER, OFFICE OF FIELD OPERATIONS, U.S. CUSTOMS AND BORDER PROTECTION, DEPARTMENT OF HOMELAND SECURITY

Mr. OWEN. Good morning, Chairman Miller, Ranking Member Broun, distinguished Members of the Subcommittee. As the Acting Deputy Assistant Commissioner for the Office of Field Operations with U.S. Customs and Border Protection, I am honored to be here this morning alongside Dr. Hagan to discuss the detection of radioactive and nuclear material in cargo containers and the future role that Advanced Spectroscopic Portal technology will have on CBP operations.

I would also like to express my gratitude to the Congress for its continued support of CBP initiatives. Among the numerous priorities that were recognized in the American Recovery and Reinvestment Act, Congress provided CBP with $100 million worth of stimulus funding towards non-intrusive inspection equipment. This funding will allow CBP to upgrade and expand its successful Non-Intrusive Inspection (NII) program and more efficiently inspect containers and vehicles crossing the border, allowing them to enter our country and its commerce in a safe and prompt manner.

CBP has made tremendous progress in ensuring that supply chains importing goods into the United States are more secure against potential exploitation by terrorist groups aiming to deliver weapons of mass effect. CBP uses a multi-layered approach to ensure the integrity of supply chains from point of stuffing through the arrival in the U.S. ports of entry. This multi-layered defense is built upon interrelated initiatives, which include the 24-hour rule in the *Trade Act of 2002,* the automated targeting system, the use of Non-Intrusive Inspection equipment and radiation portal monitors, our container security initiative and the Customs Trade Partnership Against Terrorism program. These complementary layers enhance security and protect our nation.

Prior to 9/11, not a single radiation portal monitor and only 64 large-scale non-intrusive inspection systems were deployed to our nation's borders. By October of 2002, CBP had deployed the first RPM at the Ambassador Bridge in Detroit. Today CBP has well over 1,200 RPMs and 227 large-scale NII technology systems deployed nationwide. NII technology allows the officers to detect possible anomalies, anomalies which may indicate the presence of a weapon of mass effect or some other contraband, and to date in fiscal year 2009, CBP NII systems have conducted over 3.1 million exams resulting in over 7,800 narcotic seizures with a total weight of over 2.6 million pounds as well as $6.2 million in currency seized.

In addition to the significant strides made in the area of NII equipment, CBP also continues to deploy first-generation radiation portal monitors to our ports of entry. Currently, 97 percent of the trucks and 93 percent of the personally owned vehicles arriving from Canada, 100 percent of the trucks and vehicles from Mexico and 98 percent of the arriving sea containers are scanned by our current radiation detection technologies. In total, CBP scans 98 percent of all cargo arriving into the United States by land and sea using radiation portal monitors. In addition, CBP officers scan 100 percent of general aviation aircraft arriving to the United States from foreign destinations using hand-held radiation identification devices.

Since the first RPM was deployed in 2002, CBP officers have scanned over 368 million conveyances for the presence of radiation, and we have resolved 2.1 million radiological alarms successfully with minimal or no impact to the flow of legitimate trade and travel. CBP continues to closely coordinate with key stakeholders to ensure the impact of this activity causes minimal disruption to port operations. The first-generation RPM systems, although very sensitive, do have limitations. While they alert CBP officers to the presence of radiation, a secondary exam is necessary to positively identify the specific isotope causing the alert. In the event that a CBP officer is unable to positively resolve the alert, scientific reachback is available 24 hours a day, seven days a week.

The ASP is expected to enhance our detection capability while significantly reducing the number of secondary examinations. This is due to its ability to distinguish between actual threats and natural or medical radiation sources that are not security threats. CBP has worked closely with the DNDO in the development and operational testing of ASP, has provided DNDO with functional requirements and has been actively engaged in every step of the evaluation process. CBP's focus for operational testing is to evaluate the effectiveness for systems deployed in our operational environments. We will continue to work with DNDO and the DHS Science and Technology Directorate towards secretarial certification, and we are also working within DHS to ensure that any future ASP acquisitions and deployment decisions are consistent with DHS priorities. The decision to purchase and deploy ASPs in the operational arena will be based on CBP's mission needs, operational requirements, comprehensive cost-benefit analysis to include the full understanding of maintenance and operation costs, and analysis alternatives and other considerations.

Mr. Chairman, Members of the Subcommittee, today I have addressed CBP's commitment to invest in new technologies and emerging technology aimed at enhancing cargo security. We must continue to maintain our tactical edge by integrating new technology into our ports of entry.

Thank you again for the opportunity to be here this morning and I would be happy to answer any questions.

[The prepared statement of Mr. Owen follows:]

PREPARED STATEMENT OF TODD C. OWEN

Chairman Miller, Ranking Member Broun, esteemed Members of the Subcommittee, it is a privilege and an honor to appear before you today to discuss the work of U.S. Customs and Border Protection (CBP), particularly the detection of radioactive and nuclear material in cargo containers and the future role that the Advanced Spectroscopic Portal (ASP) program will have on our operations. CBP strives to continually improve the security of cargo entering our borders and facilitate the flow of legitimate trade and travel. Included in this process, over 98 percent of all arriving maritime containerized cargo is presently scanned for radiation through radiation portal monitors.

I want to begin by expressing my continuing gratitude to Congress for its continued support for the mission and people of CBP. It is clear that the Congress is committed to providing CBP the resources we need in order to increase and maintain the security of our borders. We appreciate your efforts and assistance.

CBP is the largest uniformed, federal law enforcement agency in the country. We station over 20,000 CBP officers at access points around the Nation, including at air, land, and sea ports. As of mid-May, we have deployed over 19,000 Border Patrol agents between the ports of entry. These forces are supplemented with 1,058 Air and Marine agents, 2,318 agricultural specialists, and other professionals. These personnel are key players in the implementation of Secretary Napolitano's Southwest Border Security Initiative.

CBP continues to execute all of its responsibilities, which include stemming the illegal flow of drugs, contraband and people, protecting our agricultural and economic interests from harmful pests and diseases, protecting American businesses from theft of their intellectual property, enforcing textile agreements, tracking import safety violations, regulating and facilitating international trade, collecting import duties, facilitating legitimate travel, and enforcing United States trade laws. CBP facilitates lawful immigration, welcoming visitors and new immigrants, while making certain those entering this country are indeed admissible and taking appropriate action when an individual fears being persecuted or tortured if returned to their home country. At the same time, our employees maintain a vigilant watch for terrorist threats. In FY 2008, CBP processed more than 396 million pedestrians and passengers, 122 million conveyances, 29 million trade entries, examined 5.6 million sea, rail, and truck containers, performed over 25 million agriculture inspections, apprehended over 720 thousand illegal aliens between our ports of entry, encountered over 220 thousand inadmissible aliens at the ports of entry, and seized more than 2.8 million pounds of illegal drugs.

We must perform our important security and trade enforcement work without stifling the flow of legitimate trade and travel that is so important to our nation's economy. These are our twin goals: border security and facilitation of legitimate trade and travel.

CBP OVERVIEW

I am pleased to appear before the Subcommittee today to highlight key accomplishments related to container security, particularly those related to new and emerging technology. CBP has made tremendous progress in securing the supply chains bringing goods into the United States from around the world to prevent their potential use by terrorist groups that seek to deliver weapons of mass effect. The use of cutting-edge technology has greatly increased the ability of front line CBP Officers to successfully detect and interdict illicit importations of nuclear and radiological materials. CBP uses a multi-layered approach to ensure the integrity of the supply chain from the point of stuffing through arrival at a U.S. port of entry. This multi-layered approach includes:

- Advanced Information
  - 24-Hour Rule
  - Automated Targeting Systems
  - Importer Security Filing
- The Customs Trade Partnership Against Terrorism
- The Container Security Initiative
- The Secure Freight Initiative
- Use of Non-Intrusive Inspection Technology and Mandatory Exams for All High-Risk Shipments

I will discuss each one of these layers in greater detail with particular focus on our radiation and nuclear detection capabilities.

ADVANCE INFORMATION

CBP requires advanced electronic cargo information as mandated in the *Trade Act of 2002* (including the 24-hour rule for maritime cargo). Advanced cargo information on all inbound shipments for all modes of transportation is effectively evaluated using the Automated Targeting System (ATS) before arrival in the United States.

ATS provides decision support functionality for CBP officers working in Advanced Targeting Units (ATUs) at our ports of entry and CSI ports. The system provides uniform review of cargo shipments for identification of the highest threat shipments, and presents data in a comprehensive, flexible format to address specific intelligence threats and trends. ATS uses a rules-based program to highlight potential risk, patterns, and targets. Through rules, the ATS alerts the user to data that meets or exceeds certain pre-defined criteria. National targeting rule sets have been implemented in ATS to provide threshold targeting for national security risks for all modes: sea, truck, rail, and air.

The Importer Security Filing interim final rule, also known as "10 + 2," went into effect earlier this year and has already yielded some promising results. This program will provide CBP timely information about cargo shipments that will enhance our ability to detect and interdict high risk shipments. Comments on aspects of this rule were accepted until June 1, 2009, and implementation using informed compliance will continue until January of next year. Shipments determined by CBP to be high-risk are examined either overseas as part of our Container Security Initiative or upon arrival at a U.S. port.

Customs Trade Partnership Against Terrorism

The Customs Trade Partnership Against Terrorism (C–TPAT) is an integral part of the CBP multi-layered strategy, in that CBP works in partnership with the trade community to better secure goods moving through the international supply chain. C–TPAT has enabled CBP to leverage supply chain security throughout international locations where CBP has no regulatory reach. In 2009, CBP will continue to expand and strengthen the C–TPAT program and ensure that certified member companies are fulfilling their commitment to the program by securing their goods moving across the international supply chain to the United States. To carry-out this critical tenet of C–TPAT in 2009, teams of Supply Chain Security Specialists (SCSS) will conduct validations and revalidations of C–TPAT members' supply chains to ensure security protocols are reliable, accurate, and effective.

As C–TPAT has evolved, we have steadily added to the rigor of the program. CBP has strengthened the C–TPAT program by clearly defining the minimum-security requirements for all categories of participants wishing to participate in the program and thereby gain trade facilitation benefits. As of June 18, 2009, there are 9,286 companies certified into the C–TPAT program. CBP's goal is to validate all partners within one year of certification, revalidate all companies not less than once every three years and revalidate all U.S./Mexico highway carriers on an annual basis, based on the risk associated with the Southern Border Highway Carrier sector of C–TPAT.

Container Security Initiative

To prevent terrorists and their weapons from entering the United States, CBP has also partnered with other countries through our Container Security Initiative (CSI). In FY 2008 CBP Officers stationed at CSI ports reviewed over 11 million bills of lading and conducted over 74,000 exams in conjunctions with their host country counterparts. Because of the sheer volume of sea container traffic, containerized shipping is uniquely vulnerable to terrorist exploitation. Under CSI, which is the first program of its kind, we are partnering with foreign governments to identify and inspect high-risk cargo containers at foreign ports before they are shipped to our seaports and pose a threat to the United States and to global trade.

CBP Officers stationed at foreign CSI ports review 100 percent of the manifests originating and/or transiting those foreign ports for containers that are destined for the United States. In locations where the tremendous volume of bills prevents the CSI team at the port itself from performing 100 percent review, or during port shutdowns, CSI targeters at the National Targeting Center provide additional support to ensure that 100 percent review is accomplished. Utilizing the overseas CSI team and the CSI targeters at our National Targeting Center, CBP is able to achieve 100 percent manifest review for the CSI program.

Today, CSI is operational in 58 ports covering 86 percent of the maritime containerized cargo shipped to the United States.

Secure Freight Initiative

The Secure Freight Initiative (SFI) is an unprecedented effort to build upon existing port security measures by enhancing the United States Government's ability to scan containers for nuclear and radiological materials in seaports worldwide and to better assess the risk of inbound containers. Secure Freight will provide carriers of maritime containerized cargo with greater confidence in the security of the shipment they are transporting, and it will increase the likelihood of an uninterrupted and secure flow of commerce. This initiative is the culmination of our work with other government agencies, foreign governments, the trade community, and vendors of leading edge technology.

Moving forward, CBP will prioritize future deployments of scanning systems to locations of strategic importance by identifying seaports where non-intrusive imaging and radiation detection data would be most practical and effective in deterring the movement of weapons of mass destruction via containerized cargo. Under this strategy, the additional scan data provided by SFI will enhance DHS' risk-based and layered approach to securing maritime containerized cargo. We will continue to work with Congress to enhance the safety of our nation's ports and the security of incoming cargo.

Non-Intrusive Inspection/Radiation Detection Technology

Today I will specifically address large-scale X-ray and gamma imaging systems and radiation detection devices; technologies that play a critical role in our layered enforcement strategy.

The deployment of imaging systems and radiation detection equipment has contributed to CBP's tremendous progress in ensuring that supply chains bringing goods into the United States from around the world are secure against exploitation by terrorist groups that seek to deliver weapons of mass effect.

Non-Intrusive Inspection (NII) technology serves as a force multiplier that allows officers to detect possible anomalies between the contents of the container and the manifest. CBP relies heavily on the use of NII as it allows us to work smarter and more efficiently in recognizing potential threats.

Prior to 9/11, not a single Radiation Portal Monitor (RPM), and only 64 large-scale NII systems, were deployed to our nation's borders. By October of 2002, CBP had deployed the first RPM at the Ambassador Bridge in Detroit. Today, CBP has deployed 1,250 operational RPMs at seaports, land border ports, and mail facilities, 227 large-scale gamma ray or x-ray imaging systems and 3,000 small scale NII systems nationwide. Additionally, CBP has deployed over 1,382 Radiation Isotope Identifier Devices (RIID) and over 17,542 Personal Radiation Detectors (PRD). These devices allow CBP to inspect 100 percent of all identified high-risk cargo.

Currently, 97 percent of trucks and 93 percent of personally owned vehicles arriving through northern border ports, 100 percent of vehicles arriving through southern border ports, and 98 percent of arriving sea containers are scanned by our radiation detection technologies. CBP uses RPMs to scan 98 percent of *all cargo* arriving in the U.S. by land and sea. In addition, CBP officers now use hand-held radiation identification devices to scan 100 percent of private aircraft arriving in the U.S. from foreign destinations. As of May 2009, CBP officers scanned over 368 million conveyances and successfully adjudicated 2.1 million radiological alarms.

It is important to distinguish these deployments from the 100 percent mandate. These deployments refer to CBP's domestic RPM deployments, which perform radiation detection (not imaging) of containers that are scanned in the U.S. but prior to release into the commerce. The 100 percent mandate requires scanning in a foreign port and both imaging and radiation detection.

The first generation RPM systems, although very sensitive, do have limitations. While they alert CBP officers to the presence of radiation, a secondary exam is necessary to positively identify the location and specific isotope causing the alert. In the event that a CBP officer is unable to positively resolve the alert, scientific reach back is available on a 24/7 basis through the National Targeting Center and CBP's Laboratory & Scientific Services Division located in the northern Virginia area.

Understanding these limitations and the need for more precise radiological detection architecture, the DNDO was chartered to develop new technologies that will improve CBP's radiation and nuclear detection capabilities. One of these new technologies is the next generation RPM, or the Advanced Spectroscopic Portal (ASP).

The ASP is able to distinguish between actual threats and natural or medical radiation sources that are not security threats. In doing so, the ASP is expected to enhance our detection capability, while significantly reducing the burden of responding to the numerous benign, nuisance alarms that are mostly generated by everyday products. This will allow CBP to focus our staffing and resources on high-risk shipments and other border security initiatives.

CBP COORDINATION WITH THE DOMESTIC NUCLEAR DETECTION OFFICE (DNDO)

In the course of our collaboration with DNDO, CBP brings knowledge of how our ports work, of the support needs of our front-line officers, and of the operational requirements for new technologies that must work consistently in a broad array of environments. Additionally, we must remain attuned to critical factors such as throughput and capacity as we seek to maintain an appropriate balance between security and the facilitation of cross-border travel and trade.

CBP has worked closely with DNDO in the developmental and operational testing of the ASP. A complete independent operational testing and evaluation will be conducted by the DHS S&T Director, T&E and Standards Director, Operational T&E, when the system is ready. CBP's objective for operational testing is ensuring that systems are operationally acceptable and effective and can be deployed in our operational environments. Specifically, CBP provided DNDO with functional requirements for the ASP and has been actively engaged in every step of testing, including performance testing at the Nevada Test Site and Integration testing currently ongoing at a mock port of entry at the Pacific Northwest National Laboratory.

During integration testing, CBP works closely with DNDO to assess each system's performance as an integrated unit, including reach back capability and ancillary equipment such as traffic lights and automated gate arms that are essential to maintain positive control of vehicles at our congested ports of entry. In addition, CBP works with DNDO to assess and categorize each system's defects to ascertain their technological impact on performance and their operational impact on front-line CBP officers—the users of the system.

CBP will continue to work with DNDO towards Certification by the Secretary, which is dependent on demonstrating a "significant increase in operational effectiveness" over existing first generation radiation detection systems. Only after this Certification has been reach can the discussion then turn to potential acquisition and deployments of the ASP systems. The decisions to purchase and deploy ASPs in the operational arena will be based on mission needs, operational requirements, and a full understanding of maintenance and operational costs, to include a comprehensive cost benefit analysis, an analysis of alternatives, etc.

CONCLUSION

In conclusion, I would like to say that technology plays an enormous role in securing the supply chain. Security technology is continuously evolving, not only in terms of capability but also in terms of compatibility, standardization, and integration with information systems. It is important to note that there is no single technological solution to improving supply chain security. As technology matures, it must be evaluated, and adjustments to operational plans must be made. Priority should be given to effective security solutions that complement and improve the business processes already in place, and which build a foundation for secure 21st century global trade.

Mr. Chairman, Members of the Committee, today I have addressed CBP's commitment to investing its efforts in the areas of new and emerging detection technology, as well as some of the steps we have taken towards enhancing cargo security.

Thank you again for this opportunity to testify. I will be happy to answer any of your questions.

BIOGRAPHY FOR TODD C. OWEN

Todd C. Owen is the Executive Director of the Cargo and Conveyance Security Office within U.S. Customs and Border Protection's Office of Field Operations. As the Executive Director for the Cargo and Conveyance Security (CCS) Office since May 2006, Mr. Owen is directly responsible for all cargo security programs and policies for CBP, including the "100 percent scanning initiative" announced in October, 2007. Included within Mr. Owen's responsibilities are the Container Security Initiative (CSI), the Customs-Trade Partnership Against Terrorism Program (C–TPAT) Office, all non-intrusive inspection technology and radiation portal monitor deployments, the National Canine Enforcement Program, and the National Targeting Center, Cargo.

Mr. Owen also coordinates CBP's maritime cargo enforcement policies and activities with the U.S. Coast Guard, and all air cargo efforts with the Transportation Security Administration.

Previously, Mr. Owen was the Director of the C–TPAT program from January 2005 through May 2006. During his tenure as C–TPAT Director, this 9,000 member strong industry partnership program was strengthened by more clearly defining the security measures which must be adopted for a member to be eligible to receive the trade facilitation benefits afforded by CBP. Strong management controls were implemented and hiring was increased, allowing for a significant increase in the level of foreign site assessments performed worldwide under this program.

Prior to arriving in Washington in January 2005, Mr. Owen was the CBP Area Port Director in New Orleans. As the Area Port Director, Mr. Owen was directly responsible for all CBP operations in New Orleans and throughout Louisiana. Two hundred forty officers are stationed in the seven Louisiana CBP port offices managed by the Area Director.

Mr. Owen began his career as an Import Specialist in Cleveland, Ohio in 1990, and transferred to Miami in 1992. Through his eight years in South Florida, Mr. Owen held various trade related positions within Field Operations and the Office of Strategic Trade, before being selected for the New Orleans Area Port Director position in 2000.

Mr. Owen, a career member of the Senior Executive Service, is a graduate of John Carroll University in Cleveland, Ohio, and was a senior executive fellow at Harvard University's John F. Kennedy School of Government. Mr. Owen also holds a Master's degree in Public Administration from St. Thomas University in Miami, Florida.

DISCUSSION

Chairman MILLER. I now recognize myself for five minutes. Dr. Hagan, you have heard a lot of criticisms of this program this morning, that is the Maginot Line of terrorism. It is pretty unlikely that terrorists will actually try to go through this system when it would be relatively easy to go around it, that a lot of the testing seems to be an afterthought to justify a conclusion that was already reached. The end-user, the Customs and Border Patrol, think that they are doing perfectly well and that their existing technology could be improved upon relatively cheaply compared to the investment that would be required, the spending that would be required for ASP. And both of the previous witnesses very much questioned the validity, the thoroughness of the testing that was being used to justify the decision to deploy ASP. What is the urgency? In view of all of that, what is the urgency about putting a certification decision before the DHS Secretary in October?

Dr. HAGAN. I guess there is a couple things I would like to say. First is that there is a sense of urgency regarding some of the limitations of the current system. We can't talk about these in open session, but we would be happy to do that at a later time. But having said that, I don't believe that today that there is a rush to deployment nor is there a 'do it by October or something bad happens.' So what we are doing though is pushing forward as aggressively as we can to get to the decision point about deployment. In other words, we are not saying we have got to deploy these right now. We are saying we have got to get, as soon as possible, to the point where we make that decision, and as was said by the earlier witnesses, the information that is required to make that decision, as I mentioned in my oral statement, there is a lot of information, a lot of data, a lot of test results that have yet to be analyzed and brought together and integrated in this cost-benefit analysis, and that would be an important part of the decision that will be made in October. So, I guess I would disagree that we are rushing to deployment. I would say that we are rushing more towards getting all the information as fast as we can but doing it in a thoughtful, deliberate, disciplined way and through this MD 102–01 process that I mentioned, to get to that decision point.

Chairman MILLER. Mr. Owen, we heard again from GAO and the National Academies of Science that the work to this point did not really instill confidence in them that this new system would perform as reliably, as effectively as we would like or even as the existing technology works. They seem not concerned about a delay. They in fact encouraged a delay. Do you agree with their recommendation to stick with what we have got and not rush either to deploy or to certify or to decide to deploy?

Mr. OWEN. Sir, as the operator, the end-user of the systems, we, as front-line officers, need technology that will not only reduce the possibility of a missed threat but as well as reduce the rate of innocent alarms that our officers are spending their time on. In the port of Long Beach, for example, we have between 400 and 600 radiation alarms every single day. We have a team of about 100 officers over the three shifts that work on just resolving these innocent alarms throughout the course of their workday. So having a new piece of technology or an enhancement to technology that will allow us to not only identify any missed potential threats, but reduce the number of innocent alarms, is something that we do support. But as I mentioned in our hearing, our testimony, we have been doing this for some time with the existing PVTs. We have been able to resolve those 2.1 million alarms without a negative throughput with the flow of commerce in our ports of entry. So the technology that we have is effective but again, as we have matured the technology, we are looking for that technology which will give us an edge, if you will, a step up from what we have, particularly in terms of missing any threats that the PVTs may not capture right now.

Chairman MILLER. With respect to the existing technologies, the PVTs with the follow-up searches, are there enhancements, improvements in that technology that seem available, achievable, and have those improvements, are those being pursued?

Mr. OWEN. Our current system with the PVT which will alert—the container will then go in a secondary where we will perform the analysis with the radiation isotope identifier and we push that information back to our laboratory and scientific folks—it is a process that we have crafted and we feel comfortable with. What we have seen in the operational area, in terms of the energy windowing that you heard from the first panel, is we have seen operational benefits to being able to make adjustments to the existing PVTs to account for the recurring, burdensome, naturally occurring radioactive shipments that come through in legitimate cargo. So we have seen the benefits from energy windowing in the operational environment.

Now, as to have we pushed those benefits as far as we can through energy windowing, we really need to defer to the scientists, to DNDO and our partners at Pacific Northwest National Laboratories to tell us if we have gone as far as we can with energy windowing. But again, as the operator of these systems, we have seen benefits in the ports of entry where we have deployed energy windowing. Have we maximized that? I would really defer to the scientists to give us that answer.

Chairman MILLER. I understand the principal problem with the current technology is as you have pointed out, not so much that it would miss—it is less a concern for missing radiation than the large number of false positives. Perhaps not false in the sense that it is not radiation, but it is not radiation that is a problem. How—I understand that the PVT system has been tested for that as well.

How did it fare compared to the existing—I am sorry. The ASP system, how did it fare compared to the PVT system in false positives?

Dr. HAGAN. I will take that. The actual test data is classified, but I can answer in a qualitative way, that in—there are two places in which the ASP is being tested and considered. One is in primary inspection and the other is secondary inspection. Do you want me to explain what I mean by that?

Chairman MILLER. Well, for the record at least, sure.

Dr. HAGAN. Okay.

Chairman MILLER. Briefly.

Dr. HAGAN. So a conveyance comes in and goes through primary inspection or screening, and goes through an RPM or radiation portal monitor of some sort. If that monitor alarms, then that conveyance is referred to secondary inspection where it is further examined either with another monitor, a radiation portal monitor or a hand-held RIID. And ASP is being considered for deployments to both of those, both primary inspection and secondary inspection. In the primary application, the ASP is a—has the ability to identify the type of—the source of the radiation. The PVT is not able to do that. So PVT simply says there is radiation, better go to secondary and off it goes. In the case of ASP, because of the spectroscopic nature of the system, it can discriminate between a threat material and non-threat material, or if it can't discriminate, then it sends it to secondary as well. So it can dismiss and reduce the number of referrals to secondary. In the secondary application, if you have ASP there, then you are comparing essentially the performance of a large spectroscopic portal which is very, very large compared to a very small hand-held detector in which case the—again, I can't talk about the specifics of the results but the ASP is far superior to the hand-held detector in terms of its ability to, in real time, identify the source of the radiation and dismiss it as appropriate.

Chairman MILLER. Is it classified to say which did better, the PVT or the ASP?

Dr. HAGAN. No. I am sorry. I should have said, yes. So the ASP does far better in the secondary application of being able to identify——

Chairman MILLER. Well, which—I am sorry. Which system produced more false positives, ASP or PVT?

Dr. HAGAN. In the most recent——

Chairman MILLER. February.

Dr. HAGAN. Okay. In the most recent—you are talking about field validation testing, I think.

Chairman MILLER. Yes.

Dr. HAGAN. In field validation tests, the ASP system sent more—had more referrals to secondary than the PVT did. However, we have now—it is actually not surprising. It was the first time that ASP had been able to operate in a real operating environment, and so just as with PVT, adjustments were made to what are called thresholds in the ASP. So we are not making software changes, we are simply tuning the system as you do with the PVT, and then we have done a lot of analysis and simulation, as was mentioned earlier, to verify that these changes will in fact improve the performance and give us the expected performance.

Chairman MILLER. Okay. It appears that my time has really and truly expired.

Dr. Broun for five minutes.

Mr. BROUN. Thank you, Mr. Chairman. I don't watch the clock very closely, as you very well know, and I will always give you—almost always give you a lot of leeway unless there is some particular reason not to.

But Dr. Hagan, what you are saying, it is my understanding that the ASPs—you just made a statement that they are better. It is my understanding that that is only with the lightly shielded radiation. Isn't it true that with heavily shielded or moderately shielded radiation, that there is not much difference between the two programs? And isn't it also true that if anybody is going to bring radiation-type special nuclear materials in any shipment, aren't they going to be shielded and very highly so?

Dr. HAGAN. The answer to the second part first. One might speculate that that would be the case but you can't really know for sure, and so yes, it is probably likely that someone would shield it, but a knowledgeable adversary might not do that for other reasons which I will talk about later. But going back to the first part of your question, yes, the two systems, both PVT monitors and ASP monitors are what are called passive detection systems. They both suffer from the limitation that if a nuclear material or a weapon is shielded enough, then there just is no signal for either detector to detect. Now, so what we are—the long-range plan for this, and it is already being implemented in part, is to say that if a—by having these passive detectors, we are forcing the adversary, knowledgeable adversary, anyway, to heavily shield the object. Well, that heavily shielded object, then, is a very—well, I shouldn't say very but is an easy target or an easy image or easy thing to identify in a radiographic image or non-intrusive inspection system which Mr. Owen talked about. So by having complementary, in the sense, orthogonal type of systems, one that is passive system that will detect lightly shielded or unshielded material, and another system that will detect shielded material, then you have covered—you have done a good job of covering the complete spectrum of possibilities. Any system, of course, can be defeated by a knowledgeable adversary, but by having those two systems combined, then you really do a much better job of dealing with that problem. That being said, the amount of shielding that is needed, the effectiveness of PVT versus ASP for lightly or moderately shielded materials is—it depends on what it is you are shielding, and we would have to go into particulars and specifics about different types of objects, which we can't do here.

Mr. BROUN. Thank you, Dr. Hagan. My time is about up. I will yield back.

Chairman MILLER. Ms. Dahlkemper for five minutes.

Ms. DAHLKEMPER. Thank you, Mr. Chairman.

I live on Lake Erie and so I go back and forth to Canada a fair amount and actually I felt much safer a few years ago when were pulled over. My father had had a stress test two weeks prior so I do actually have some personal experience with those innocent alarms. I didn't understand what was going on at the time. It was the first time I had ever been pulled over.

Mr. OWEN. I hope we didn't cause too much stress.

Ms. DAHLKEMPER. No, no, we were fine, but I actually felt much better coming back home and telling people who had no idea that this was actually being detected as we all would drive back home from Canada. But DHS has spent almost half a million—a billion dollars deploying PVT monitors at border crossings and ports across the country, including the one I came across, obviously. Does, Mr. Owen, the Customs and Border Protection believe that the current system, using PVTs and doing the secondary inspection with hand-held detectors and other means, is working well in terms of keeping us safe and moving commerce along? And I guess I am wondering what is the cost of manpower versus what is the cost of ASP? You know, I am looking at the dollars spent here, knowing we have limited resources and where are we best spending our money.

Mr. OWEN. And I would just respond, ma'am, that again two parts to that equation is, is the PVT finding all of the threats or are there threats that could be slipping through just because of the physics involved, and that is where ASP can help us in that regard. The second piece of that would be, can we respond to the number of secondaries that are caused by the existing PVT systems, and the answer is yes, we demonstrate that. There is a resource impact on this. Again, we would look at Los Angeles, we look at what we do up in the Peace Bridge there in Buffalo where you probably came through. It is a timely process. The officers do have to go through each secondary exam and treat it as if it is a real threat. We cannot let our guard down and just assume it was your father-in-law, that he had medical testing, let you go down. We have to take you out of the vehicle, we have to go through that whole process. So having a system that reduces the number of innocent alarms that are sent into secondary will help us do that. As to is the cost of the manpower savings offset by the ASP, I think that is some of the work that the DNDO is doing with their overall cost-benefit analysis. It will take into consideration those variables.

Ms. DAHLKEMPER. I wanted to ask you too about the maintenance and operation costs of the ASPs and they are estimated to be anywhere from five to twelve times more expensive than the costs of running the PVTs, and so in the worst case ASPs will cost about $100,000 a year to run as compared to $8,000 a year for the PVTs. Does Customs have the budget to support this kind of system if it were deployed nationally, and have you thought about what you would have to give up in terms of personnel or other, you know, equipment to run this?

Mr. OWEN. Yes, and that is a very good question. That is a concern that we do have now. The ASP systems, depending on how the final outcome of the cost-benefit and the cost of the systems, I think it is well accepted that it is going to cost more than what we have with the PVTs. Currently we have about 1,250 PVTs deployed nationwide. We continue to expand along the northern border. We are going to get—up to 100 percent of the cargo coming in from Canada this year will be covered by PVTs. We will end up with about 1,500 PVTs by the end of this calendar year. There is an extensive operation and maintenance tail that comes with that. I think any deployment decisions going forward with ASPs needs to be cognizant of the impact that will have on the operator. There is much talk about the initial acquisition cost and the deployment cost to buy it, put it in the ground, but I don't think we can forget about the operation and maintenance tail that comes along with this, that will then fall on the backs of the operator, in this case CBP. So it is something that we are concerned with. It is something that again is going into the overall cost adjustments for what we can expect with the ASP systems.

Ms. DAHLKEMPER. Do you have any thoughts on what this would do in terms of personnel? Would it free up great numbers for other purposes?

Mr. OWEN. Well, my view on this is, when you look at the way the layouts are in the seaports, you have to have still an officer man those exit gates where you have the radiation portal monitors. So whether it is manned with two officers or one officer because the alarms are less frequent, there will still be a cost figure associated with the manpower. There may be some operational adjustments that we can make in the secondary areas but I think the cost savings are something that we still need to measure once we are confident that the ASPs are delivering as we hope they will do. So there will be some savings from that. Will that offset the increase in operation maintenance costs associated with the ASP? That is something that we have to take very careful consideration of.

Ms. DAHLKEMPER. Thank you. My time is up. I yield back.

Chairman MILLER. Thank you, Ms. Dahlkemper. That will be the last round of questions. Dr. Hagan, I trust that when DHS has completed its cost-benefit analysis, that we will get a copy that is still warm from the printer.

Dr. HAGAN. Okay.

Chairman MILLER. So under the rules—before we bring the hearing to a close, I do want to thank all of our witnesses for testifying before the Subcommittee today. Under the rules of the Committee, the record will remain open for two weeks for additional statements from the Members and for answers to any follow-up questions any Member of the Committee may have for witnesses, and I understand that Dr. Broun does have questions. The witnesses are excused and the hearing is now adjourned.

[Whereupon, at 11:41 a.m., the Subcommittee was adjourned.]

Appendix:

ADDITIONAL MATERIAL FOR THE RECORD

United States Government Accountability Office

GAO Report to Congressional Requesters

May 2009

COMBATING NUCLEAR SMUGGLING

DHS Improved Testing of Advanced Radiation Detection Portal Monitors, but Preliminary Results Show Limits of the New Technology

GAO

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GAO-09-655

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Highlights

Highlights of GAO-09-655, a report to congressional requesters

May 2009

COMBATING NUCLEAR SMUGGLING

DHS Improved Testing of Advanced Radiation Detection Portal Monitors, but Preliminary Results Show Limits of the New Technology

Why GAO Did This Study

The Department of Homeland Security's (DHS) Domestic Nuclear Detection Office (DNDO) is testing new advanced spectroscopic portal (ASP) radiation detection monitors. DNDO expects ASPs to reduce both the risk of missed threats and the rate of innocent alarms, which DNDO considers to be key limitations of radiation detection equipment currently used by Customs and Border Protection (CBP) at U.S. ports of entry. Congress has required that the Secretary of DHS certify that ASPs provide a significant increase in operational effectiveness before obligating funds for full-scale procurement. GAO was asked to review (1) the degree to which DHS's criteria for a significant increase in operational effectiveness address the limitations of existing radiation detection equipment, (2) the rigor of ASP testing and preliminary test results, and (3) the ASP test schedule. GAO reviewed the DHS criteria, analyzed test plans, and interviewed DHS officials.

What GAO Recommends

GAO recommends that DHS assess ASPs against the full potential of current equipment and revise the program schedule to allow time to conduct computer simulations of ASPs' capabilities and to uncover and resolve problems with ASPs before full-scale deployment. DHS agreed to a phased deployment that should allow time to uncover ASP problems but disagreed with GAO's other recommendations. GAO believes its recommendations remain valid.

View GAO-09-655 or key components.
For more information, contact Gene Aloise at (202) 512-3841 or aloisee@gao.gov.

What GAO Found

The DHS criteria for a significant increase in operational effectiveness require a minimal improvement in the detection of threats and a large reduction in innocent alarms. Specifically, the criteria require a marginal improvement in the detection of certain weapons-usable nuclear materials, considered to be a key limitation of current-generation portal monitors. The criteria require improved performance over the current detection threshold, which for certain nuclear materials is based on the equipment's limited sensitivity to anything more than lightly shielded materials, but do not specify a level of shielding that smugglers could realistically use. In addition, DNDO has not completed efforts to improve current-generation portal monitors' performance. As a result, the criteria do not take the current equipment's full potential into account. With regard to innocent alarms, the other key limitation of current equipment, meeting the criteria could result in hundreds fewer innocent alarms per day, thereby reducing CBP's workload and delays to commerce.

DHS increased the rigor of ASP testing in comparison with previous tests. For example, DNDO mitigated the potential for bias in performance testing (a concern GAO raised about prior testing) by stipulating that there would be no ASP contractor involvement in test execution. Such improvements added credibility to the test results. However, the testing still had limitations, such as a limited set of scenarios used in performance testing to conceal test objects from detection. Moreover, the preliminary results are mixed. The results show that the new portal monitors have a limited ability to detect certain nuclear materials at anything more than light shielding levels: ASPs performed better than current-generation portal monitors in detection of such materials concealed by light shielding approximating the threat guidance for setting detection thresholds, but differences in sensitivity were less notable when shielding was slightly below or above that level. Testing also uncovered multiple problems in ASPs meeting the requirements for successful integration into operations at ports of entry. CBP officials anticipate that, if ASPs are certified, new problems will appear during the first few years of deployment in the field.

While DNDO's schedule underestimated the time needed for ASP testing, test delays have allowed more time for review and analysis of results. DNDO's original schedule anticipated completion in September 2008. Problems uncovered during testing of ASPs' readiness to be integrated into operations at U.S. ports of entry caused the greatest delays to this schedule. DHS's most recent schedule anticipated a decision on ASP certification as early as May 2009, but DHS recently suspended field validation due to ASP performance problems and has not updated its schedule for testing and certification. In any case, DNDO does not plan to complete computer simulations that could provide additional insight into ASP capabilities and limitations prior to certification even though delays have allowed more time to conduct the simulations. DNDO officials believe the other tests are sufficient for ASPs to demonstrate a significant increase in operational effectiveness.

United States Government Accountability Office

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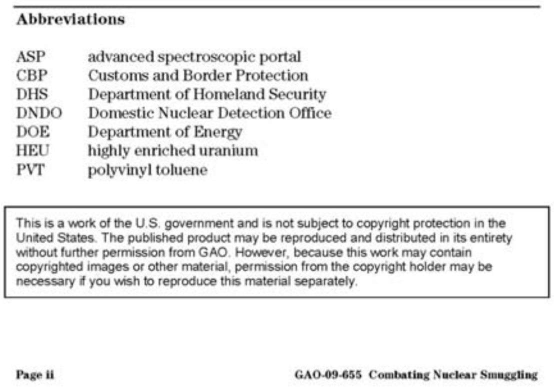

Abbreviations

ASP	advanced spectroscopic portal
CBP	Customs and Border Protection
DHS	Department of Homeland Security
DNDO	Domestic Nuclear Detection Office
DOE	Department of Energy
HEU	highly enriched uranium
PVT	polyvinyl toluene

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United States Government Accountability Office
Washington, DC 20548

May 21, 2009

Congressional Requesters

Preventing radioactive material from being smuggled into the United States is a key national security objective. In particular, terrorists could use special nuclear material such as highly enriched uranium (HEU) or plutonium in a nuclear weapon; other radioactive materials could be used in a radiological dispersal device (a "dirty bomb"). The national security mission of U.S. Customs and Border Protection (CBP), an agency within the Department of Homeland Security (DHS), includes screening for smuggled nuclear or radiological material while facilitating the flow of legitimate trade and travel. To screen cargo at ports of entry, CBP conducts primary inspections with radiation detection equipment called portal monitors—large stationary detectors through which cargo containers and vehicles pass as they enter the United States. When radiation is detected, CBP conducts secondary inspections using a second portal monitor to confirm the original alarm and a handheld radioactive isotope identification device to identify the radiation's source and determine whether it constitutes a threat. CBP officers must investigate each alarm until they are convinced that the vehicle, occupants, and any cargo pose no threat and can be allowed to enter the United States.

According to DHS's Domestic Nuclear Detection Office (DNDO), the current generation of radiation detection equipment has limitations.[1] Specifically, the polyvinyl toluene (PVT) portal monitors currently in use can detect radiation but cannot identify the source. As a result, the monitors' radiation alarms can be set off even by benign, naturally occurring radioactive material. One way to reduce the rate of such innocent alarms—and thereby minimize unnecessary secondary inspections and enhance the flow of commerce—is to adjust the operational thresholds for the level of radiation required for PVTs to alarm (i.e., operate the PVTs at a reduced level of sensitivity). However, reducing

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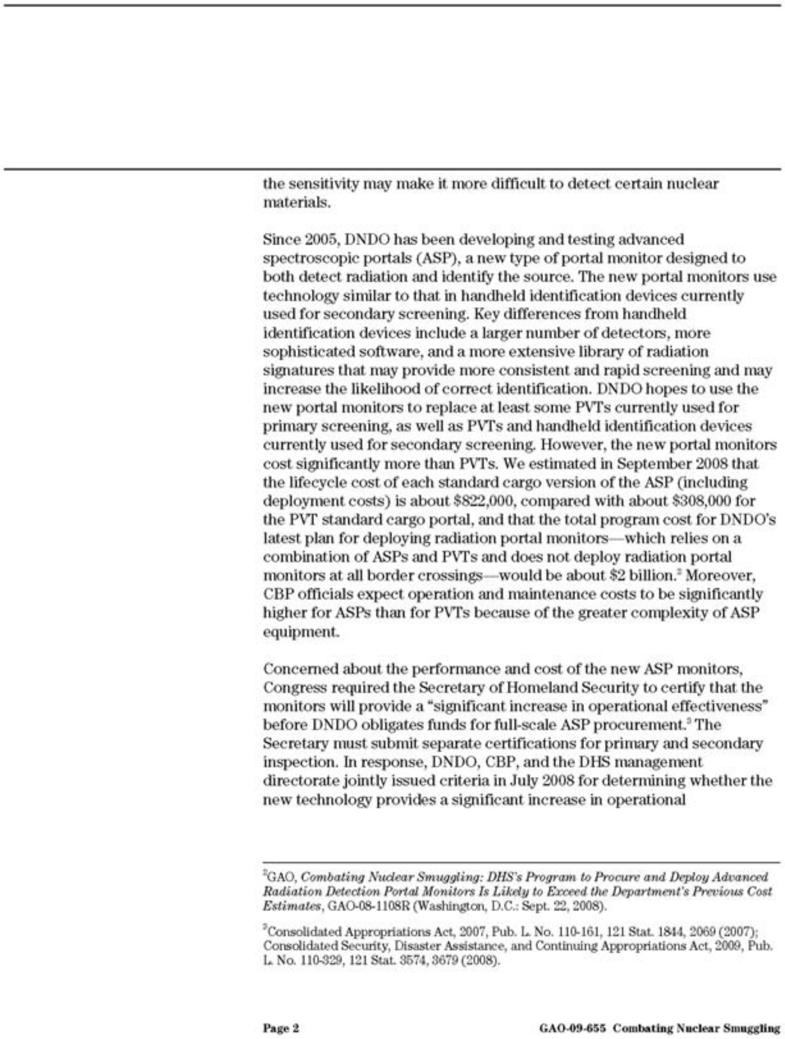
[1] DNDO was established within DHS in 2005; its mission includes developing, testing, acquiring, and supporting the deployment of radiation detection equipment at U.S. ports of entry. CBP began deploying portal monitors in 2002, prior to DNDO's creation, under the radiation portal monitor project. For additional information on DNDO's overall efforts to combat nuclear smuggling, see GAO, *Nuclear Detection: Domestic Nuclear Detection Office Should Improve Planning to Better Address Gaps and Vulnerabilities*, GAO-09-257 (Washington, D.C.: Jan. 29, 2009).



the sensitivity may make it more difficult to detect certain nuclear materials.

Since 2005, DNDO has been developing and testing advanced spectroscopic portals (ASP), a new type of portal monitor designed to both detect radiation and identify the source. The new portal monitors use technology similar to that in handheld identification devices currently used for secondary screening. Key differences from handheld identification devices include a larger number of detectors, more sophisticated software, and a more extensive library of radiation signatures that may provide more consistent and rapid screening and may increase the likelihood of correct identification. DNDO hopes to use the new portal monitors to replace at least some PVTs currently used for primary screening, as well as PVTs and handheld identification devices currently used for secondary screening. However, the new portal monitors cost significantly more than PVTs. We estimated in September 2008 that the lifecycle cost of each standard cargo version of the ASP (including deployment costs) is about $822,000, compared with about $308,000 for the PVT standard cargo portal, and that the total program cost for DNDO's latest plan for deploying radiation portal monitors—which relies on a combination of ASPs and PVTs and does not deploy radiation portal monitors at all border crossings—would be about $2 billion.[2] Moreover, CBP officials expect operation and maintenance costs to be significantly higher for ASPs than for PVTs because of the greater complexity of ASP equipment.

Concerned about the performance and cost of the new ASP monitors, Congress required the Secretary of Homeland Security to certify that the monitors will provide a "significant increase in operational effectiveness" before DNDO obligates funds for full-scale ASP procurement.[3] The Secretary must submit separate certifications for primary and secondary inspection. In response, DNDO, CBP, and the DHS management directorate jointly issued criteria in July 2008 for determining whether the new technology provides a significant increase in operational

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[2] GAO, *Combating Nuclear Smuggling: DHS's Program to Procure and Deploy Advanced Radiation Detection Portal Monitors Is Likely to Exceed the Department's Previous Cost Estimates*, GAO-08-1108R (Washington, D.C.: Sept. 22, 2008).

[3] Consolidated Appropriations Act, 2007, Pub. L. No. 110-161, 121 Stat. 1844, 2069 (2007); Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009, Pub. L. No. 110-329, 121 Stat. 3574, 3679 (2008).

effectiveness—four criteria for primary screening and two for secondary screening (see fig. 1). The primary screening criteria require that the new portal monitors detect potential threats as well as or better than PVTs, show improved performance in detection of HEU, and reduce innocent alarms. To meet the secondary screening criteria, the new portal monitors must reduce the probability of misidentifying special nuclear material (e.g., HEU and plutonium) and the average time to conduct secondary screenings.

Figure 1: DHS Criteria for Demonstrating a Significant Increase in Operational Effectiveness

Primary screening criteria

When special nuclear material is present in cargo without naturally occurring radioactive material, the ASP probability of a correct operational outcome must be equal to or greater than that of the PVT. (For HEU, ASPs must show improved performance compared to PVTs at operational thresholds.)

When special nuclear material is present in cargo with naturally occurring radioactive material, the ASP in primary must increase the probability of a correct operational outcome compared to the current end-to-end system.

When licensable medical or industrial isotopes are present in cargo, the ASP probability of a correct operational outcome must be equal to or greater than that of the PVT.

When the only radioactive source present in the cargo is naturally occurring radioactive material, the ASP must refer at least 80 percent fewer conveyances for further inspection than the PVT.

Secondary screening criteria

When compared to the handheld radioactive isotope identification device, ASP must reduce, by at least a factor of two, the probability that special nuclear material is misidentified as naturally occurring radioactive material, a medical/industrial radionuclide, unknown, or no source at all.

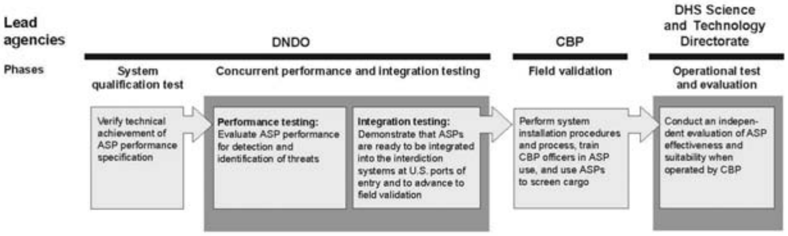
When compared to the handheld radioactive isotope identification device, the ASP must reduce the average time required to correctly release conveyances from secondary screening.

Source: DHS.

To demonstrate a significant increase in operational effectiveness for either primary or secondary screening, ASPs must satisfy all of the criteria for that deployment option, independent of satisfying the criteria for the other option. The criteria generally compare the new portal monitors to current-generation equipment as used under CBP's standard operating procedure. For example, the standard operating procedure for secondary screening calls for inconclusive readings to be sent for additional analysis to CBP's Laboratories and Scientific Services, which has access to additional software and trained experts.

DNDO designed and coordinated a series of tests, originally scheduled to run from April 2008 through September 2008, to determine whether the new portal monitors meet the certification criteria for primary and secondary screening and are ready for deployment. Key phases of testing completed to date include verifying that ASPs meet DNDO's performance specification, which was followed by concurrent testing of the new and current equipments' ability to detect and identify threats and of ASPs' readiness to be integrated into operations for both primary and secondary screening at ports of entry. Two remaining phases not yet completed include field validation at four northern and southern border crossings and two seaports, as well as an independent evaluation, conducted by the DHS Science and Technology Directorate at one of the seaports, of the new portal monitors' effectiveness and suitability (see fig. 2). Two ASP vendors have contracts with DNDO to develop the new portal monitors and are participating in the round of testing that began in 2008.[4] DNDO designed the testing to allow each vendor's system to complete all test phases and be certified based on its own performance as providing a significant increase in operational effectiveness.

Figure 2: Test Sequence Leading Up to ASP Certification



Source: GAO analysis of DNDO information.

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[4] DNDO had a contract with a third ASP vendor whose system uses a more expensive type of detector that must be cooled by liquid nitrogen. DNDO determined it was not in the best interests of the government to exercise the option on the contract and allowed it to expire in November 2008. The vendor's ASP did not participate in the 2008 round of testing.

We have raised concerns since 2006 regarding DNDO's previous efforts to develop and test the new portal monitors. In October 2006, we found that DNDO's analysis of the benefits and costs of deploying the new portal monitors relied on assumptions of their anticipated performance level instead of actual test data.[5] Among other things, we recommended that DNDO conduct further testing before spending additional funds to purchase the new equipment. In September 2007, we testified that DNDO's testing at the Department of Energy's (DOE) Nevada Test Site did not represent an objective or rigorous assessment because DNDO used biased test methods that enhanced the apparent performance of the ASPs and did not test the limitations of their detection capabilities.[6] Most recently, we found in September 2008 that a DNDO report on testing conducted in 2007 did not accurately depict test results and could potentially be misleading.[7] We concluded that the results could identify areas for improvement but should not be used as indicators of ASPs' overall performance.

In this context, you asked us to review the 2008 round of testing leading up to the Secretary of Homeland Security's decision on ASP certification. We reviewed (1) the degree to which DHS's criteria for a significant increase in operational effectiveness address the limitations of the current generation of radiation detection equipment, (2) the rigor of the testing as a basis for determining ASPs' operational effectiveness and preliminary results of testing completed to date, and (3) the extent to which the test schedule allows time for DHS to review and analyze results. This report updates our September 2008 testimony, which included preliminary observations on the DHS criteria for a significant increase in operational effectiveness and the 2008 round of testing.[8]

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[5] GAO, *Combating Nuclear Smuggling: DHS's Cost-Benefit Analysis to Support the Purchase of New Radiation Detection Portal Monitors Was Not Based on Available Performance Data and Did Not Fully Evaluate All the Monitors' Costs and Benefits*, GAO-07-133R (Washington, D.C.: Oct. 17, 2006).

[6] GAO, *Combating Nuclear Smuggling: Additional Actions Needed to Ensure Adequate Testing of Next Generation Radiation Detection Equipment*, GAO-07-1247T (Washington, D.C.: Sept. 18, 2007).

[7] GAO, *Combating Nuclear Smuggling: DHS's Phase 3 Test Report on Advanced Portal Monitors Does Not Fully Disclose the Limitations of the Test Results*, GAO-08-979 (Washington, D.C.: Sept. 30, 2008).

[8] GAO, *Combating Nuclear Smuggling: DHS Needs to Consider the Full Costs and Complete All Tests Prior to Making a Decision on Whether to Purchase Advanced Portal Monitors*, GAO-08-1178T (Washington, D.C.: Sept. 25, 2008).

To conduct our review, we analyzed DHS's criteria for a significant increase in operational effectiveness and DNDO's written response to our detailed questions regarding the criteria. Because the criteria compare the new portal monitors to existing equipment, we analyzed the threat guidance used to set detection thresholds for PVTs and interviewed DOE and national laboratory officials responsible for the guidance. In addition, we analyzed the test plans for the 2008 round of testing, including the test schedule and reasons for any delays. We interviewed DNDO, CBP, and other DHS officials responsible for conducting and monitoring tests, and we observed 1 day each of performance testing at the Nevada Test Site and integration testing at DOE's Pacific Northwest National Laboratory. We analyzed preliminary or final results for the phases of testing completed during our review, and we interviewed DNDO and CBP officials regarding the results. (App. I presents a detailed discussion of the scope and methodology of our review.)

We conducted this performance audit from May 2008 to May 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.[9]

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[9] This report does not include certain details about the capabilities and limitations of PVTs and ASPs that DHS considers to be "for official use only." We have prepared a "for official use only" version of this report in which we include such details (GAO-09-354SU).

DHS's Criteria for Significant Increase in Operational Effectiveness Require a Marginal Improvement in the Detection of Certain Nuclear Materials and a Large Reduction in Innocent Alarms

Although the DHS criteria for primary screening require an improved ability to detect certain nuclear materials at operational thresholds, ASPs could meet the criteria for improvement while still failing to detect anything more than lightly shielded material. DNDO officials acknowledge that passive radiation detection equipment, which includes both the new and current-generation portal monitors, is capable of detecting certain nuclear materials only when this material is unshielded or lightly shielded.[10] For this reason, the DOE threat guidance used to set PVTs' detection threshold is based on the equipment's limited sensitivity to anything more than lightly shielded nuclear material rather than on the assumption that smugglers would take effective shielding measures. DOE developed the guidance in 2002 and 2003 when CBP began deploying PVTs for primary screening. DOE and national laboratory officials responsible for the guidance told us the assumption of light shielding was based not on an analysis of the capabilities of potential smugglers to take effective shielding measures but rather on the limited sensitivity of PVTs to detect anything more than certain lightly shielded nuclear materials. In contrast, PVTs are more sensitive to the relatively strong radiation signature of other nuclear materials, and the threat guidance assumes a higher level of shielding for setting the operational threshold for detection of such materials. However, even for such materials, the DOE threat guidance assumes that shielding would not exceed a level provided by the contents of an average cargo container.

Moreover, DNDO has not completed efforts to fine-tune PVTs' software and thereby improve sensitivity to nuclear materials. As a result, the criteria compare ASPs to the current performance of PVTs and do not take potential improvements into account, which affects any assessment of "significant" improvement over current technology. DNDO officials expect they can achieve small improvements to PVTs' performance through additional development of "energy windowing," a technique currently being used in PVTs to provide greater sensitivity than otherwise possible. Pacific Northwest National Laboratory officials responsible for developing the technique also told us small improvements may be possible, and CBP officials have repeatedly urged DNDO to investigate the potential of the technique. DNDO collected the data needed to further develop energy

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[10] According to DNDO and CBP officials, active imaging techniques (e.g., radiography systems to provide images of the contents of cargo containers) and other measures complement radiation detection equipment. In particular, such measures provide the capability to spot smuggled nuclear materials that are too heavily shielded to be detected by PVTs or ASPs.

windowing during the 2008 performance testing at the Nevada Test Site but has not yet funded Pacific Northwest National Laboratory efforts to analyze the data and further develop the technique.

Other aspects of the criteria for a significant increase in operational effectiveness require that ASPs either provide more than a marginal improvement in addressing other limitations of current-generation equipment or at least maintain the same level of performance in areas in which the current-generation equipment is considered adequate:

- The primary screening requirement for an 80 percent reduction in the rate of innocent alarms could result in hundreds of fewer secondary screenings per day, thereby reducing CBP's workload and delays to commerce. The actual reduction in the volume of innocent alarms would vary and would be greatest at the nation's busiest ports of entry, such as Los Angeles/Long Beach, where CBP officials report that PVTs generate up to about 600 innocent alarms per day.[11] A DNDO official said the requirement for an 80 percent reduction in innocent alarms was developed in conjunction with CBP and was based on a level that would provide meaningful workload relief.
- The primary screening criteria requiring that ASPs provide at least the same level of sensitivity to plutonium and medical and industrial isotopes, but not specifying an improvement, were based on DNDO's assessment that PVTs adequately detect such materials, which have a stronger radiation signature than HEU.[12] In addition, CBP officials said that including medical and industrial isotopes in the criteria addressed a CBP requirement for verifying that those transporting certain quantities of these materials into the United States are properly licensed.[13]
- The secondary screening requirement that ASPs reduce the probability of misidentifying special nuclear material by one-half addresses the inability of relatively small handheld devices to consistently locate and identify

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[11] About 45 percent of all sea containers arriving in the United States come through Los Angeles/Long Beach. In fiscal year 2006, CBP cleared more than 5 million containers through the port.

[12] The criteria require an improvement when the radiation emitted by naturally occurring radioactive material is used to mask smuggled special nuclear material, including both HEU and plutonium.

[13] For additional information regarding the requirement to verify the legitimacy of radioactive material shipments, see GAO, *Nuclear Security: NRC and DHS Need to Take Additional Steps to Better Track and Detect Radioactive Materials*, GAO-08-598 (Washington, D.C.: June 19, 2008).

potential threats in large cargo containers. For example, a handheld device may fail to correctly identify special nuclear material if the material is well-shielded or the device is not placed close enough to a radiation source to obtain a recognizable measurement. According to CBP and DNDO, the requirement for a reduction in the average time to conduct secondary screenings is not more specific because the time varies significantly among ports of entry and types of cargo being screened.

DHS Increased the Rigor of Advanced Portal Monitor Testing

Improvements to the 2008 round of testing addressed concerns we raised about earlier rounds of ASP testing. However, the testing still had limitations, and the preliminary results are mixed.

Improvements to Testing Provided Credibility to Test Results

As we testified in September 2008, DHS's improvements to the 2008 round of ASP testing addressed concerns we raised about previous tests. A particular area of improvement was in the performance testing at the Nevada Test Site, where DNDO compared the capability of ASP and current-generation equipment to detect and identify nuclear and radiological materials, including those that could be used in a nuclear weapon. The improvements addressed concerns we previously raised about the potential for bias and provided credibility to the results within the limited range of scenarios tested by DNDO. For example, we reported in 2007 that DNDO had allowed ASP contractors to adjust their systems after preliminary runs using the same radiological materials that would be used in the formal tests. In contrast, the plan for the 2008 performance test stipulated that there would be no system contractor involvement in test execution, and no ASP contractors were at the test location on the day we observed performance testing. Furthermore, DNDO officials told us, and we observed, that they did not conduct preliminary runs with threat objects used in the formal tests. In 2007, we reported that DNDO did not objectively test the handheld identification devices because it did not adhere to CBP's standard operating procedure for using the devices to conduct a secondary inspection, which is fundamental to the equipment's performance in the field. DNDO addressed this limitation in the 2008 round of performance testing: CBP officers operated the devices and adhered as closely to the standard operating procedure as test conditions allowed. While the test conditions did not allow CBP officers to obtain real-time technical support in interpreting the device's measurements, as they would in the field to increase the probability of correctly identifying a radiation source, DNDO officials said they addressed this limitation. For example, they treated a decision by a CBP officer to indicate the need for technical support as a correct outcome if the test scenario involved the use of a potential threat, such as HEU.

Other aspects of testing, while not specifically addressing concerns we previously raised, also added credibility to the test results. Based on our analysis of the performance test plan, we concluded that the test design was sufficient to identify statistically significant differences between the new technology and current-generation systems when there were relatively large differences in performance. Specifically, DNDO conducted a sufficient number of runs of each scenario used in the 2008 performance testing to identify such differences.

With regard to the general conduct of the 2008 round of testing, two aspects, in particular, enhanced the overall rigor of the tests: (1) criteria for ensuring that ASPs met the requirements for each phase before advancing to the next, and (2) the participation of CBP and the DHS Science and Technology Directorate.[14] The test and evaluation master plan established criteria requiring that the ASPs have no critical or severe issues rendering them completely unusable or impairing their function before starting or completing any test phase. In addition, the criteria established a cumulative limit of 10 issues requiring a work-around (e.g., a straightforward corrective step, such as a minor change in standard operating procedures) and 15 cosmetic issues not affecting proper functioning. DNDO and CBP adhered to the criteria even though doing so resulted in integration testing conducted at the Pacific Northwest National Laboratory taking longer than anticipated and delaying the start of field validation. For example, DNDO and CBP did not allow a vendor's ASP system to complete integration testing until all critical or severe issues had been resolved.

The involvement of CBP and the DHS Science and Technology Directorate provided an independent check, within DHS, of DNDO's efforts to develop and test the new portal monitors. For example, the lead CBP official involved in ASP testing told us that DNDO provided an initial assessment of the severity of issues uncovered during testing, but CBP made the final decision on categorizing them as critical, severe, work-around, or cosmetic issues. CBP also added a final requirement to integration testing

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[14] In the case of ASP testing, the Science and Technology Directorate serves as the independent operational test authority, which reports directly to the DHS Under Secretary for Management.

before proceeding to field validation to demonstrate ASPs' ability to operate for 40 hours without additional problems. According to CBP officials, their efforts to resolve issues prior to field validation reflect the importance CBP places on ensuring that ASPs are sufficiently stable and technically mature to operate effectively in a working port of entry and thereby provide for a productive field validation.

The DHS Science and Technology Directorate, which is responsible for developing and implementing the department's test and evaluation policies and standards, will have the lead role in the final phase of ASP testing; the final phase, consisting of 21 days of continuous operation, is scheduled to begin at one seaport after the completion of field validation. The Science and Technology Directorate identified two critical questions to be addressed through operational testing: (1) Will the ASP system improve operational effectiveness (i.e., detection and identification of threats) relative to the current-generation system, and (2) is the ASP system suitable for use in the operational environment at land and sea ports of entry? The suitability of ASPs includes factors such as reliability, maintainability, and supportability. Because the operational testing conducted at one seaport is not sufficient to fully answer these questions—for example, because the testing will not allow threat objects to be inserted into cargo containers—the directorate plans to also conduct an independent analysis of the results from previous test phases, including performance testing.

The 2008 testing still had limitations, which do not detract from the test results' credibility but do require that results be appropriately qualified. Limitations included the following:

- The number of handheld identification device measurements collected during performance testing was sufficient to distinguish only particularly large differences from ASPs' identification ability. In particular, the standard operating procedure for conducting secondary inspections using ASPs, which requires less time than when using handheld devices, allowed DNDO to collect more than twice as many ASP measurements and to test ASPs' identification ability against more radiation sources than used to test handheld identification devices.
- The performance test results cannot be generalized beyond the limited set of scenarios tested. For example, DNDO used a variety of masking and shielding scenarios designed to include cases where both systems had 100 percent detection, cases where both had zero percent detection, and

several configurations in between so as to estimate the point where detection capability ceased.[15] However, the scenarios did not represent the full range of possibilities for concealing smuggled nuclear or radiological material. For example, DNDO only tested shielding and masking scenarios separately, to differentiate between the impacts of shielding and masking on the probabilities of detection and identification. As a result, the performance test results cannot show how well each system would detect and identify nuclear or radiological material that is both shielded and masked, which might be expected in an actual smuggling incident. Similarly, DNDO used a limited number of threat objects to test ASPs' detection and identification performance, such as weapons-grade plutonium but not reactor-grade plutonium, which has a different isotopic composition. A report on special testing of ASPs conducted by Sandia National Laboratories in 2007 recommended that future tests use plutonium sources having alternative isotopic compositions. Sandia based its recommendations on results showing that the performance of ASP systems varied depending on the isotopic composition of plutonium.

- The Science and Technology Directorate's operational testing is designed to demonstrate that the average time between equipment failures (the measure of ASPs' reliability) is not less than 1,000 hours. Thus, the testing will not show how reliable the equipment will be over a longer term. DHS Science and Technology Directorate officials recognize this limitation and said they designed operational testing only to demonstrate compliance with the ASP performance specification. Furthermore, to the extent that the Science and Technology Directorate relies on performance test results to evaluate ASPs' ability to detect and identify threats, its analysis of ASPs' effectiveness will be subject to the same limitations as the original testing and analysis conducted by DNDO.

Preliminary Test Results Are Mixed

The preliminary results presented to us by DNDO are mixed, particularly in the capability of ASPs used for primary screening to detect certain shielded nuclear materials. However, we did not obtain DNDO's final report on performance testing conducted at the Nevada Test Site until early April 2009, and thus we had limited opportunity to evaluate the report. In addition, we are not commenting on the degree to which the final report provides a fair representation of ASPs' performance. Preliminary results from performance testing show that the new portal

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[15] Masking is the use of naturally occurring radioactive material to make the radiation emitted by smuggled material appear to be caused by innocent cargo. In contrast, shielding blocks radiation from being emitted.

monitors detected certain nuclear materials better than PVTs when shielding approximated DOE threat guidance, which is based on light shielding. In contrast, differences in system performance were less notable when shielding was slightly increased or decreased: Both the PVTs and ASPs were frequently able to detect certain nuclear materials when shielding was below threat guidance, and both systems had difficulty detecting such materials when shielding was somewhat greater than threat guidance. DNDO did not test ASPs or PVTs against moderate or greater shielding because such scenarios are beyond both systems' ability. (See fig. 3 for a summary of performance test results for detection of certain nuclear materials.)

Figure 3: Preliminary Results from 2008 Performance Testing for Detection of Certain Nuclear Materials

Portal monitor system	At lowest shielding levels tested	Light shielding		Moderate to heavy shielding
		At about DOE threat guidance	At more than DOE threat guidance	
ASP	○	○	●	✹
PVT	○	●	●	✹

○ Frequent
● Difficult
✹ Not tested

Source: GAO analysis of DNDO information.

Note: The specific amount and type of shielding assumed in DOE threat guidance is classified.

With regard to secondary screening, ASPs performed better than handheld devices in identification of threats when masked by naturally occurring radioactive material. However, differences in the ability to identify certain shielded nuclear materials depended on the level of shielding, with increasing levels appearing to reduce any ASP advantages over the handheld identification devices—another indication of the fundamental limitation of passive radiation detection.

Other phases of testing, particularly integration testing, uncovered multiple problems meeting requirements for successfully integrating the new technology into operations at ports of entry. Of the two ASP vendors participating in the 2008 round of testing, one has fallen several months behind in testing due to the severity of the problems it encountered during integration testing; the problems were so severe that it may have to redo previous test phases to be considered for certification. The other vendor's system completed integration testing, but CBP suspended field validation of the system after 2 weeks because of serious performance problems that may require software revisions. In particular, CBP found that the performance problems resulted in an overall increase in the number of referrals for secondary screening compared to the existing equipment. According to CBP, this problem will require significant corrective actions before testing can resume; such corrective actions could in turn change the ability of the ASP system to detect threats. The problem identified during field validation was in addition to ones identified during integration testing, which required multiple work-arounds and cosmetic changes before proceeding to the next test phase. For example, one problem requiring a work-around related to the amount of time it takes for the ASP to sound an alarm when a potential threat material has been detected. Specifications require that ASPs alarm within two seconds of a vehicle exiting the ASP. However, during testing, the vendor's ASP took longer to alarm when a particular isotope was detected. The work-around to be implemented during field validation requires that all vehicles be detained until cleared by the ASP; the effect on commerce must ultimately be ascertained during field validation.

CBP officials anticipate that they will continue to uncover problems during the first few years of use if the new technology is deployed in the field. The officials do not necessarily regard such problems to be a sign that testing was not rigorous but rather a result of the complexity and newness of the technology and equipment.

Schedule Delays Have Allowed More Time for Analysis and Review of Test Results, but DNDO's Latest Schedule Does Not Include Computer Simulations to Provide Additional Insight into ASP Capabilities

Delays to the schedule for the 2008 round of testing have allowed more time for analysis and review of results, particularly from performance testing conducted at the Nevada Test Site. The original schedule, which underestimated the time needed for testing, anticipated completion of testing in mid-September 2008 and the DHS Secretary's decision on ASP certification between September and November 2008. DHS officials acknowledged that scheduling a certification decision shortly after completion of testing would leave limited time to complete final test reports and said the DHS Secretary could rely instead on preliminary reports if the results were favorable to ASPs. DHS's most recent schedule anticipated a decision on ASP certification as early as May 2009, but DHS has not updated its schedule for testing and certification since suspending field validation in February 2009 due to ASP performance problems.

Problems uncovered during testing of ASPs' readiness to be integrated into operations at U.S. ports of entry have caused the greatest delays to date and have allowed more time for DNDO to analyze and review the results of performance testing. Integration testing was originally scheduled to conclude in late July 2008 for both ASP vendors. The one ASP system that successfully passed integration testing did not complete the test until late November 2008—approximately 4 months behind schedule. (The delays to integration testing were due in large part to the adherence of DNDO and CBP to the criteria discussed earlier for ensuring that ASPs met the requirements for each test phase.) In contrast, delays to performance testing, which was scheduled to run concurrently with integration testing, were relatively minor. Both ASP systems completed performance testing in August 2008, about a month later than DNDO originally planned.

The schedule delays have allowed more time to conduct injection studies—computer simulations for testing the response of ASPs and PVTs to the radiation signatures of threat objects randomly "injected" (combined) into portal monitor records of actual cargo containers transported into the United States, including some containers with innocent sources of radiation. However, DNDO does not plan to complete the studies prior to the Secretary of Homeland Security's decision on certification even though DNDO and other officials have indicated that the studies could provide additional insight into the capabilities and limitations of advanced portal monitors. According to DNDO officials, injection studies address the inability of performance testing conducted at the Nevada Test Site to replicate the wide variety of cargo coming into the United States and the inability to bring special nuclear material and other threat objects to ports of entry and place them in cargo during field validation. Similarly, while they acknowledged that injection studies have limitations, DOE national laboratory officials said the studies can increase the statistical confidence in comparisons of ASPs' and PVTs' probability of detecting threats concealed in cargo because of the possibility of supporting larger sample sizes than feasible with actual testing. A February 2008 DHS independent review team report on ASP testing also highlighted the benefits of injection studies, including the ability to explore ASP performance against a large number of threat scenarios at a practical cost and schedule and to permit an estimate of the minimum detectable amount for various threats.[16]

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[16] DHS Homeland Security Institute, *Independent Review of the Department of Homeland Security Domestic Nuclear Detection Office Advanced Spectroscopic Portal: Final Report* (Feb. 20, 2008).

DNDO has the data needed to conduct the studies. It has supported efforts to collect data on the radiation signatures for a variety of threat objects, including special nuclear materials, as recorded by both ASP and PVT systems. It has also collected about 7,000 usable "stream-of-commerce" records from ASP and PVT systems installed at a seaport. Furthermore, DNDO had earlier indicated that injection studies could provide information comparing the performance of the two systems as part of the certification process for both primary and secondary screening. However, addressing deficiencies in the stream-of-commerce data delayed the studies, and DNDO subsequently decided that performance testing would provide sufficient information to support a decision on ASP certification. DNDO officials said they would instead use injection studies to support effective deployment of the new portal monitors.

Conclusions

Given that radiation detection equipment is already being used at ports of entry to screen for smuggled nuclear or radiological materials, the decision whether to replace existing equipment requires that the benefits of the new portal monitors be weighed against the costs. DNDO acknowledges that ASPs are significantly more expensive than PVTs to deploy and maintain, and based on preliminary results from the 2008 testing, it is not yet clear that the $2 billion cost of DNDO's deployment plan is justified. Even if ASPs are able to reduce the volume of innocent cargo referred for secondary screening, they are not expected to detect certain nuclear materials that are surrounded by a realistic level of shielding better than PVTs could. Preliminary results of DNDO's performance testing show that ASPs outperformed the PVTs in detection of such materials during runs with light shielding, but ASPs' performance rapidly deteriorated once shielding was slightly increased. Furthermore, DNDO and DOE officials acknowledged that the performance of both portal monitors in detecting such materials with a moderate amount of shielding would be similarly poor. This was one of the reasons that performance testing did not include runs with a moderate level of shielding.

Two additional aspects of the 2008 round of testing call into question whether ASPs' ability to provide a marginal improvement in detection of nuclear materials and reduce innocent alarms warrants the cost of the new technology. First, the DHS criteria for a significant increase in operational effectiveness do not take into account recent efforts to improve the current-generation portal monitors' sensitivity to nuclear materials through the "energy windowing" technique, most likely at a much lower cost. Data on developing this technique were collected during the 2008 round of performance testing but have not been analyzed. Second, while DNDO made improvements to the 2008 round of ASP testing that provided credibility to the test results, its test schedule does not allow for completion of injection studies prior to certification even though the studies could provide additional insight into the performance of the new technology. Without results from injection studies, the Secretary of Homeland Security would have to make a decision on certification based on a limited number of test scenarios conducted at the Nevada Test Site.

Assuming that the Secretary of Homeland Security certifies ASPs, CBP officials anticipate that they will discover problems with the equipment when they start using it in the field. Integration testing uncovered a number of such problems, which delayed testing and resulted in ASP vendors making multiple changes to their systems. Correcting such problems in the field could prove to be more costly and time consuming than correcting problems uncovered through testing, particularly if DNDO proceeds directly from certification to full-scale deployment, as allowed under the congressional certification requirement that ASPs provide a significant increase in operational effectiveness.

Recommendations for Executive Action

We recommend that the Secretary of Homeland Security direct the Director of DNDO to take the following two actions to ensure a sound basis for a decision on ASP certification:

- Assess whether ASPs meet the criteria for a significant increase in operational effectiveness based on a valid comparison with PVTs' full performance potential, including the potential to further develop PVTs' use of energy windowing to provide greater sensitivity to threats. Such a comparison could also be factored into an updated cost-benefit analysis to determine whether it would be more cost-effective to continue to use PVTs or deploy ASPs for primary screening at particular ports of entry.
- Revise the schedule for ASP testing and certification to allow sufficient time for review and analysis of results from the final phases of testing and completion of all tests, including injection studies.

If ASPs are certified, we further recommend that the Secretary of Homeland Security direct the Director of DNDO to develop an initial deployment plan that allows CBP to uncover and resolve any additional problems not identified through testing before proceeding to full-scale deployment—for example, by initially deploying ASPs at a limited number of ports of entry.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE and DHS for their review and comment. DOE provided technical comments, which we have incorporated into our report as appropriate. DHS's written comments are reproduced in appendix II.

DHS agreed in part with our recommendations. Specifically, DHS stated that it believes its plan to deploy ASPs in phases, starting at a small number of low-impact locations, is in accordance with our recommendation to develop an initial deployment plan that allows problems to be uncovered and resolved prior to full-scale deployment. We agree that this deployment plan would address our recommendation and note that DHS's comments are the first indication provided to us of the department's intention to pursue such a plan.

In contrast, DHS did not concur with our recommendations to (1) assess whether ASPs meet the criteria for a significant increase in operational effectiveness based on a comparison with PVTs' full potential, including further developing PVTs' use of energy windowing; and (2) revise the ASP testing and certification schedule to allow sufficient time for completion of all tests, including injection studies. With regard to energy windowing, DHS stated that using current PVT performance as a baseline for comparison is a valid approach because the majority of increased PVT performance through energy windowing has already been achieved. While DHS may be correct, its assessment is based on expert judgment rather than the results of testing and analysis being considered by the department to optimize the use of energy windowing. Given the marginal increase in sensitivity required of ASPs, we stand by our recommendation to assess ASPs against PVTs' full potential. DHS can then factor PVTs' full potential into a cost-benefit analysis prior to acquiring ASPs. On this point, DHS commented that its current cost-benefit analysis is a reasonable basis to guide programmatic decisions. However, upon receiving DHS's comments, we contacted DNDO to obtain a copy of its cost-benefit analysis and were told the analysis is not yet complete.

With regard to injection studies, DHS agreed that the schedule for ASP certification must allow sufficient time for review and analysis of test results but stated that DHS and DOE experts concluded injection studies were not required for certification. DHS instead stated that the series of ASP test campaigns would provide a technically defensible basis for assessing the new technology against the certification criteria. However, DHS did not rebut the reasons we cited for conducting injection studies prior to certification, including test delays that have allowed more time to conduct the studies and the ability to explore ASP performance against a large number of threat scenarios at a practical cost and schedule. On the contrary, DHS acknowledged the delays to testing and the usefulness of injection studies. Given that each phase of testing has revealed new information about the capabilities and limitations of ASPs, we believe conducting injection studies prior to certification would likely offer similar insights and would therefore be prudent prior to a certification decision.

DHS provided additional comments regarding our assessment of the relative sensitivity of ASPs and PVTs and our characterization of the severity of the ASPs' software problems uncovered during field validation. With regard to sensitivity, DHS implied that our characterization of the relative ability of ASPs and PVTs is inaccurate and misleading because we did not provide a complete analysis of test results. We disagree. First, in meetings to discuss the preliminary results of performance testing conducted at the Nevada Test Site, DNDO officials agreed with our understanding of the ability of ASPs and PVTs deployed for primary screening to detect shielded nuclear materials. Furthermore, contrary to the assertion that a complete analysis requires a comparison of ASPs to handheld identification devices, our presentation is consistent with DHS's primary screening criterion for detection of shielded nuclear materials, which only requires that ASPs be compared with PVTs. Finally, while we agree that the performance test results require a more complete analysis, DNDO did not provide us with its final performance test report until early April 2009, after DHS provided its comments on our draft report. In the absence of the final report, which DNDO officials told us took longer than anticipated to complete, we summarized the preliminary results that DNDO presented to us during the course of our review as well as to congressional stakeholders.

With regard to ASP software problems uncovered during field validation, we clarified our report in response to DHS's comment that the severity of the problems has not yet been determined. DHS stated that its preliminary analysis indicates the problems should be resolved by routine adjustments to threshold settings rather than presumably more significant software "revisions." However, given the history of lengthy delays during ASP testing, we believe that DHS's assessment of the severity of problems encountered during field validation may be overly optimistic.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the Secretaries of Homeland Security and Energy; the Administrator of NNSA; and interested congressional committees. The report will also be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staffs have any questions about this report, please contact me at (202) 512-3841 or aloisee@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

Gene Aloise

Gene Aloise
Director, Natural Resources
and Environment

List of Requesters

The Honorable Joseph I. Lieberman
Chairman
Committee on Homeland Security
and Governmental Affairs
United States Senate

The Honorable Henry A. Waxman
Chairman
The Honorable John D. Dingell
Chair Emeritus
The Honorable Joe Barton
Ranking Member
Committee on Energy and Commerce
House of Representatives

The Honorable Bennie G. Thompson
Chairman
The Honorable Peter T. King
Ranking Member
Committee on Homeland Security
House of Representatives

The Honorable Edolphus Towns
Chairman
Committee on Oversight and Government Reform
House of Representatives

The Honorable Bart Gordon
Chairman
Committee on Science and Technology
House of Representatives

The Honorable Bart Stupak
Chairman
The Honorable Greg Walden
Ranking Member
Subcommittee on Oversight and Investigations
Committee on Energy and Commerce
House of Representatives

The Honorable Yvette D. Clarke
Chairwoman
The Honorable Daniel E. Lungren
Ranking Member
Subcommittee on Emerging Threats,
Cybersecurity, and Science and Technology
Committee on Homeland Security
House of Representatives

The Honorable Charles E. Schumer
United States Senate

The Honorable James R. Langevin
House of Representatives

The Honorable Michael T. McCaul
House of Representatives

Appendix I: Scope and Methodology

To evaluate the degree to which Department of Homeland Security's (DHS) criteria for a significant increase in operational effectiveness address the limitations of the current generation of radiation detection equipment, we clarified the intent of the criteria through the Domestic Nuclear Detection Office's (DNDO) written answers to our questions and through interviews with U.S. Customs and Border Protection (CBP) officials. We also took steps to gain a fuller understanding of the strengths and limitations of the current-generation equipment, which the criteria use as a baseline for evaluating the effectiveness of advanced spectroscopic portals (ASP). In particular, we obtained copies of the Department of Energy (DOE) threat guidance and related documents used to set polyvinyl toluene (PVT) thresholds for detection of nuclear materials. We interviewed DOE and national laboratory officials responsible for the threat guidance about the process for developing it and the basis for its underlying assumptions, including shielding levels. We also interviewed DNDO and Pacific Northwest National Laboratory officials regarding the extent to which PVTs currently deployed at ports of entry meet the guidance and the development and use of energy windowing to enhance PVTs' sensitivity to nuclear materials.

To evaluate the rigor of the 2008 round of testing as a basis for determining ASPs' operational effectiveness, we reviewed the test and evaluation master plan and plans for individual phases of testing, including system qualification testing conducted at vendors' facilities, performance testing conducted at the Nevada Test Site for evaluating ASP detection and identification capabilities, and integration testing conducted at Pacific Northwest National Laboratory for evaluating the readiness of ASPs to be used in an operational environment at ports of entry. We also reviewed draft plans for field validation conducted at CBP ports of entry and the DHS Science and Technology Directorate's independent operational test and evaluation. In reviewing these documents, we specifically evaluated the extent to which the performance test design was sufficient to identify statistically significant differences between the ASP and current-generation systems and whether DHS had addressed our concerns about previous rounds of ASP testing. We interviewed DNDO, CBP, and other DHS officials responsible for conducting and monitoring tests, and we observed, for one day each, performance testing at the Nevada Test Site and integration testing at DOE's Pacific Northwest National Laboratory. We also interviewed representatives of entities that supported testing, including DOE's National Nuclear Security Administration and Pacific Northwest National Laboratory, the National Institute of Standards and Technology, and the Johns Hopkins University Applied Physics Laboratory. We reviewed the DHS independent review team report of previous ASP testing conducted in 2007, and we interviewed the chair of the review team to clarify the report's findings. Finally, we examined preliminary or final results for the phases of testing completed during our review, and we interviewed DNDO and CBP officials regarding the results.

To evaluate the test schedule, we analyzed the initial working schedule DNDO provided to us in May 2008 and the schedule presented in the August 2008 test and evaluation master plan, and we tracked changes to the schedule and the reasons for any delays. We interviewed DNDO and other officials with a role in testing to determine the amount of time allowed for analysis and review of results. We interviewed DNDO and Pacific Northwest National Laboratory officials regarding the injection studies, including reasons for delays in the studies and plans for including the results as part of the ASP certification process.

We conducted this performance audit from May 2008 to May 2009 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the Department of Homeland Security

U.S. Department of Homeland Security
Washington, DC 20528

Homeland Security

March 24, 2009

Mr. Gene Aloise
Director, Natural Resources and Environment
U.S Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Mr. Aloise:

RE: Draft Report GAO-09-354SU, Combating Nuclear Terrorism: DHS Improved Testing of Advanced Radiation Detection Portal Monitors, But Preliminary Results Show Limits of the New Technology (360961)

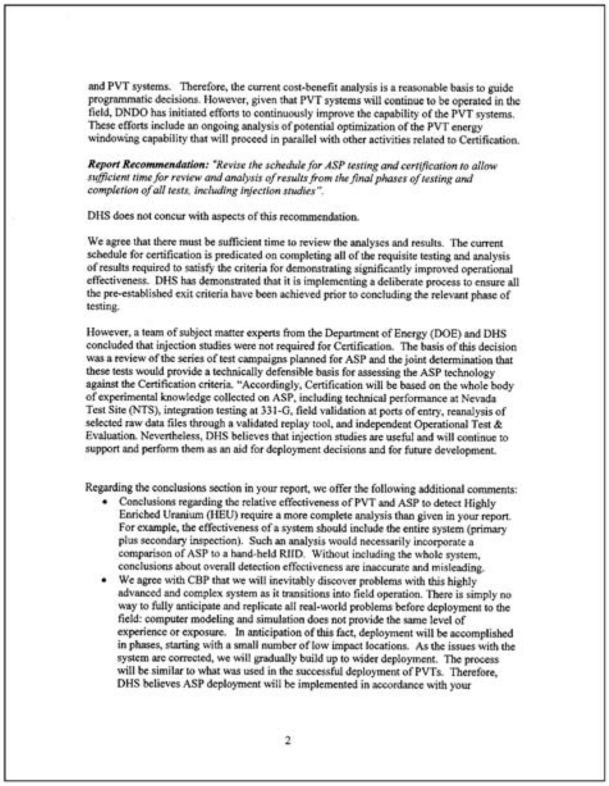
The Department of Homeland Security (DHS) appreciates the opportunity to comment on the above referenced draft report and clarify several points. DHS is committed to rigorous testing prior to the deployment of new technologies and is pleased that the Government Accountability Office (GAO) recognizes improvements that the Domestic Nuclear Detection Office (DNDO) has incorporated into its testing programs.

The comments provided below in response to the subject report are restricted to points that are directly relevant to the three areas that GAO was asked to review: (1) the degree to which DHS's criteria for significant increase in operational effectiveness address the limitations of existing radiation detection equipment, (2) the rigor of Advanced Spectroscopic Portal (ASP) testing and preliminary test results, and (3) the ASP test schedule.

Report Recommendation: *"Assess whether ASPs meet the criteria for significant increase in operational effectiveness based on a valid comparison with PVTs' full performance potential, including the potential to further develop PVTs' use of energy windowing to provide greater sensitivity to threats. Such a comparison could also be factored in to an updated cost-benefit analysis to determine whether it would be more cost-effective to continue to use PVTs or deploy ASPs for primary screening at particular ports of entry."*

DHS does not concur with this recommendation.

It is the judgment of experts that the majority of any increased Polyvinyl Toluene (PVT) performance from energy windowing has already been achieved in the existing systems; therefore we are confident that using the current understanding on PVT energy windowing as a baseline is a valid approach. DHS believes that Customs and Border Protection (CBP), the Office of the Undersecretary for Management, and DNDO have collaborated to establish a meaningful set of criteria to measure the relative operational effectiveness of the current ASP



and PVT systems. Therefore, the current cost-benefit analysis is a reasonable basis to guide programmatic decisions. However, given that PVT systems will continue to be operated in the field, DNDO has initiated efforts to continuously improve the capability of the PVT systems. These efforts include an ongoing analysis of potential optimization of the PVT energy windowing capability that will proceed in parallel with other activities related to Certification.

Report Recommendation: *"Revise the schedule for ASP testing and certification to allow sufficient time for review and analysis of results from the final phases of testing and completion of all tests, including injection studies".*

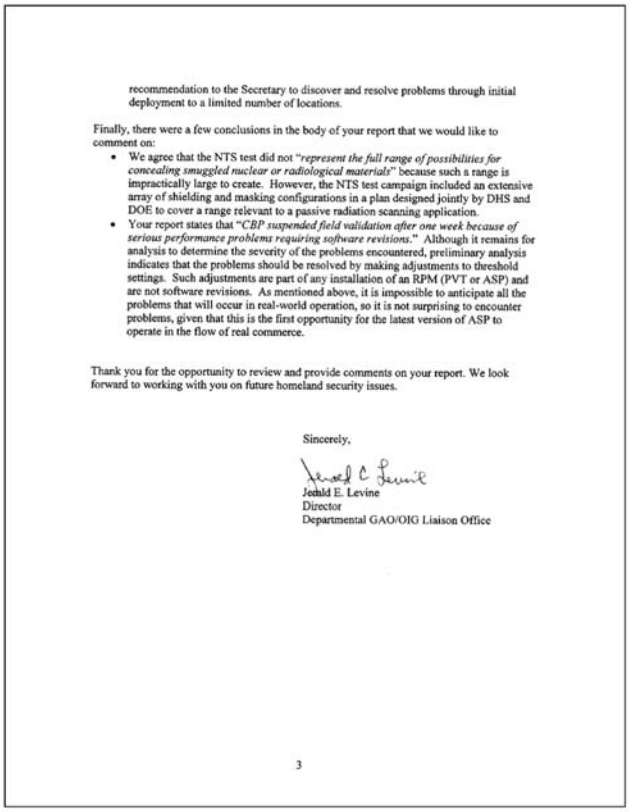
DHS does not concur with aspects of this recommendation.

We agree that there must be sufficient time to review the analyses and results. The current schedule for certification is predicated on completing all of the requisite testing and analysis of results required to satisfy the criteria for demonstrating significantly improved operational effectiveness. DHS has demonstrated that it is implementing a deliberate process to ensure all the pre-established exit criteria have been achieved prior to concluding the relevant phase of testing.

However, a team of subject matter experts from the Department of Energy (DOE) and DHS concluded that injection studies were not required for Certification. The basis of this decision was a review of the series of test campaigns planned for ASP and the joint determination that these tests would provide a technically defensible basis for assessing the ASP technology against the Certification criteria. "Accordingly, Certification will be based on the whole body of experimental knowledge collected on ASP, including technical performance at Nevada Test Site (NTS), integration testing at 331-G, field validation at ports of entry, reanalysis of selected raw data files through a validated replay tool, and independent Operational Test & Evaluation. Nevertheless, DHS believes that injection studies are useful and will continue to support and perform them as an aid for deployment decisions and for future development.

Regarding the conclusions section in your report, we offer the following additional comments:

- Conclusions regarding the relative effectiveness of PVT and ASP to detect Highly Enriched Uranium (HEU) require a more complete analysis than given in your report. For example, the effectiveness of a system should include the entire system (primary plus secondary inspection). Such an analysis would necessarily incorporate a comparison of ASP to a hand-held RIID. Without including the whole system, conclusions about overall detection effectiveness are inaccurate and misleading.
- We agree with CBP that we will inevitably discover problems with this highly advanced and complex system as it transitions into field operation. There is simply no way to fully anticipate and replicate all real-world problems before deployment to the field: computer modeling and simulation does not provide the same level of experience or exposure. In anticipation of this fact, deployment will be accomplished in phases, starting with a small number of low impact locations. As the issues with the system are corrected, we will gradually build up to wider deployment. The process will be similar to what was used in the successful deployment of PVTs. Therefore, DHS believes ASP deployment will be implemented in accordance with your



recommendation to the Secretary to discover and resolve problems through initial deployment to a limited number of locations.

Finally, there were a few conclusions in the body of your report that we would like to comment on:

- We agree that the NTS test did not "*represent the full range of possibilities for concealing smuggled nuclear or radiological materials*" because such a range is impractically large to create. However, the NTS test campaign included an extensive array of shielding and masking configurations in a plan designed jointly by DHS and DOE to cover a range relevant to a passive radiation scanning application.
- Your report states that "*CBP suspended field validation after one week because of serious performance problems requiring software revisions.*" Although it remains for analysis to determine the severity of the problems encountered, preliminary analysis indicates that the problems should be resolved by making adjustments to threshold settings. Such adjustments are part of any installation of an RPM (PVT or ASP) and are not software revisions. As mentioned above, it is impossible to anticipate all the problems that will occur in real-world operation, so it is not surprising to encounter problems, given that this is the first opportunity for the latest version of ASP to operate in the flow of real commerce.

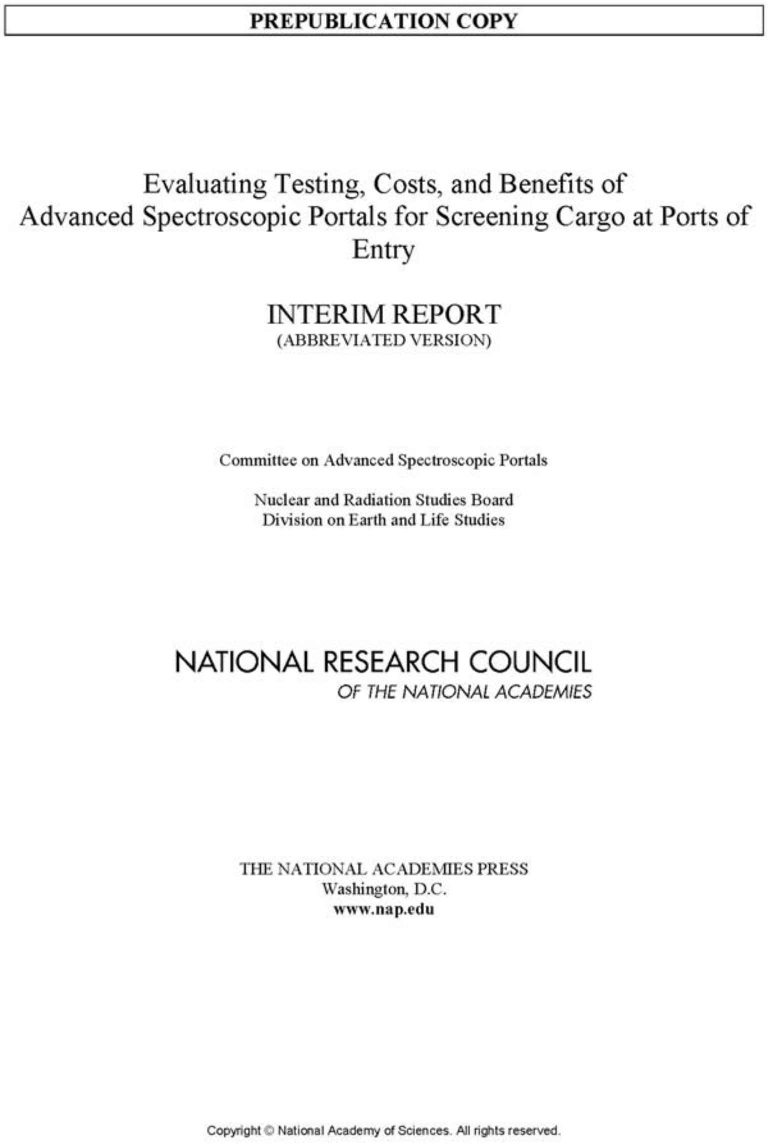
Thank you for the opportunity to review and provide comments on your report. We look forward to working with you on future homeland security issues.

Sincerely,

Jerald E. Levine
Director
Departmental GAO/OIG Liaison Office

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact	Gene Aloise, (202) 512-3841 or aloisee@gao.gov
Staff Acknowledgments	In addition to the contact named above, Ned Woodward, Assistant Director; Dr. Timothy Persons, Chief Scientist; James Ashley; Steve Caldwell; Joseph Cook; Omari Norman; Alison O'Neill; Rebecca Shea; Kevin Tarmann; and Eugene Wisnoski made key contributions to this report.



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Evaluating Testing, Costs, and Benefits of Advanced Spectroscopic Portals for Screening Cargo at Ports of Entry

INTERIM REPORT

(ABBREVIATED VERSION)

Committee on Advanced Spectroscopic Portals

Nuclear and Radiation Studies Board
Division on Earth and Life Studies

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Preface

The threat of a nuclear attack on the United States has haunted the U.S. public consciousness and been a central motivation in U.S. national defense since the 1950s. This was vividly demonstrated by the image of American schoolchildren doing "duck and cover" drills at the early heights of tensions between the United States and the Soviet Union. With the end of the Cold War, the prospect of a full-scale nuclear exchange between superpowers diminished, but the specter of new and different threats emerged: nuclear terrorism and clandestine nuclear attacks. Countering these new threats is a different kind of challenge and a goal that all reasonable people support. The question however, is where to devote limited funds to achieve the greatest impact against these risks. This report is an interim report of a study on the testing of next generation radiation detectors for screening cargo at ports of entry to the United States, one layer of the defense against such attacks. These new detectors are called advanced spectroscopic portals (ASPs).

U.S. Customs and Border Protection (CBP) is responsible for screening cargo for nuclear and radiological material at ports of entry. The Domestic Nuclear Detection Office (DNDO) is responsible for development and testing of new detectors and coordinating efforts for this mission. Both CBP and DNDO are in the Department of Homeland Security (DHS). DNDO issued the contract for this study to the National Academy of Sciences (NAS) in late April 2008 at the direction of Congress. The study is to advise the Secretary of Homeland Security on testing, analysis, costs, and benefits of the systems. DNDO wanted the NAS to issue a report in just over 4 months, and the NAS was prepared and equipped to deliver a report on that schedule, provided that all of the necessary information was provided by DHS. To carry out the study, the National Research Council (which is the operating arm of the NAS) assembled a committee with expertise in detection and identification of radioactive materials (nuclear materials and devices), cost-benefit analysis, statistical interpretation of data, algorithms for analysis of measurements, radiation shielding, deployment of detection systems, and port-of-entry operations.

To gather information for the study, the committee observed operations during visits to ports of entry and test sites, reviewed the test plans and results, and met with experts and program managers. The committee obviously could not observe the prior tests, and so in addition to looking at the test plans and results from those tests, the committee took as valuable input reports by the Government Accountability Office (GAO) and the Independent Review Team, which was convened at the request of the DHS Secretary. Like the prior tests, those reports were completed before the committee was formed, and indeed led to the request for this study. Given that DNDO acknowledged several of the problems with earlier testing, the committee focused more of its efforts on testing conducted in 2008 and the analysis that followed. The committee met in May, June, July, August, and October 2008 for information gathering, and subgroups of the committee visited ports in Seattle, Los Angeles, and Long Beach; border crossings in Blaine, Washington, and Otay Mesa, California; and met with experts at Pacific Northwest National Laboratory, Los Alamos National Laboratory, and Sandia National Laboratories in Albuquerque. The committee also heard from ASP program staff, the vendors, and outside experts in meetings in Washington, D.C.

The original plan for testing, evaluation, and consultation was a tightly coupled schedule dictated by the Secretary of Homeland Security's intent to make a decision in September 2008 whether to certify that the ASPs would provide "a significant increase in operational effectiveness". This wording was in the Department of Homeland Security Appropriations Act for Fiscal Year 2007, and certification was required by Congress before DHS obligates funds for full-scale procurement of ASPs. This requirement was repeated in fiscal year 2008. In late July of 2008, DHS issued a signed memorandum defining what is a significant increase in operational effectiveness, in the context of ASP testing. At the same time, it became clear that the equipment vendors, DNDO, and CBP could not meet their September target date because testing would not be completed until much later. Also, DNDO had not finalized some of the methods for analyzing results, and particularly for assessing costs and benefits. In the fall, as testing and evaluation continued to take longer than DHS hoped, the NAS proposed to DHS that the committee issue an interim report that would help DNDO and CBP complete their testing and evaluation more effectively. DHS accepted this proposal.

At the time that this report entered peer review, the committee had only seen preliminary results and analyses from the performance testing and an incomplete version of the DNDO cost-benefit analysis, both in briefing form. Because of the preliminary nature of the results the committee has seen and the incomplete state of the cost-benefit analysis methodology, this interim report focuses more on methodology than on results. During the peer review, DNDO provided a draft final report on performance testing. Unfortunately, the DNDO report was received too late to be considered in this Academy review. DNDO and DHS still have analysis and decisions ahead of them, even after the analysis of performance testing is finalized, and this interim report should help with that work. The final report will address the balance of the committee's statement of task. The committee wrote this interim report to assist DHS in its procurement efforts, to provide the Secretary with initial advice, and to begin to fulfill Congress' request. It is the committee's hope that DNDO, CBP, and DHS will consider the report in the spirit it is intended.

This report is an abbreviated version of the classified report provided to DNDO, DHS, and Congress. Some sensitive details have been removed, but the findings and recommendations remain unchanged from the full report.

Robert Dynes, Chairman
Committee on Advanced Spectroscopic Portals

REVIEWERS

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The content of the review comments and draft manuscript remains confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their participation in the review of this report:

Vicki Bier, University of Wisconsin, Madison,
Jay C. Davis, Lawrence Livermore National Laboratory and Defense Threat Reduction Agency (retired),
Robin Dillon-Merrill, Georgetown University,
Glenn Knoll, University of Michigan, Ann Arbor (retired),
Richard Meserve, Carnegie Institution of Washington,
Dennis Slaughter, Lawrence Livermore National Laboratory (retired),
George Thompson, Homeland Security Institute, and
Alyson Wilson, Iowa State University.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Dr. John Ahearne, Sigma Xi, the Scientific Research Society. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the National Research Council.

ACKNOWLEDGMENTS

This study began as a fast-track effort, and the committee had to obtain and learn a large amount of information from different sources over a short period of time. The committee was able to accomplish this with the assistance of program staff in the Domestic Nuclear Detection Office and U.S. Customs and Border Protection, as well as from several other people and organizations. The committee gratefully acknowledges the following people and organizations that provided information to the committee: Vayl Oxford, Walt Dickey, Julian Hill, Ernie Muenchau, Mark Mullen, John Roland, Jason Shergur, Domestic Nuclear Detection Office; George Ryan, Department of Homeland Security; Ben Nicholson, House Committee on Appropriations, Homeland Security Subcommittee staff; Gene Aloise, Ned Woodward, Joe Cook, Kevin Tarmin, Government Accountability Office; George Thompson, Homeland Security Institute; Thomas Cochran and Matthew McKinzie, Natural Resources Defense Council; John O'Sullivan, Raytheon Corporation; Mark Ramlo, Thermo-Fisher Corporation; Steve Mettler, Canberra Corporation; Mark Abhold, Los Alamos National Laboratory; Sonya Bowyer, J. Mark Henderson, Asim Khawaja, John Schweppe, Eric Smith, Pacific Northwest National Laboratory; RAND Corporation; the Port of Los Angeles; Maersk Shipping; the Port of Long Beach; Mel Chicazola and colleagues, Otay Mesa Border Crossing; Patrick Simmons, Todd Hoffman, Javier Larios, and CBP officers at the Port of Los Angeles, the Port of Long Beach, the Port of Seattle, and the Otay Mesa and Blaine border crossings, U.S. Customs and Border Protection; the Nevada Test Site; and Dean Mitchell, Sandia National Laboratory. The committee particularly acknowledges the assistance it received from its liaison from the Domestic Nuclear Detection Office, LTC Chad Russell.

The committee appreciates the assistance received from the following organizations in facilitating the committee's work: RAND Corporation; U.S. Coast Guard, Long Beach; and Lawrence Livermore National Laboratory.

The committee is also grateful for the assistance provided by the National Research Council staff in preparing this report. Mandi Boykin and Toni Greenleaf provided the committee with administrative and logistical support through a series of many meetings arranged on short notice at a variety of locations. Sarah Case, Kathryn Hughes, and Micah Lowenthal provided professional support to the committee, without which the report would not have been completed.

Robert Dynes, Chairman
Committee on Advanced Spectroscopic Portals

Contents

Executive Summary

To improve screening of containerized cargo for nuclear and radiological material that might be entering the United States, the Department of Homeland Security (DHS) is seeking to deploy new radiation detectors, called advanced spectroscopic portals (ASPs). The ASPs are intended to replace some or all of the current system of radiation portal monitors (called PVT RPMs) used in conjunction with handheld radioisotope identifiers (RIIDs) to detect and identify radioactive material in cargo. The U.S. Congress required the Secretary of Homeland Security to certify that ASPs will provide a "significant increase in operational effectiveness" over continued use of the existing screening devices before DHS can proceed with full-scale procurement of ASPs for deployment. Congress also directed DHS to request this National Research Council study to advise the Secretary of Homeland Security about testing, analysis, costs, and benefits of the ASPs prior to the certification decision. The objectives of this study are to: (1) evaluate the adequacy of the past testing and analyses of the ASP systems; (2) evaluate the scientific rigor and robustness of the testing and analysis approach; and (3) evaluate the cost-benefit analysis of ASP technology. Each of these is discussed below. This interim report is based on testing done before 2008; on plans for, observations of, and preliminary results from tests done in 2008; and on the agency's draft cost-benefit analysis as of October 2008. The report provides advice on how DHS' Domestic Nuclear Detection Office (DNDO) can complete and make more rigorous its ASP evaluation for the Secretary and the nation.

Testing: The committee finds that past testing had serious flaws. DNDO has acknowledged and addressed a number of those flaws in later testing. The 2008 performance tests were an improvement over previous tests: DNDO physically tested some of the limits of the systems, although shortcomings remain. DHS needs to address these shortcomings for a rigorous approach.

Scientific Rigor: To make the testing and evaluation more scientifically rigorous, the committee recommends an iterative approach with modeling and physical testing complementing each other. DNDO's current approach is to physically test small portions of the threat space (possible threat and cargo configurations) and to use other experimental data to test algorithms in the systems. However, the set of combinations of threats and cargo configurations is so large and multidimensional that DNDO needs an analytical basis for understanding the capabilities of its detector systems. In a more rigorous approach, scientists and engineers would use models of threat objects, radiation transport, and detector response to simulate performance and use physical experiments to validate the models' fidelity and enable developers to refine the models iteratively. Much of the foundation for modeling sources, radiation transport, and detector response is already in place in the national laboratories. This kind of interaction between computer models and physical tests is standard for the development of high-technology equipment and is essential for building scientific confidence.

The idea of an iterative approach also extends to deployment: the committee recommends a process for incremental deployment and continuous improvement, with experience leading to refinements in both technologies and operations over time. As a first step in this process DHS should deploy its currently unused low-rate initial production ASPs for primary and secondary inspection at various sites to assess their capabilities in multiple environments without investing in a much larger acquisition at the outset.

Cost-Benefit: DHS' definition of a "significant increase in operational effectiveness" is a modest set of goals. Preliminary estimates indicate that the cost increases from replacing the PVT/RIID combination with ASPs outweigh the cost reductions from operational efficiencies. Therefore, a careful cost-benefit analysis will need to reveal the advantages of ASPs among alternatives. The cost-benefit analysis was not complete when this report was written, but it should include three key elements: a clear statement of the objectives of the program; an assessment of meaningful alternatives; and a comprehensive, credible and transparent analysis of in-scope benefits and costs. The committee recommends that DHS not proceed with further procurement until it has addressed the findings and recommendations in this report and the ASP is shown to be a favored option in the cost-benefit analysis.

Summary

Containerized cargo entering the United States at sea ports and land-border crossings for trucks is currently screened for radiation using detectors, called radiation portal monitors (RPMs) made from a plastic scintillator, called PVT,[1] in conjunction with handheld radioisotope identifiers (RIIDs). The Department of Homeland Security (DHS) is seeking to deploy new radiation detectors, called advanced spectroscopic portals (ASPs), to replace the PVT and RIID combination, which has known deficiencies. Title IV of division E of the Consolidated Appropriations Act, 2008 (Public Law 110-161) requires the Secretary of Homeland Security to submit to Congress a report certifying that a "significant increase in operational effectiveness" over continued use of the existing screening devices will be achieved with the ASP before "funds appropriated under this heading shall be obligated for full-scale procurement of Advanced Spectroscopic Portal Monitors." DHS is testing and evaluating the ASPs to inform the Secretary's certification decision. If the Secretary certifies the ASPs, DHS may purchase more than one billion dollars worth of ASPs. The net lifecycle cost of these ASPs could be more than twice that figure.

The U.S. Congress directed DHS to request that the National Research Council of the National Academies conduct a study prior to certification to: (1) evaluate the adequacy of the past testing and analyses of the ASP systems performed by DHS's Domestic Nuclear Detection Office (DNDO); (2) evaluate the scientific rigor and robustness of DNDO's current testing and analysis approach; and (3) evaluate DNDO's cost-benefit analysis of ASP technology. Due to delays in the test and evaluation program, the Academies and DHS agreed that the study committee would issue an interim report that provides the committee's evaluation of testing plans and execution it has seen, and advice on how DNDO can complete and make more rigorous its ASP evaluation for the Secretary and the nation.

This interim report is based on testing done before 2008, plans for and preliminary results from tests done in 2008, and the agency's draft cost-benefit analysis as of October 2008. The committee received briefings on the performance test results and analysis and on the cost-benefit analysis, but the committee did not receive written reports on those topics by February 2009, when the interim report entered the Academy peer review process. The committee addresses each element of the study task below.

PAST PERFORMANCE TESTING

Performance tests prior to 2008 had serious flaws that were identified by the Government Accountability Office and the Secretary's ASP Independent Review Team. All truck-conveyed containers at ports and border crossings pass through a PVT portal which constitutes primary screening, and those trucks that trigger an alarm are sent to secondary screening, which is conducted with a PVT portal and RIID. The tests prior to 2008 did not adequately assess the capabilities of the ASP systems in primary and secondary screening compared with the currently deployed PVT and RIID screening systems, nor whether the ASP systems met criteria for procurement. DNDO utilized the same sources in performance testing that were used to set up and calibrate this testing. The number of sources available was small, but this is not sufficient

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[1] PVT stands for polyvinyl toluene.

reason to use the same sources for both set up and testing. Device setup and any calibration must use separate sources from those used for testing. A component of the standard operating procedures for the RIIDs in secondary screening was not followed in the performance tests, which disadvantaged the RIID in comparisons with ASPs.

2008 PERFORMANCE TESTING

In describing and discussing the tests with the committee, DNDO staff acknowledged several pre-2008 deficiencies. According to the 2008 test plan and briefings to the committee in Washington, D.C., and at the Nevada Test Site, these deficiencies were corrected. This is consistent with the committee's observations of tests and questioning of test personnel.

Because they have large detectors and because of their configuration, ASPs would be expected to improve isotope identification, and provide greater consistency in screening each container, greater coverage of each container, and increased speed of screening over that of the PVT/RIID combination when used in secondary screening. Consequently, tests of ASPs in secondary screening focused on confirming and quantifying that advantage for several threat objects, cargos, and configurations.

When used for primary screening, an ASP system must be compared to the existing combined primary and secondary screening system (both PVT and RIID) because of differences in standard operating procedures for primary screening (ASPs in primary have an identification function). DNDO's preliminary analysis did account for this difference.

The 2008 performance tests were an improvement over previous tests. DNDO physically tested some of the limits of the systems. However, the following shortcomings remain. (1) Without modeling to complement the physical experiments, the selected test configurations are too limited; (2) the sample sizes are small and limit the confidence that can be placed in comparisons among the results; and (3) in its analysis, some of the performance metrics are not the correct ones for comparing operational performance of screening systems. These shortcomings are described in greater detail within the report. For these reasons, DHS cannot conclude definitively whether ASPs will consistently outperform the current PVT-RIID systems in routine practice until the shortcomings are addressed. Better measurement and characterization are a necessary first step but may not be sufficient to enable DHS to conclude that the ASPs meet the criteria DHS has defined for achieving a "significant increase in operational effectiveness." The committee recommends modifications to the current DHS approach to the evaluation procedure. These modifications would influence subsequent procurement steps.

RECOMMENDED APPROACH FOR TESTING AND EVALUATION

To make the testing and evaluation more scientifically rigorous, the committee recommends an iterative approach with modeling and physical testing complementing each other. The threat space—that is, the set of possible threat objects, configurations, surrounding cargoes, and conditions of transport—is so large and multidimensional that DNDO needs an analytical basis for understanding the capabilities of detectors for screening cargo. DNDO's current approach is to physically test small portions of the threat space and to use other experimental data to interpolate and extrapolate throughout the threat space to test the identification algorithms in the detector systems.

For a more rigorous approach, DNDO should use theory and models of threat objects, radiation transport, and detector response to simulate performance and predict outcomes. Then DNDO can use physical experiments to validate the predictions and allow a critique of the models' fidelity to reality. This would enable developers to refine the models iteratively. With validated models, DNDO can evaluate the performance of the ASP systems over a larger, more meaningful range of cases and threat space than is feasible with physical tests alone.

This kind of interaction between computer models and physical tests is standard for the development of some high-technology equipment and is essential for building scientific confidence. The performance tests conducted in 2008, and even prior to 2008, can be used to help refine and validate models.

RECOMMENDED APPROACH FOR THE PROCUREMENT PROCESS

The idea of an iterative approach extends to deployment, too. The committee noted that DHS's testing philosophy is oriented toward a one-time certification decision in the near future. However, the mandate for passive radiation screening of cargo at ports of entry is expected to continue indefinitely. Rather than focusing on the single decision about the deployment of ASPs, the current testing should be viewed as a first step in a continuous process of improvement and adaptation of the systems. The threat environment, the composition of container cargo, technological and analytical capabilities, and the nature of commerce at the ports of entry have changed significantly over the last decade and can be expected to evolve in both predictable and unpredictable ways in the coming years. DHS should develop a process for incremental deployment and continuous improvement, with experience leading to refinements in both technologies and operations over time, rather than a single product purchase to replace current screening technology. The process should be developed to address and exploit changes. This would result in a system that can be adapted and updated continuously so that it would not be outdated by the time all of the ASPs are deployed.

As the first step in this process DHS should deploy its currently unused low-rate initial production ASPs for primary and secondary inspection at various sites as extended operational testing. Such deployment, even on this limited scale, would provide additional data concerning their operation, reliability, and performance, and allow DHS to better assess their capabilities in multiple environments without investing in a much larger acquisition at the outset.

The development of the hardware for radiation detection and the software for analyzing the signals from the detectors is separable. It has been useful to have a competitive approach for the combined systems and to see the results. However, as DHS moves forward, it should match the best hardware to the best software (particularly the algorithms), drawing on tools developed for the competition and elsewhere, such as the national laboratories.

ASPs will not eliminate the need for handheld detectors with spectroscopic capabilities. Because some of the improvement in isotope identification offered by the ASPs over the RIIDs is a result of software improvements, the best software package also should be incorporated into improved handheld detectors. Newer RIIDs with better software might significantly improve their performance and expand the range of deployment options available to CBP for cargo screening.

By separating these elements and engaging the broader science and engineering community, DHS would have increased confidence in its procurement of the best product available with current technology, and simultaneously could advance the state of the art.

RECOMMENDED APPROACH FOR COST-BENEFIT ANALYSIS

The preliminary analysis presented to the committee suggests that benefits of deploying the ASPs may not be clearly and undeniably greater than the costs. Because DNDO's preliminary estimates indicate that the cost increases from replacing the PVT/RIID combination with ASPs outweigh the cost reductions from operational efficiencies, it is important to consider carefully the conditions under which the benefits of deploying ASPs justify the program costs. A cost-benefit analysis (CBA) can provide a structure for evaluating whether a proposed program (such as the ASP program) is reasonable and justified.

The Secretary's decision on ASP certification is to rely, at least in part, on whether the ASPs meet the objectives in DHS' definition of "significant increase in operational effectiveness" (SIOE); however, other factors relating to the costs and benefits of the proposed ASP program will also need to be taken into account. DHS' definition of a SIOE is a modest set of goals: As noted above, the increases in operational efficiency do not by themselves appear to outweigh the cost increases from replacing the PVT/RIID combination with ASPs, based on DNDO's preliminary estimates, and the criteria do not require significantly improved ability to detect SNM in primary screening (see Sidebar 3.1). If the ASPs meet the defined criteria and are able to detect the minimum quantities of nuclear threat material that DOE recommends (the "DOE guidance"), DHS still will not know whether the benefits of the ASPs outweigh the additional costs associated with them, or whether the funds are more effectively spent on other elements of the Global Architecture.

A CBA can provide insight about the effects of alternative decisions, whether the benefits of a given program exceed its costs, and which choices are most cost-effective. To do this, the cost-benefit analysis needs to include three key elements: (1) a clear statement of the objectives of the screening program; (2) an assessment of meaningful alternatives to deploying ASPs; and (3) a comprehensive, credible and transparent analysis of in-scope benefits and costs.

The CBA should begin by stating clearly what operational problem the ASPs are intended to address. This statement will define the role that the system plays in providing a layer in the defense against the importation of a nuclear or radiological device. It should include a narrative that clarifies how the task of improving detection for containers at ports of entry to the United States fits into a larger effort to implement or improve detection capabilities, in recognition of the many ways that materials could be brought into the United States through ports of entry that are not already screened, or across uncontrolled stretches of border. Furthermore, to be useful in a procurement decision, a CBA will need to address whether funds are better spent to replace the currently deployed equipment rather than to expand coverage to other pathways that currently have no radiation screening. This is needed in the ASP CBA because it is not evident that it has been done elsewhere.

The CBA needs to account for meaningful alternatives (including non-ASP programs) to reveal the scale of the benefits of ASPs for radiation screening and determine whether these benefits outweigh the additional costs. The complexity of the container screening task provides opportunities for many different options worthy of consideration. These options include variations on deployment configuration and operational processes, and application of technologies beyond the PVT/RIID and ASP detectors such as improved versions of existing handheld passive detectors (deploying handhelds with state-of-the-art software) and advanced methods for detecting nuclear materials. Considerations should include active interrogation, improved imaging systems, and integration of existing technologies.

These alternatives need to be compared to a baseline that reflects as realistically as possible the screening capability that DHS currently has in place. Thus, the baseline should reflect the number and placement of PVT and RIID detectors, sensitivity of the sensors based on how they are operated at each port, and performance of existing handheld detectors in the manner they are used in the field. Such an analysis would indicate what capability an investment in ASPs will provide beyond the existing systems as they are currently deployed and operated or beyond alternative technologies that could be developed and deployed for radiation detection.

In comparing these alternatives, it is important that the cost-benefit analysis treat benefits and costs in a comprehensive, credible, and transparent manner. The benefit assessment should show how this program contributes to improving security with respect to prevention of the detonation of a nuclear device or radiological weapon in the United States. Because this is the primary objective of the ASP program, a cost-benefit analysis that is silent on this subject would be incomplete. Such an assessment is difficult and no assessment of such benefits will be definitive or unassailable, however it remains important to consider these factors. The cost assessment should cover all phases of the acquisition life cycle in a manner that is independent of contractor or program office biases and assess the risk of cost escalation associated with the estimate.

The committee recommends that DHS not proceed with further procurement until it has addressed the findings and recommendations in this report and the ASP is shown to be a favored option in the cost-benefit analysis.

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Introduction

In 2007, more than 11 million cargo containers arrived on ships and were offloaded at U.S. sea ports. An approximately equal number arrived by truck and another 2.75 million arrived by rail across land borders. The previous year, the SAFE Port Act (P.L. 109-347) was signed into law and required that "not later than December 31, 2007, all containers entering the United States through the 22 ports through which the greatest volume of containers enter the United States by vessel shall be scanned for radiation. To the extent practicable, the Secretary shall deploy next generation radiation detection technology." Cargo screening at ports of entry to the United States[2] is carried out by U.S. Customs and Border Protection (CBP) in the Department of Homeland Security (DHS). The Domestic Nuclear Detection Office (DNDO, also in DHS) coordinates federal, state, and local detection efforts to address the threat of nuclear terrorism, and develops, procures, and supports the deployment of detection equipment within the United States. One of DNDO's chief clients is CBP. This report concerns efforts to develop, test, and deploy next generation radiation detection technology. The following paragraphs provide some history of events that preceded the request for this study.

DNDO requested proposals for the next generation of radiation detectors for cargo screening (called advanced spectroscopic portals, or ASPs) from commercial vendors. DNDO selected three vendors for full testing, awarding contracts worth up to $1.2 billion for both testing and acquisition. The Government Accountability Office (GAO) and others raised questions about the reliability of DNDO's testing of the devices. Consequently, Congress restricted use of the funds for "full-scale procurement of Advanced Spectroscopic Portal Monitors" until the Secretary of Homeland Security submits to Congress "a report certifying that a significant increase in operational effectiveness will be achieved" by deploying ASPs to replace the screening devices that are already in place.[3]

The GAO has on-going audits of the ASP testing and procurement program and has raised several objections to the way the program, including its testing, evaluation, and life-cycle cost analyses have been conducted (GAO 2006; 2007a; 2008a), as well as criticisms of the larger "global architecture" of which the cargo screening is a piece (GAO 2008b; 2009). In August 2007, the DHS Secretary formed a group to carry out an independent review. That group issued its draft final report in November 2007.[4] In December 2007, the 2008 Consolidated Appropriations Act (P.L. 110-161) stated "[t]hat the Secretary of Homeland Security shall consult with the National Academy of Sciences before making such certification." In its Joint Explanatory Statement accompanying the legislation, Congress clarified its intent and this statement was the basis for the committee's statement of task (see Appendix A).

The ASP testing and evaluation program encountered some delays in 2008, which delayed any NAS report but created an opportunity for the NAS committee to provide input on

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[2] "A Port of Entry is any designated place at which a CBP officer is authorized to accept entries of merchandise to collect duties, and to enforce the various provisions of the customs and navigation laws (19 CFR 101.1)."

[3] See Title IV of division E of the Consolidated Appropriations Act, 2008, Public Law 110-161.

[4] The Independent Review Team's final report was issued in February 2008. Some of its findings are discussed in Chapter 3.

how testing and evaluation and the cost-benefit analysis should be completed. This interim report provides that advice to support future decisions by the Secretary of Homeland Security concerning development, certification, and deployment of ASPs. This chapter describes the origin of the study, the broader context of the threat of nuclear terrorism, and the currently deployed system for screening cargo containers for radiation. Chapter 2 gives readers who are not familiar with technologies for radiation detection some background on how detectors work. Chapter 3 provides the committee's views on ASP testing and analysis conducted by DHS offices both prior to 2008 and during 2008, including findings and recommendations on how to complete the work. Chapter 4 provides the committee's findings and recommendations for completing the ASP cost-benefit analysis. A final report will contain the committee's findings and recommendations on DNDO's completed tests and analyses.

WHY SCREEN FOR RADIATION? THE THREAT OF NUCLEAR TERRORISM

The possibility of nuclear terrorism has become more credible as it has become clearer that non-state actors may have or be able to acquire the means for a nuclear attack: gaining the knowledge of how to design a weapon, the materials for a nuclear explosive, and the ability to deliver and detonate the device. After the attacks on the United States on September 11, 2001, there is little doubt that well-funded, well-organized, and capable groups have the motive and intent to carry out high-consequence attacks on the United States. The knowledge of how to build a nuclear explosive is increasingly seen as a small hurdle, as designs of simple weapons have been discovered in non-nuclear weapons states, and given reports that A.Q. Khan's black market nuclear distribution network offered a weapon design, in addition to designs and equipment for uranium enrichment.[5] Production of special nuclear material (SNM)—the fuel for a nuclear explosive—is still generally thought to require the resources of a nation, but the material could be acquired by other means, such as theft or black market sales. After the collapse of the Soviet Union, the United States and Russia agreed to work together to ensure that scientists with weapons-design and production expertise remain in Russia, and not sell their expert services to others. They agreed to begin to account for and secure weapons-grade material in states of the former Soviet Union and to emplace radiation detectors to catch special nuclear material illicitly leaving Russia (the second line of defense). It became evident through this cooperation that the Soviet Union had not kept careful records of its inventory of special nuclear material at several dozen locations, so it is unknown whether material was already stolen from the stockpiles.[6]

To detonate a nuclear device on U.S. soil (including smuggled weapons, improvised nuclear devices, or dirty bombs), a terrorist must either acquire the necessary materials within the United States or smuggle them across U.S. borders. One potential path would be to bring the material in through one of the 327 official ports of entry into the United States, including land, air, and seaports, concealed as apparently ordinary cargo.

Each day in 2007, U.S. container ports[7] handled an average of 71,000 twenty-foot equivalent units (TEUs, a measure of container size) of cargo.[8] In addition, an average of 22,000

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[5] See, e.g., Corera (2006).

[6] See, for example, reports from the National Research Council on materials protection control and accounting (NAS 2009, 2007, 2005a, 2005b, 2005c, 1999, and 1997)

[7] In this case, "container ports" refers to sea ports, and excludes cargo coming into the United States via land border crossings.

truck and rail containers entered the U.S. by land each day in 2007. In fact, an average of one in nine containers carrying global trade is bound for or is coming from the United States (USDOT, 2007).

According to testimony from Jayson Ahern, acting Commissioner of U.S. Customs and Border Protection, in March 2009, radiation portal monitors (RPMs) in place now scan about 98% of the shipping containers entering U.S. maritime ports, 96% of trucks at Northern land border crossings, and 100% of those at Southern border crossings.[9] Additional monitors are being installed in the remaining ports and border crossings, and plans are in development to cover rail lines. This is a significant accomplishment. However, it is only a first step. The system does not cover small water vessels or general aviation, and much uncertainty remains about how to improve the overall capability of the system to reduce the threat posed by nuclear terrorism[10] in view of ever-increasing technological innovations and limited financial resources.

EFFORTS TO INTERDICT NUCLEAR MATERIALS AT PORTS OF ENTRY

The U.S. government—both the administration and Congress—concluded that it would be valuable to screen people, luggage, vehicles, and cargo entering the United States for nuclear and radiological material. U.S. Customs and Border Protection put in place a system of RPMs that use passive devices to detect radioactive material entering the country. Typical RPMs at a small border crossing are shown in Figure 1.1. In the towers on each side of the roadway or traffic lane are two panels (one high, one low) containing radiation detectors. The RPMs use PVT plastic scintillation detectors, which detect gamma rays emitted by most radionuclides, but have a limited ability to characterize the source of those gamma rays. The PVT detectors are capable of measuring only crude spectral information. The RPMs also have neutron detectors, which can detect neutron-emitting materials, such as plutonium.

Cargo screening is just one of several overlapping layers of defense against unlawful import of nuclear material, none of which offers perfect protection. The layered defense system begins with securing the materials in the facilities where they reside overseas and has additional layers for detecting and preventing smuggling efforts at foreign nations' borders and interdicting in transit. The Department of Energy, through the Second Line of Defense and other programs, uses many of the same detectors as CBP but deploys them overseas at border crossings and sea

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[8] The numbers cited for container traffic can be confusing. The maritime industry counts twenty-foot equivalent units (TEUs) when counting cargo containers of varying lengths—a forty foot container is two TEUs—but others count actual containers, or even conveyances. In this report, TEUs will only be used to describe overall container traffic for sea ports.

[9] Statement of Jayson P. Ahern, Acting Commissioner, U.S. Customs and Border Protection, Department of Homeland Security before the Committee on Appropriations, Subcommittee on Homeland Security, April 1, 2009.

[10] In 2008, David Maurer of the Government Accountability Office testified that the Department of Homeland Security's Domestic Nuclear Detection Office (DNDO) "lacks an overarching strategic plan to help guide how it will achieve a more comprehensive architecture." (GAO 2008b)

(a) (b)

Figure 1.1 (a) The tall pillars closest to the foreground in this photograph are RPMs at a land border crossing between Canada and New York. (b) A truck is shown passing through a series of RPMs and ASPs on a test track. SOURCE: CBP (2008).

ports under agreements with the foreign governments where they are located.[11] The final layer is at our borders' ports of entry, with the RPMs (and the associated hand-held radiation detectors). Over 1070 RPMs were in operation at U.S. ports of entry, as of July 2008. Hand-held radioisotope identification devices (RIIDs)[12] also were in operation at ports of entry at that time.

Every container of foreign origin carried by a truck passes through screening. At sea ports, the procedure is not totally consistent at each site or for each container. Containers may be loaded onto a chassis which is then connected to a tractor that drives the container through an RPM and off the terminal. Containers destined for rail transport may be carried by a truck to a nearby location with a rail line where the train is built (some of these are screened with a RPM when the truck is pulling them) or they may be loaded directly onto rail cars (so-called on-dock rail or roll-on, roll-off rail loading). Mobile detectors are used for some of the containers that are not conveyed by truck. The ASP-C RPMs are only used for containers conveyed by truck.

The current concept of operations (CONOPS) for screening of cargo containers for radioactive material consists of a two-stage screening process. In the first stage, primary screening, the container is driven through a PVT RPM. When an RPM used in primary screening detects radiation levels above a gamma-ray or neutron alarm threshold, the container is diverted to a lane dedicated to secondary screening. Because there is radioactive material in a small but significant fraction of ordinary cargo, radiation alarms in primary screening are quite common. This radioactive material includes naturally occurring radioactive material (NORM),[13] as well as

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[11] The National Nuclear Security Administration, a semi-autonomous agency within the Department of Energy (DOE), runs these programs. The committee refers to DOE here and throughout the report for simplicity. The similarity and overlapping nature of the DOE and CBP-DNDO programs has led DNDO to consult and cooperate with DOE on some aspects of the ASP program.

[12] The term "isotope identification" or "radioisotope identification" is commonly used, although it is usually not technically correct. It is only meaningful to refer to an isotope in the context of a specific element. The same is true of the term radioisotope. A nuclide or a radionuclide may be any isotope of any element. In this report, the terms "isotope" and "radioisotope" are synonymous with nuclide and radionuclide, respectively, consistent with common usage.

[13] NORM comprises many materials derived from rocks, such as granite table tops, porcelain, and kitty litter, and materials high in potassium, such as bananas and potassium chloride (salt substitute).

radiopharmaceuticals used in medicine and industrial radiation sources. Even when radiation is not detected at a primary RPM, secondary actions may be taken based on independent information about the cargo or a CBP agent's judgment that the cargo is suspect.

In secondary screening, the container is driven through another RPM and examined with a "spectroscopic" detector, which in principle is capable of identifying specific radioactive substances. The spectrometer currently in use is a handheld radioisotope identification device (RIID, see Figure 1.2).

One or more CBP officers examine the container with a RIID to identify whether the source is NORM, an industrial source, medical radionuclides, a threat object, or some combination of these. CBP may decide to send the spectrum electronically to a centralized group of specialists, called Laboratories and Scientific Services (LSS), for analysis. CBP may also open the container and visually inspect the contents as well as further monitor the contents with the RIID. At some ports of entry, the container may also be subject to additional inspections such as imaging with an X-ray type machine (a radiography device with a gamma or X-ray source) to look for localized heavy metal objects (shielding or SNM), and direct examination of the cargo, including removal from the truck or shipping container.

Figure 1.2: A handheld RIID. SOURCE: DNDO (2008a)

Committee members observed secondary screening operations at two border crossings and three ports. The committee's observations were consistent with descriptions given in briefings to the committee by CBP in May and October. A truck carrying a container that triggers a primary alarm may be delayed by 5 to 15 minutes or more, depending on the configuration of the port of entry and the relative ease or difficulty of identifying the source of radiation. First, because of the layout of the primary and secondary screening areas, at some ports of entry it may take several minutes for a truck stopped in primary screening to be diverted to secondary screening. At some ports of entry, it requires that a CBP officer stop all lanes traffic through the RPMs to allow the truck that caused the alarm to cross to the secondary screening area. Switching to ASPs would not reduce this delay for a truck that triggers a primary alarm, but to be certified for primary screening, ASPs must alarm on fewer trucks. The result of deploying ASPs that meet the criteria would be some reduction in the time spent in screening overall. Screening a truck with a handheld RIID may take several minutes or more, depending on how quickly the alarm can be resolved.

However, the time required to carry out screening is only part of the picture of actual operations at ports of entry. CBP has stated repeatedly that the current system of radiation screening, using PVT RPMs and RIIDs, does not impede the flow of commerce. The committee's observations were, again, consistent with those statements. In no case that the committee observed was there a backup of trucks resulting from radiation screening. Other steps—manifests and immigration at border crossings, and safety inspections at border crossings and ports—had trucks waiting. While an alarm on the primary screening detectors sometimes stopped traffic for all of the lanes, typically it resulted in no net delay for the trucks that did not trigger the alarm. This is because the queue at the next inspection station usually had not yet cleared. DNDO and CBP officials also told the committee that replacing the current system with an ASP system would not reduce the number of CBP officers who conduct radiation screening at ports of entry.

2

Background on Radiation Detection

Portal monitors contain detectors for both gamma rays and neutrons. There are thousands of known radionuclides, and most of them emit one or more gamma rays, so most radioactive materials emit some gamma rays. A single radionuclide can emit one or many distinct gamma rays, each having a characteristic energy and intensity,[14] resulting in a gamma ray spectrum[15] characteristic of that radionuclide. The intensity depends on the probability of emission in each decay event and the amount of the nuclide present.[16] The ability to reliably determine the presence of a radionuclide, especially in the actual or potential presence of other radionuclides, depends on having a detector with sufficient sensitivity and energy resolution.

The neutron detectors employed in the radiation portal monitors (RPMs) do not resolve the energies of the neutrons. However, this is not a major drawback because relatively few radionuclides or combinations of radionuclides emit neutrons, and nearly all of those sources are of interest for security reasons. The detection of neutrons, then, is a strong indicator of the presence of threat material and the need to interdict the truck. Although many of these radionuclides and their daughters also emit alpha or beta particles, only gamma rays and neutrons are sufficiently penetrating to be detectable outside of a shipping container that holds the radiation source.

When screening cargo, the Department of Homeland Security (DHS) tries to identify whether the cargo contains radionuclides useable in a radiological or a nuclear weapon.[17] The radionuclides of greatest concern for radiological attacks have been identified in several studies, including those by the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy, the International Atomic Energy Agency, and others (see NRC-DOE 2003; IAEA 2003; NAS 2008), and include americium-241, cesium-137, cobalt-60, iridium-192, and strontium-90. Some of these radionuclides are easy to detect if they are present in significant quantities. For example, cobalt-60 emits two relatively high energy gamma rays with each disintegration, one at 1173 keV and one at 1333 keV. Strong cobalt-60, cesium-137, and iridium-192 (used in radiography) sources require heavy shielding to enable people to work near them.

The materials of greatest concern for nuclear explosive devices are called direct-use nuclear materials—materials that are directly useable in a nuclear explosive device (this includes special nuclear material: uranium-233, uranium-235, and plutonium)—and do not necessarily require heavy shielding. For example, uranium-235 emits one intense gamma ray of energy 185.7 keV in 57.2% of its disintegrations. Plutonium-239 emits numerous weak (low-intensity or low-probability) gamma rays. The strongest, most readily detectable of these have energies of

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[14] For example, iridium-192 emits dozens of gamma rays as it decays, 4 of which are intense (iridium-192 emits them in approximately 30 percent or more decays).. Iodine-131, used in medicine, emits one intense gamma ray (emitted in over 80 percent of decays) and 17 other gamma rays (emitted in between 0.00009 and 7 percent of decays).

[15] A gamma ray spectrum, the set of gamma rays of different energies emitted by a source, is represented as a plot of the number of gamma rays versus energy.

[16] The relative intensities of multiple gamma rays from a single radionuclide can also be used to help identify it.

[17] A radiological weapon uses radioactive material to cause harm based on the radiation the material emits. A nuclear weapon uses nuclear reactions to release large amounts of energy in a nuclear explosion, which also releases radioactive material. A radiological weapon is unlikely to kill many people, but can cause harm and economic damage. A nuclear weapon is the most devastating weapon in the U.S. arsenal.

51.6, 98.4, 129.3, 375.1, 451.5, 650 (a "multiplet" containing about a dozen gamma rays of nearly the same energy), and 769.3 (doublet) keV. Plutonium also emits neutrons because of spontaneous fission. No real material is purely composed of one radionuclide. Other nuclides, including other radionuclides in many cases, are present because they are byproducts of the creation of the radionuclide or because they are decay products of the main radionuclide. Highly enriched uranium (HEU) contains, by definition, at least 20 percent uranium-235, with the rest typically being uranium-238 and trace quantities of uranium-234. Even weapons-grade uranium (generally considered to be at least 90 percent uranium-235, and what a weapons state would use in a nuclear weapon) may contain up to 10 percent uranium-238. The composition of plutonium typically has even more isotopes in measureable quantities: some mix of plutonium-238, -239, -240, -241, and possibly -242.

A notional gamma-ray spectrum would show up simply as a curve with peaks (spikes of counts) at the characteristic gamma-ray energies, but zero counts everywhere else. As discussed below, the width of the peaks, or "energy resolution" is different for different types of detectors. Real spectra are necessarily more complicated, due to the existence of alternative physical mechanisms for absorption and scattering of gamma rays in the detector and, to a lesser extent, to imperfections in the way different types of detectors and individual detectors of the same type operate. The most important difference between a real spectrum and the above-described "notional" spectrum is the presence of a broad continuum of gamma rays caused by Compton scattering.[18] For a gamma ray of given energy, the continuum lies below the peak and has a predictable shape, based on the gamma-ray energy and the composition and size of the detector. The continuum tends to fill in the regions between the peaks, and can make it difficult to identify peaks if the peaks are broad (i.e., in low-resolution detectors), and/or the peaks are weak compared to the continuum. Additionally, as noted, shielding can attenuate the peaks and add to the continuum, and additional radiation from natural background and masking materials can introduce additional gamma-ray peaks and add to the "Compton" continuum. The combination of these effects complicates the spectrum and creates a formidable challenge to the identification of radionuclides, especially with detection systems of relatively low resolution like thalium-activated sodium iodide [NaI(Tl), sodium iodide or NaI for short] detectors. Thus the challenge of testing the ability of a system to detect and identify a particular source under varying conditions is great. This chapter describes important technical aspects of passive detectors used to detect radiation from sources located in cargo containers.

SHIELDING

The observed gamma-ray spectrum from a source, (e.g., special nuclear material, SNM) is influenced by the presence and distribution of surrounding materials, which attenuate and scatter gamma rays by absorption and Compton scattering. These materials can include, containers, other materials being shipped with the source or placed around it in an attempt to shield it from detection (shielding), and an air gap. Attenuation even occurs in the radioactive material itself (self shielding). High-energy gamma rays are attenuated less than low-energy

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[18] Compton scattering is a fundamental physical process in which a gamma ray scatters off an electron, giving up some of its energy to the electron and retaining the rest in the scattered gamma ray. When this occurs in the detector (and the scattered gamma ray exits the detector without further interaction), the detector "sees" the energy of the scattering electron. When it occurs in material outside the detector (e.g., shielding), the scattered gamma-ray might be detected by the detector. Because the amount of gamma-ray energy given up to the electron varies continuously, the result in either case is a contribution to the continuum in the detector.

gamma rays, and high-atomic number (high-Z) materials, such as tungsten and lead attenuate more than low-Z materials, such as aluminum and wood. High density materials also attenuate more than low-density materials, and there is a correlation between pure high-Z materials and high-density materials, and between pure low-Z materials and low-density materials. Shielding can reduce the intensity of gamma-rays observed by the detector (both peaks and continuum), and also shift the continuum to lower energies and increase its intensity relative to the peaks.

Self Shielding

An important consideration for detection of nuclear materials is self shielding. Because uranium and plutonium are very heavy elements with large number of electrons (high-Z), they strongly absorb gamma rays. Gamma rays produced in the interior of a thick piece of nuclear material are likely to be absorbed within the material. This effect makes it more difficult to detect these materials.

HEU emits very few neutrons, virtually all of them from the small percentage of uranium-238 present in the material.[19] Consequently, one cannot reliably detect HEU with a neutron detector. Plutonium emits neutrons, most of which are emitted by the isotope plutonium-240. Self-shielding has little effect in diminishing neutron emission, because sub-critical multiplication actually increases the neutron emission. Testing of RPMs carried out with SNM has demonstrated the detection of plutonium with some shielding and, in some tests, HEU. With sufficient shielding, passive detectors would fail to detect even large quantities of these materials.

MASKING

Masking is the phenomenon that occurs when benign radioactive materials obscure the signature of a radionuclide of interest. This occurs when the benign radionuclide either overwhelms the detector with a stronger signal or creates spectral signals that compromise the algorithm's ability to analyze the spectra. Multiple radionuclide sources in the cargo, including masking materials, produce spectra that are linear sums of the spectra of individual radionuclides. The geometry of the source and masking materials can affect the spectrum, because different radioactive materials can be located in different positions relative to the detectors and any shielding materials.

In addition, the interaction between the radioactive material and the shielding or masking material may result in secondary emissions that could confound identification. When testing for the effects of shielding, both high-Z and low-Z materials should be investigated. High-Z materials are more effective at attenuating gamma rays, especially low-energy gamma rays, whereas low-Z materials, notably materials containing hydrogen atoms, enhance the absorption of neutrons.[20] High-Z materials close to a source that emits beta particles, such as strontium-90, will enhance the production of Bremsstrahlung, a continuum spectrum of photons (gamma rays) resulting from the stopping of electrons. If shielding and masking are used in combination, it is important to consider scenarios where the masking material is closer to the source than the

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[19] HEU containing very small amounts of chemical impurities emits some neutrons, produced by reactions of alpha particles on light elements in these impurities.

[20] Neutrons lose more of their kinetic energy in collisions with low-Z nuclei than with high-Z nuclei, and low-energy neutrons are much more likely to be absorbed than high-energy neutrons.

shielding and vice versa, because the order may affect the observed gamma ray spectrum and the angular dispersion of scattered gamma rays.

Finally, all radioactive decay data are subject to statistical variations, which are particularly significant for weak sources.[21]

HOW DETECTORS WORK

Gamma-ray detectors and neutron detectors are used in both the proposed Advanced Spectroscopic Portals (ASPs) and the currently-used PVT portals. Both systems use moderated helium-3 proportional counters for neutron detection. For gamma-rays, the ASP system uses thallium-activated sodium iodide [NaI(Tl), sodium iodide or NaI for short] detectors for gamma-ray detection, and the PVT system uses polyvinyl toluene based plastic scintillation detectors for gamma-ray detection. The plastic scintillator is made of a polyvinyl toluene solvent with a (typically) p-terphenyl solute. After mixing the two materials, the solvent is polymerized to make the plastic. Another system proposed for the ASP portals uses high purity germanium (HPGe) detectors for gamma-ray detection. How each detector works is discussed in the following paragraphs.

Sodium Iodide Detectors

Sodium iodide detectors consist of a NaI crystal containing approximately 0.1% thallium, coupled optically to a photomultiplier tube.[22] They are scintillation detectors: gamma rays interact with the detector to produce low-energy photons in the energy range of visible light, a phenomenon called scintillation. The NaI crystal is transparent to light. A scintillation photon is captured by the photomultiplier, which converts it into an electron, which is then accelerated and amplified in the photomultiplier to produce many electrons. The total electrical signal at the output of the photomultiplier is related to the sum of the photons from across the crystal and is roughly proportional to the energy deposited in the detector by the gamma ray, so the size of this signal is logged and tallied as the energy of one gamma ray. NaI detectors are expensive compared to plastic detectors, but inexpensive compared to HPGe detectors. (See below.)

The range of energies detected for the full-energy gamma-ray peak in a NaI detector is typically around 8% of energy FWHM.[23] In other words, the peak in a NaI detector spectrum from a 1 MeV gamma ray might be 80 keV wide. This is relatively low (poor) energy resolution for gamma spectroscopy. When several different gamma rays are closer together in energy than the detector resolution, as can be the case with some sources observed by NaI detectors, it is difficult to identify them all. This is particularly true for a weak gamma ray (one with few counts observed) close to a stronger one. Another problem with a low-resolution detector, such as NaI, is that a weak gamma ray peak can be difficult to observe above the Compton continuum from

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[21] Radioactive decay is measured by detector counts of emitted particles and is modeled most naturally and rather faithfully by the Poisson distribution with standard deviation equal to the square root of its mean; hence a good estimate of the statistical variation in the number counts N is $\sqrt{N}$, and the variation relative to the count is $\sqrt{N}/N = 1/\sqrt{N}$.

[22] Originally, single crystals were grown for the detectors. Currently many of the detectors are made of a polycrystalline material that has better resistance to cleavage from mechanical or thermal shock.

[23] FWHM stands for full width at half maximum, the width (energy spread) of the peak in the spectrum at half the height of the peak above any underlying continuum. The low resolution of NaI detectors is the result of low efficiencies in the conversion of gamma-ray energy to energy of the light photons, and a low yield of electrons (around 0.15 per photon) at the photocathode.

higher energy gamma rays, because the few counts in the peak are spread of a range of energies. Figure 2.1 shows a typical gamma-ray spectrum of naturally occurring radioactive material (NORM) measured with a NaI detector. Low detector resolution poses a challenge to analysis algorithms necessary to process the data and obtain meaningful conclusions, especially when there is a large statistical uncertainty in the data (i.e., few counts).

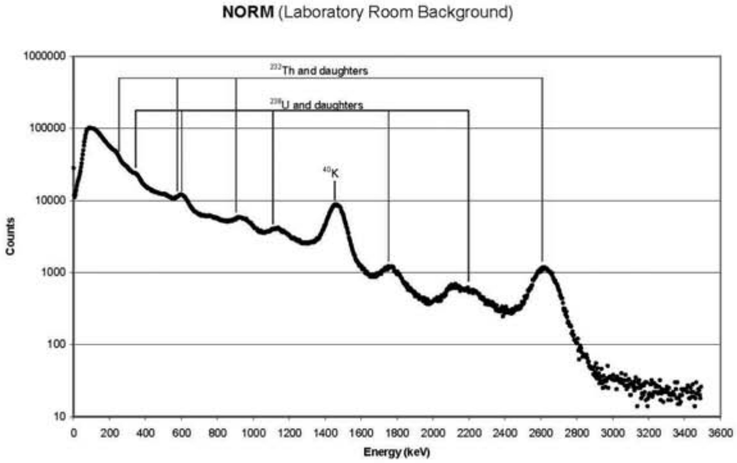

Figure 2.1 A gamma-ray spectrum gathered from the background radiation in a laboratory using a sodium-iodide detector. The x-axis is the energy in keV and the y-axis is the number of gamma-ray detections counted within a particular energy range. Gamma-ray peaks from common background radionuclides are labeled on the figure.

PVT Detectors

Like NaI detectors, PVT detectors are scintillation detectors. Unlike crystals, plastic scintillators can easily be fabricated into large detectors, and are relatively inexpensive. The larger size permits the detection of a larger number of events from the same gamma-ray source. However, the low density, low light yield, and especially the low atomic number[24] of the plastic scintillator combine to make the detector much less effective than NaI for spectroscopic measurements. They provide only crude information about the gamma-ray energy. Figure 2.2 shows a typical gamma-ray spectrum of radionuclides measured with a PVT detector, illustrating the absence of observable full-energy peaks.

Permission For Figure Pending

Figure 2.2. A calibration gamma-ray spectrum gathered by a PVT portal monitor. The background has been subtracted. SOURCE: Stromswold et al. (2004).

HPGe Semiconductor Detectors

Gamma-ray spectrometers based on high-purity germanium (HPGe, or germanium) detectors are widely used as laboratory scientific instruments. Their energy resolution is typically around 0.1-0.2% FWHM of the gamma-ray energy, nearly two orders of magnitude better (narrower peaks) than a NaI detector. An HPGe detector is a semiconductor ionization-type detector, which operates on a different principle from NaI and PVT detectors. In an ionization detector, the gamma-ray energy is converted directly into electrons, which form the signal proportional to the energy deposited by the gamma ray.[25]

Figure 2.3 shows the HPGe spectrum of the same NORM source whose measurement with an NaI detector was shown above (Figure 2.1). The advantage of the higher-resolution

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[24] Materials with low atomic numbers have almost no photoelectric interactions with gamma rays and therefore exhibit no full energy peak.

[25] The high resolution of germanium detectors results from efficient conversion of the gamma-ray energy into electrons.

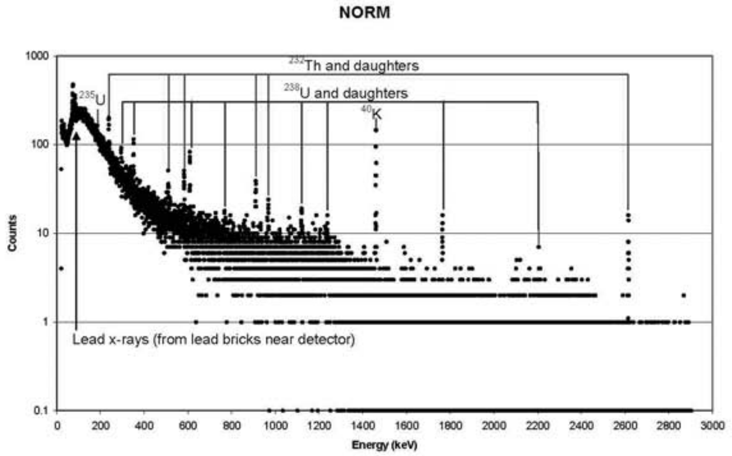

Figure 2.3 A gamma-ray spectrum gathered with a germanium detector from the background radiation in the same laboratory mentioned in Figure 2.1. Again, the x-axis is the energy in keV and the y-axis is the number of gamma-ray detections counted within a particular energy range. Gamma-ray peaks from common background radionuclides are labeled on the figure.

detector is evident. (Note that the presence of uranium-235, whose strongest gamma-ray is buried in the continuum with a NaI detector, is clearly revealed in the HPGe spectrum.)

Although the higher energy resolution of HPGe detectors is essential in many laboratory measurements and would be desirable for detecting nuclear and radiological materials, especially under difficult conditions (e.g., masking), these detectors have other characteristics that make their widespread use in RPMs problematic. The main drawbacks are the difficulty of producing detectors in very large sizes needed to detect relatively small amounts of radiation in a short time, and the high cost per detector, which makes it expensive to use large numbers of them in an RPM. Also, the detectors must be cooled to low temperatures, requiring liquid nitrogen or special, mechanical or thermoelectric cooling devices.

Neutron Detectors

Neutron detection in the RPMs use helium-3 proportional counters, a type of gas-filled ionization detector that has built-in amplification caused by a complex process of charge multiplication. The detectors are embedded in polyethylene, which acts as a "moderator," slowing ("thermalizing") the neutrons emitted by sources of interest to low energies.[26]

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[26] In the detector, the neutron reacts with a helium-3 nucleus to produce an energetic proton (p or hydrogen-1) and a triton (t or hydrogen-3). This reaction has a low cross-section (probability) for all but low-energy neutrons, so

Because the neutrons must be slowed down to make them detectable, the counter does not measure the energy of the incident neutrons. This means that the detectors measure no useful spectroscopic information about the neutrons. Because very few radionuclides emit neutrons, and almost all of them are of security interest, this is not a serious drawback. Neutrons are simply counted. The mere detection of any neutrons above the low natural neutron background counting rate signals a likely cause for concern.[27]

ANALYZING SPECTRA

Once a gamma-ray spectrum has been collected, it must still be analyzed to identify the radionuclide(s) that generated the radiation. Two different strategies have been employed for this analysis in the ASPs: peak matching and template matching. Each has advantages in some configurations. It is also likely that the available algorithms could be improved by involving more of the science and engineering community to work on these problems.

As described in the previous section, a detector pulse-height spectrum for a monoenergetic gamma-ray source has a peak centered on the full energy of the incident gamma rays and a continuous tail at lower energies caused by Compton scattering. A peak-matching algorithm identifies the full-energy peak and matches that energy to the signature energies in its library of radionuclides. Many radionuclides have multiple characteristic gamma rays, and more than one radionuclide may be present in cargo, so the algorithm must be able to identify and match multiple peaks in a single spectrum.

The advantage of peak matching is that there is always a full-energy peak that is separate from the Compton tail. One disadvantage is that only a fraction of the detector counts are in the full energy peak. Peaks are also obscured by the Compton distribution of higher-energy gamma rays. Also, attenuating material between the source and the detector can drastically reduce the number of full-energy gamma rays that even reach the detector, making it difficult to differentiate full-energy peaks from the background.

A template-matching algorithm has a library of energies of gamma rays emitted in radioactive decay and also a library of full detector spectra from radionuclides with intervening attenuating materials. Template matching compares not just the full-energy peak, but the whole spectrum to its libraries. An advantage of template matching is that all of the detector counts are used toward identification, and the effect of shielding can be accounted for, at least approximately. The challenge in template matching is the nearly limitless set of combinations of sources and attenuating materials and thicknesses, along with background radiation.

Although software implementing algorithms for gamma-ray spectral analysis has been the subject of intense development in the national laboratories, and several vendors of spectrometers provide such software, there are in fact few commercial products available for radionuclide identification using gamma spectroscopy.[28] A particular problem is the dearth of

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neutrons must be slowed down for them to be detected well. The reaction energy is carried off by the proton and triton, which lose their energy by ionizing atoms in the detector gas. The ionized atoms make an electrical signal that is amplified by the proportional counter.

[27] One likely source of neutrons is plutonium. Neutron sources such as the isotope californium-252 and mixtures of natural or man-made alpha-emitting isotopes with beryllium are used in some applications, including downhole measurements in oil wells.

[28] Isotope identification software and algorithms are different from the ASP software for interaction with the operational hardware (occupancy sensors, gate arms, etc.). The former are exchangeable modules that analyze spectral data found in data files that follow standard formats. The latter are specific to each vendor's ASP.

commercial software for the complex problem of analyzing sources that can be shielded and masked with low-resolution (NaI) detectors—a problem of current interest mainly to detection systems for nuclear and radiological materials. Even the scientific literature on this topic is sparse. Engaging the broader science and engineering community in this challenge could lead to more sophisticated analytical methods from statistics and signal processing being applied to radionuclide identification, resulting in better algorithms.

Radiation Detectors at Ports of Entry Today

As noted in Chapter 1, the RPMs currently in use are PVT plastic scintillation detectors. Because these detectors are inexpensive and easily fabricated in large volumes, they can be made to be quite sensitive to radiation. But PVT detectors have very poor energy resolution; they cannot distinguish one gamma ray energy from another, except over broad energy ranges, so they have very limited ability to characterize the source of those gamma rays. The PVT detectors in the RPMs at most ports of entry have been equipped with crude energy resolution in the form of energy windowing: The gamma-ray events are binned into four large energy windows. Although these energy windows are too broad for isotope identification, the ratios of the counts in different windows and to background levels in the same window help to identify the presence of radiation sources that require further examination.[29] The RPMs are also equipped with moderated helium-3 neutron detectors. The RPMs alarm if the container occupancy causes the RPM to exceed a gross gamma-ray counting threshold, exceed an allowed gamma-ray energy windowing ratio value, or exceed a gross counting threshold for neutrons.

The spectrometer currently in use in the secondary inspection is a handheld radioisotope identification device (RIID) which contains a small NaI detector.

At some ports of entry, the container may also be subjected to additional interrogation inspections such as imaging with an X-ray type machine (a radiography device with a gamma or X-ray source) to look for localized heavy metal objects (shielding or SNM), and direct examination of the cargo, including removal from the truck or shipping container. This or other suspicious results can trigger additional inspections.

The gamma ray alarm threshold (the count rate above which the alarm is triggered) is established for each port based on the threat guidance and a number of other factors.[30] Performance of the RPMs relative to the threat guidance is tested by measurements using standard sources that are not special nuclear material, but have gamma-ray signatures that are similar to that of plutonium or uranium, and so can serve as surrogates. CBP has said that the threshold is selected to balance the needs for sensitivity for commerce to flow. Although most RPM gross-gamma-count thresholds are set to meet a particular guidance level, a fraction of them are set to a different level. Using the energy windowing mentioned above, PNNL reports that *all* of the RPMs can detect a plutonium surrogate source that is lower than the guidance activity (i.e., the RPM is more sensitive than the plutonium guidance).

NEXT GENERATION RADIATION DETECTION TECHNOLOGIES: ASPs

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[29] All deployed SAIC RPM8 PVT systems have energy windowing algorithms that use four energy windows. CBP also has some Ludlum RPMs that only have two windows and hence 1 ratio on which to alarm.

[30] The threat guidance, which is classified, was established by the Department of Energy in a 2003 letter to Parney Albright, assistant secretary of homeland security for science and technology.

The goal of DHS in replacing the PVT RPM systems with the ASP technology is to address three perceived needs (Test and Evaluation Master Plan, August 2008):

- "To improve the detection of nuclear weapons and radiological/nuclear threat sources
- To reduce the burden associated with unnecessary inspection of conveyances with only naturally-occurring radioactive material (NORM)
- To improve the consistency and accuracy of the identification of nuclear weapons and radiological/nuclear threat sources"

Specifically, the ASP performance specifications called for systems that can detect and identify SNM, weapon-indicating radionuclides, NORM, medical radionuclides, and industrial radionuclides alone and in combination. According to DHS, the portal detection systems should respond consistently and predictably, and should assist CBP personnel in determining whether to release a conveyance or to detain it per the agency's standard operating procedure or concept of operations (CONOPS, from the Performance Specifications July 2007). The ASP systems are expected to detect and identify these threat materials when surrounded by "engineered shielding or masking and/or significant amounts of cargo." Improved RPMs, such as ASPs, should tolerate a wide range of conditions including variations in natural background radiation, environmental stress and weather conditions, and should be able to accommodate low- and high-volume traffic areas.

Benign sources of radiation in normal commerce (such as medical radionuclides) would not need to be sent to secondary inspection if they could be identified in the primary inspection. The ASPs were developed to provide both detection and identification of radiation sources in cargo containers. The portals use NaI or HPGe detectors, which provide greater differentiation in the detector response to gamma rays of different energies than PVT. With suitable software to analyze the gamma-ray spectrum, the source of the gamma rays can, in principle, be identified. At the time that the committee prepared this report, the HPGe ASP had not met requirements to undergo full testing by CBP and DNDO,[31] so the committee's report focuses on the NaI systems.

There are reasons to believe that the ASP could perform the functions now being performed in both primary and secondary screening, in most cases. A confident identification of NORM in primary screening would significantly reduce the number of referrals to secondary screening. For cases in which primary screening determines that the cargo is suspect, an ASP could be used also in a secondary screening with the container moving at a lower speed to obtain greater statistical accuracy and hence more effective identification. CBP is also considering a hybrid deployment, with some ASPs deployed primarily in high traffic ports, and retaining PVTs in other, lower-traffic ports, and using ASPs for secondary screening at all ports.

The ASP has advantages over the combination of a PVT portal and RIID detector in secondary inspections. The detection and identification feature of the ASP is enhanced by the slower speed in secondary as compared to the primary. The ASP is larger than the RIID and therefore can collect comparable or better statistical spectral data (e.g., higher counts and hence lower relative statistical variation), and the ASP has better identification software. The ASP

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[31] As noted above, gamma-ray energy resolution in a HPGe detector is far superior to that in a NaI detector, but the cost of HPGe crystals is much higher than sodium iodide crystals. The cost and the difficulty of growing large HPGe crystals resulted in the HPGe ASP having a much smaller detector volume than the others. A smaller detector requires more time being exposed to get a statistically useful number of counts (detection events). Consequently the HPGe ASP could not meet the requirement to screen cargo containers passing at the speeds required in the systems specifications. Because it could not meet these criteria, the contract with the vendor of the HPGe ASP was not extended. A change in CONOPs to allow for longer exposure times could enable the HPGe detectors to operate in secondary screening, but performance with different CONOPs has not been evaluated in the DNDO program.

localization of the source is better than that of the RIID because the ASP uses data from a continuous screening and can analyze time-slices of data. The larger detector has much better coverage of the cargo container. Most containers will spend less time in secondary inspection with an ASP because the slow-speed scan will confirm the presence of radiation sources that are only NORM, so that the manual (hand-held detector) survey would not be necessary unless the container is unloaded and a RIID would be used to investigate specific packages in the container.

The ASPs are required to identify as well as to detect the radioactive material. As a result, assessment of the performance of the instrument is not limited to the sensitivity of the detectors, but also includes determining the level of confidence in the threat identification algorithm for each system. Although there is evidence that the spectral analysis programs work remarkably well under challenging circumstances, the two vendors' algorithms appear to yield somewhat different results, and it is not clear at this point that either is optimal.

3

Testing and Analyses of the ASP and PVT/RIID Systems

The committee was asked to evaluate the adequacy of past testing and analyses of the advanced spectroscopic portal (ASP) systems performed by the Department of Homeland Security's (DHS's) Domestic Nuclear Detection Office (DNDO), and the scientific rigor and robustness of DNDO's testing and analysis approach. The Joint Explanatory Statement from Congress states that the intent of the Secretary of Homeland Security's consultation with the National Academies is to "bring robustness and scientific rigor to the procurement process." As noted at the beginning of this report, when the committee ended its information gathering for this interim report in mid-January, the testing and analyses were incomplete and DNDO had not provided written reports describing test results. No one on the study committee observed ASP tests before the committee was formed in May 2008. This chapter is based on the committee's observations in visits to ports of entry and test sites, reports of testing done before 2008 and documented plans for 2008 tests, observations of performance tests conducted in 2008 at the Nevada Test Site, and a briefing (October 8, 2008) on preliminary results from performance tests done in 2008.

The Government Accountability Office (GAO), DHS's Independent Review Team (IRT), and Congress already have reviewed and criticized pre-2008 testing of ASPs and PVT/RIIDs. The criticism resulted in the requirement for additional testing to support a decision about procurement of ASPs. Another factor that led to the requirement for DNDO to revisit testing in 2008 is that Customs and Border Protection (CBP) was dissatisfied with the ASP systems' reliability and compatibility with other CBP systems. Systems qualification testing, and particularly systems integration testing, were more rigorous and demanding in 2008. These tests took much longer than expected and only one vendor had successfully completed systems integration testing, as of January 2009.

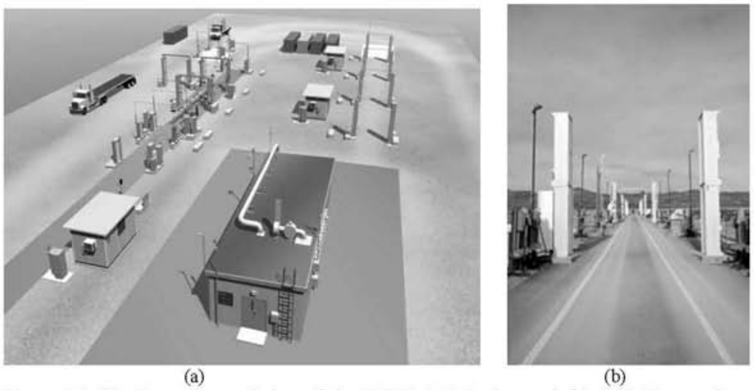
DNDO, CBP, and their contractors have conducted many tests over the last three years. A list of the major tests conducted on the ASPs and RPMs can be found in Table 3.1. DNDO has a complex set of criteria to evaluate. The characterization of a system is a process, and no one set of tests is expected to describe thoroughly all variables. Indeed, the scientific method describes a cycle of hypothesis and experimentation, which when applied to instrument development, allows for an iterative process of identification and mitigation of weaknesses. How the tests could be better crafted to carry out this process is described in detail later in this chapter.

The process for testing radiation portal monitor systems, such as the ASP systems, begins at the component level and progresses to the subsystem and system level. Initial testing is conducted with components and subsystems in the laboratory, such as functional and environmental testing of individual detector elements, graduating to larger subsystems and full systems in systems qualification testing. The last of these is done at Pacific Northwest Laboratory. Overall systems performance is measured with live radiation sources and a simulated port of entry at the Nevada Test Site (NTS, see Figure 3.1), and field validation testing is conducted outdoors at U.S. ports of entry with representative container cargo loadings.

Table 3.1 Tests and Key Questions

Tests	Description	Objective	Key Questions
NYCT Tests	ASP and PVT portals were installed in primary and secondary screening sites. The data collected were used for modeling and injection studies.	To collect data (spectra) on stream of commerce cargo containers to feed into injection studies	What does radiation in the stream of commerce look like? What is the range and variation in radiation emitted by typical cargo?
Special ("Blind" or "Demo") Testing	Set of 12 "relatively blind" test configurations. Tests performed at NTS. Anticipated results were compared to results given to the operator. When available, underlying data (raw spectra) were evaluated by third party isotope identification algorithm. These results were compared to operator results. Statistical analysis was performed by NIST to determine how special test results compared to standard test results.	To assess vulnerabilities in the performance test plan. To evaluate the possibility that bias had been introduced into the test results by vendors or the test team. To provide additional data to the vendors for system development.	Has bias been introduced into the ASP test results by either vendors or the test team? Does the test plan contain enough of a diversity of sources and test configurations?
Phase 3 Tests	Tests performed at NTS with various sources and attenuating materials in cargo containers moving at different speeds.	To aid in development of secondary screening operations and procedures.	How do known areas for improvement affect the performance of ASPs, and what can be done to address them?
Environmental Product Qualification Testing	Tests took place at the vendor's facility and at a National Recognized Test Laboratory and witnessed by government representatives.	Verify that the system can function within the environment, including weather and climate, in which the system will be operated and maintained.	Are all components of the ASP system durable enough to withstand the climate and environmental stresses at ports of entry (POEs) across the country?
Systems Qualification Tests	A series of tests designed by the vendors and approved by DNDO to assure that the system requirements of the performance specification have been met. Tests took place at the vendor's facility and PNNL's 331G facility and were witnessed by government representatives.	Verify technical achievement of the system requirements as described in the Performance Specification for ASPs	Have the basic system requirements been met? Is the system ready to enter performance testing? Is the ASP system suitable and deployable within the existing nuclear detection architecture?
Performance Tests at NTS	Cargo containers loaded with varying configurations of shielding material, masking material, threat objects, and surrogate sources are run on a roadway flanked by the	Evaluate system performance and collect data to support operational test and evaluation. - Compare ASP system performance with that of the PVT and RIID	How do the ASP systems perform relative to the current generation of detection and identification systems? What are the thresholds for detection of threat materials?

	PVT and ASP detectors in sequence. Secondary RIID screening is carried out in the staging area	systems. - Characterize the effect of shielding and masking on ASP and RIID performance against threat objects and NORM - Collect data to support verification of system requirements Collect data in support of operational testing and evaluation requirements	How do the systems perform with threat sources in the presence of masking and attenuating material?
Integration Tests	Tests conducted by DNDO at PNNL's 331G test facility. Test systems were placed in a simulated port of entry environment and evaluated for compatibility with CBP standard operating procedures (SOP) and other equipment, such as gate arms and traffic lights. Both hardware and software were evaluated.	Demonstrate that the ASP systems are ready to be integrated into the interdiction systems at U.S. POEs for field validation in primary and secondary configurations	Do the ASP systems meet the necessary integration requirements associated with their deployment, and are they suitable for operator use?
Field Validation Test	Test conducted at ports of entry. Conducted by CBP with ASP systems in place screening the stream of commerce trucks. PNNL will draft the final report.	- Perform system installation procedures and process - Train officers in the use of the system - Familiarize officers with operations of ASP systems with PVT systems - Conduct operations with ASP alone	Does the ASP system fit readily into the existing POE RPM sites? Are they suitable for operator use? Is the ASP system interoperable with users/stakeholders to execute the nuclear detection and reporting mission?
Operational Test	ASP systems will be placed at a POE in both primary and secondary locations in conjunction with PVT monitors to screen stream of commerce cargo containers. The systems will be operated by CPB officers using standard operating procedures. A survey of CBP personnel will also occur.	Validate the operational effectiveness and suitability of ASP at ports of entry under realistic operating conditions	How effective is the ASP system in terms of time to conduct screening, number of referrals to secondary screening, involvement of LSS, and reliability, availability, and maintenance of the system? Have CBP personnel identified any concerns or limitations of the system? Is the ASP system interoperable with users/stakeholders to execute the nuclear detection and reporting mission? Is the ASP system suitable and deployable within the existing nuclear detection architecture?



(a) (b)

Figure 3.1 (a) Computer rendering of the PNNL 331-G site; and (b) ASP Test track at the Nevada Test Site.

Because certain masking or shielding materials can interfere with the ability of the warning system to detect or identify objects containing special nuclear material (SNM), tests are also conducted at NTS with such masking or shielding materials and SNM. Fully integrated operational tests follow the field validation tests and also are conducted outdoors at selected U.S. ports of entry.

The committee has focused much of its attention on performance testing. This is not because the other tests are unimportant: Regardless of the performance, the portals will be of little use if they cannot operate in real conditions (rain for example) or if they are incompatible with CBP's computer systems. However, the design, execution, and evaluation of these tests are comparatively routine, even if solutions to problems revealed by the tests are not. The design, execution, and evaluation of performance tests for the portals is more challenging and involves more of the science and engineering principles on which the committee has advice to offer.

Some types of testing for ASPs are constrained in ways that testing of many Department of Defense procurement subjects (for example) are not. The main restrictions arise from the DOE security regulations for SNM and health and safety requirements. These requirements result in the need to separate the testing venues to meet the security needs and not impact health, safety, and commerce at operational ports. While it was hoped that later testing would address the criticisms of the earlier testing, DHS still has to operate under the limitations and constraints of security required for SNM and minimal impact to the flow of commerce. Furthermore, it is neither possible nor desirable to test every possible combination of cargoes and configurations. Physical testing with radiation sources, especially special nuclear material, is expensive and time consuming, and procurement decisions must be made in a timely fashion. For all of these reasons, the tests need to be designed strategically to answer questions about performance across the vast space of possible cargo and threat objects, rather than testing that space comprehensively through gross effort.

As a general principle, the goals of testing and criteria for evaluation need to be clear and testable for a test and evaluation program to be effective. In some past testing, the goals and criteria were not clear, or they shifted with time. This is one factor that led to test designs the results of which did not adequately answer key questions about performance. Furthermore, to be useful, the goals and criteria need to be relevant. In this case, relevance means that the tests need to reflect conditions in real world cargo, real environments, and the actual operation of detectors in the field. DNDO did base some of its test design on data collected on the stream of commerce using a PVT system and an ASP system at NYCT. Much more information relevant to test design could have been elicited from data collected on alarms, correlated to shipping manifests at ports of entry around the country, even without ASP data.

One set of goals has been articulated following Congress' language that requires that the ASPs demonstrate "a significant increase in operational effectiveness." DHS was responsible for defining these terms and in July 2008 issued the definition, found in Sidebar 3.1. The criteria in the definition pertain to detection, identification, referrals from primary screening to secondary screening, and speed of screening.

SIDEBAR 3.1 DHS definition of Significant Increase in Operational Effectiveness of the ASP-C

Criteria for Significant Increase in Operational Effectiveness [SIOE] of the ASP-C when deployed for:
Primary Screening

If ASP-C satisfies all of the following four criteria for primary screening, then a SIOE has been demonstrated, independent of whether the criteria for deployment to secondary screening have been satisfied. These enhancements would increase CBP's capability to interdict SNM as well as reduce the volume of traffic requiring secondary screening.

1. When Special Nuclear Material [SNM] is present in cargo without NORM, the probability of a correct operational outcome for the ASP-C must be equal to or greater than[a] the PVT RPM.
2. When SNM is present in cargo with NORM, the ASP-C in primary must increase the probability of a correct operational outcome compared to the current end-to-end system as defined above.
3. When licensable medical or industrial isotopes are present in cargo, the probability of a correct operational outcome for the ASP-C must be equal to or greater than the PVT RPM.
4. When the only radioactive source present in the cargo is NORM, the ASP-C must refer at least 80% fewer conveyances for further inspection than the PVT RPM.

Criteria for Significant Increase in Operational Effectiveness of the ASP-C when deployed for
Secondary Screening

If ASP-C satisfies both of the following criteria for secondary screening, then a SIOE has been demonstrated, independent of whether the criteria for deployment to primary have been satisfied. These enhancements would increase CBP's capability to interdict SNM while more consistently and expeditiously executing secondary screening operations.

1. When compared to the handheld Radioactive Isotope Identification Device (RIID), ASP-C must reduce, by at least a factor of two, the probability that SNM is misidentified as NORM, a medical/industrial radionuclide, unknown, or no source at all.
2. When compared to the handheld RIID, the ASP-C must reduce the average time required to correctly release conveyances from secondary screening.

[a] For HEU, ASP-C must show improved performance compared to PVT RPMs at operational thresholds.

SOURCE: Oxford et al. (2008)

PAST TESTING

FINDING

Performance tests prior to 2008 had serious flaws that were identified by the Government Accountability Office and the Secretary's ASP Independent Review Team. Tests prior to 2008 did not adequately establish the full capabilities of the ASP systems compared with the currently deployed PVT and RIID screening systems, nor whether the ASP systems met criteria for procurement.

This finding is based on several factors, which are discussed in some detail below. In briefings to the committee in 2008, DNDO staff agreed with several of the criticisms of its prior tests and stated that its 2008 tests were designed to address those deficiencies. The 2008 testing approach is described in the next section.

The GAO in 2007 stated that DNDO used biased test methods that enhanced the performance of the ASPs; DNDO's NTS tests were not designed to test the limitations of the ASPs' detection capabilities; and DNDO did not objectively test the performance of handheld detectors because they did not use a critical CBP standard operating procedure that is fundamental to this equipment's performance in the field (GAO 2007b). Specifically, GAO wrote "DNDO conducted numerous preliminary runs of almost all of the materials, and combinations of materials, that were used in the formal tests and then allowed ASP contractors to collect test data and adjust their systems to identify these materials."

With respect to bias, the IRT(2008) stated:

> However the IRT's assessment is that the system's configurations were locked and the test results were derived from automated systems that had not been modified to benefit from the reduced set of possible outcomes. Operators were given no advance guidance on the sequence in which threat objects were presented. In short, the IRT did not find any evidence to support the notion that the NTS test procedure resulted in the manipulation or biasing of test results, nor does the committee believe that the NTS data needs to be discarded on the basis of this issue. [Page 91.]

The committee did not independently verify these facts (e.g., that the configurations in 2007 were locked). The committee's understanding of the operational use of the ASP and PVT is that the systems provide alarm outputs based on programmed algorithms, not on operator decisions, so no intentional real-time biasing of results by test operators was possible during the tests. However, DNDO utilized the same sources, masking material, attenuating material, and configurations in performance testing that were used in the set up for testing (dry runs and dress rehearsals). If the vendors were allowed to calibrate their equipment and adjust their algorithms using the test threat objects, then the equipment could more easily recognize the spectra. The numbers of sources available were small, but this is not sufficient reason to use the same sources for both set up and testing. Device setup and any calibration must use separate sources from those used for testing.

In contrast with the ASP, the RIID requires much more operator interaction. DNDO performance tests prior to 2008 did not follow all of the relevant standard operating procedures for use of the RIIDs. According to the test plan (DNDO test plan) and briefings to the committee, this error was corrected in the 2008 performance tests. Regarding those procedures, the committee observed in visits to ports of entry that the operator actions with RIID and Laboratories and Scientific Services (LSS) are inconsistent, which could affect results, and would even permit bias—either a positive or a negative bias—for comparing PVT/RIID and ASP in secondary, although the committee observed no operator bias. Based upon observations at operational ports and during the testing at NTS in 2008, even under the best circumstances (ideal technical performance by the RIID), the effective use of the RIID depends on the actions of the operator and decisions on the spot, which may not be consistent. The committee observed variations in procedure, from one inspection to another, even with the same operator. The committee therefore concludes that the RIID is susceptible to ineffective use.

The committee agrees that pre-2008 tests did not examine the limitations of the ASP's detection capabilities. If all of the results from a particular test are either positive (able to detect) or negative (unable to detect), the examiner does not know how close the detector is to the transition between positive and negative. The transition can be quite steep, and can be affected by other factors that are not controlled in an operational environment. Furthermore, it is useful to identify cases in which the ability to detect is poor both because it could help to provide guidance on how to improve the system and because there is good reason to believe that smugglers will choose smuggling strategies that result in poorer detection. A good physical test of the capabilities and performance of a detector system maps the output of the system (the result) as one parameter, such as the shielding, is increased stepwise and the detector transitions from being able to detect to not being able to detect the radiation of interest. For example, according to the IRT review (IRT 2008), the average NORM used in the 2007 NTS tests was comparable to the average NORM in cargo observed at NYCT. But a small percentage of cargo observed at NYCT had much higher levels, which may be sufficient to mask at least some of the threat objects identified by DOE and DNDO.

SCIENTIFIC RIGOR AND ROBUSTNESS OF DNDO'S 2008 TESTING AND ANALYSIS APPROACH

FINDING

The 2008 performance tests were an improvement over previous tests. DNDO physically tested some of the limits of the systems. However, the following shortcomings remain. (1) Without modeling to complement the physical experiments, the selected test configurations are too limited; (2) the sample sizes are small and limit the confidence that can be placed in comparisons among the results; and (3) in its analysis, some of the performance metrics are not the correct ones for comparing operational performance of screening systems.

Many of the flaws in past testing were addressed in 2008 tests. For example, in 2008 performance tests, real CBP officers conducted the RIID screening of containers referred to secondary screening, and DNDO included LSS analysis in evaluating the outcomes of those screens. The threat objects (highly enriched uranium and plutonium sources) used in 2008 tests had not been used in any previous tests or calibrations, which addressed another criticism of the 2007 NTS tests. Also, more challenging masking material was used for some cases. Appendix D lists the combinations of threat objects, shielding material, and masking material, and their configurations used in the 2008 performance tests.

However, even with these improvements, shortcomings remain. These include structural problems with the testing.

Without modeling to complement the physical experiments, the selected test configurations are too limited

DNDO was limited by time and resources in what could be evaluated. For example, the number and type of threat objects available to the testers through NTS and the Device Assembly Facility (DAF) was small, and only one was the same mass and shape as the objects described in the threat guidance.[32] DNDO and its supporting scientists adapted to the lack of a threat source that corresponds to the guidance threat by using computer simulations to model the sources and determine what mass of threat material in a standard shape would emit equivalent radiation. The number and type of sources tested cannot be considered "canonical," i.e., they do not comprise a "complete set" from which any possible source in a cargo container can be constructed. Although a complete set is not practical or feasible, in the context of modeling described below it is likely that a useful subset that spans the space of possible threats can be identified.

Because the number of possible permutations of cargo material is very large, loading and unloading the shipping containers during the tests to cover all possible shielding and masking variants is impossible, and the fact that the test sources are only available at NTS precluded the assessment of background effects at multiple sites. In light of these limitations, the tests were designed to evaluate the response of the detectors to containers with different configurations: empty, a radiation source without additional shielding, a radiation source with shielding, and a radiation source with masking material. The test design takes advantage of factorial design, which allows for multiple factors to be tested and evaluated at one time, and is considered a sound method of experimental design to obtain much information in a limited number of test runs (see Appendix C).[33] However, while the test design is reasonable as far as it goes, the tests performed are not adequate to fully characterize the instruments nor to predict their performance when monitoring the stream of commerce.

In part to address this problem, DNDO engaged scientists at Pacific Northwest National Laboratory, Sandia National Laboratories, the Johns Hopkins Applied Physics Laboratory, and Los Alamos National Laboratory to carry out "injection studies." These are virtual tests in which the gamma spectra of additional test sources, which were experimentally recorded at the national labs under controlled circumstances, are added to ("injected into") spectra of cargo in the stream of commerce collected by ASPs during the 2007 New York Container Terminal test. These combined spectra were then used to challenge the threat identification algorithms of the ASPs. For example, of the 22 radiological and industrial isotopes of concern to DNDO, 13 were acquired for testing, and nine were considered impractical or unnecessary to obtain for physical testing. The response of the detectors to these nine radioisotopes is assessed by "an inspection of the threat algorithm" alone. (Description of Medical and Industrial Radionuclides in version 4.10 of the ASP-C Performance Specification April, 2008)

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[32] The committee was told that DNDO selected among the few SNM sources available from the DAF.

[33] Practical constraints on the performance testing prevented DNDO from conducting random trials. In other words, the same threat object and configuration was passed through the portals repetitively in a linear sequence. Such a testing approach is unlikely to detect some kinds of systematic errors, although the committee could not identify credible, significant systematic errors that would be missed. Randomness is important because the usual methods for assigning uncertainties to the results assume random trials and do not account for possible systematic effects. However, there are good reasons why these tests could not be random and the committee was unable to identify a significant consequence of the non-random tests.

This type of testing is appropriate, and calculations of this kind seem to have helped DNDO address the problems from 2007, when the performance tests did not chart the performance across detection thresholds. The preliminary 2008 test results that the committee has seen suggest that the tests found the transition ranges from undetectable to detectable. The committee concludes, however, that DNDO should go beyond the existing tests and model a set of test sources that represents the spectrum of possible sources and compare the results of the studies to the physical data acquired during testing to identify flaws in the modeling and algorithms.

For baseline information, DNDO needs to characterize the performance of the ASP and PVT detection systems for the cases of highly enriched uranium, plutonium, uranium-238, with and without NORM, and shielding, as well as NORM without threat material. In addition, DNDO needs characterization data for the background spectra for non-radioactive containers at both NTS and one or more of the representative ports. These data will provide basic detector characterization information, which will assist in the development and assessment of computerized system models.

The committee recognizes that the security and health and safety restrictions for using SNM in tests preclude doing realistic tests at operational ports of entry and that some calculational bridge is needed to explore a detection system's capability. At the time of this interim report the committee had not received a full description of the "Injection Studies," but the briefing the committee received indicates that they were done by adding experimental threat-object spectra to data collected on actual commerce traffic with NORM present and using the algorithms to see what the detection probability would be for the superposed spectra. The committee would like to see this approach extended to a more robust modeling approach that uses simulations of the radiation source, radiation transport through the material in the container and to the detector, and the response of the detector to generate the spectrum. These simulations need experimental validation and so should be compared to the performance data collected at NTS. If they do not agree within statistical uncertainties, then the reasons for disagreement should be examined and corrected. When broad agreement has been obtained, then examples of observed NORM and medical and industrial radiation sources can be integrated in a model with threat material to explore the capabilities of the ASPs and PVTs against a much larger, more multidimensional threat space.

These new simulations are distinct from the isotope identification step. DNDO has required that the detector systems record data in a standard format, which represents the gamma spectrum. The isotope identification software algorithm analyzes the spectrum in that data file. Any isotope identification software should be able to analyze the spectrum from any detector and from any simulations. There are other important elements of the software, such as reading the occupancy sensor and operating the gate arms. Those pertain to integration with the physical system, but the isotope identification module is the essential piece for performance of the system and is separable from the rest of the system (see Figure 3.2).

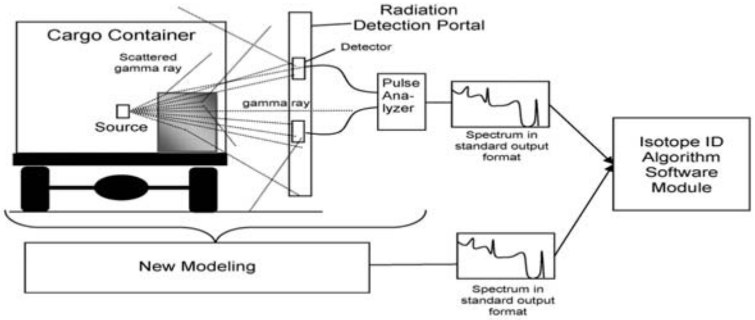

Figure 3.2 Illustration of the physical system that generates a detected gamma ray spectrum (top) and the suggested new modeling to simulate the same process and generate a spectrum (bottom). Note: This drawing is not to scale and does not show all of the elements or components of the detector system.

To overcome the inherent limitations of physical testing, modeling of the ASP systems responses would be invaluable to the DNDO testing and analysis. With these models, many test geometries could be evaluated and the selected results compared to the actual physical tests to verify the modeling. Modeling can help to identify configurations for physical testing, and the physical tests can be used to validate the models. Accurate modeling could help identify the limitations inherent to the technology and the detectors and can assist in the development of new technology over time.

In the current round of testing, the effects of shielding and masking were assessed separately. While this allows for characterization of instrument response when faced with each scenario, it does not reflect a realistic scenario in which both masking and shielding material could be used to conceal radioactive material. The effects of the two types of concealment are not simply additive, and a combination of the two should be investigated. The number of test configurations that can be tested physically is finite. Loading and unloading of containers with shielding and masking material is time-consuming, and time spent on testing is costly.

Here again is a case where a thorough modeling of the well-characterized spectral response of the ASP systems would be beneficial in assessing a wider range of scenarios for concealment of radioactive material. Data from the shielded-only, masked-only, and shielded + masked sources would enable DNDO to assess the validity of the simulations and their ability to accurately reflect detector performance capabilities. Using modeling calculations with the vendors' algorithms, test scientists can determine configurations of shielding and masking that would likely result in detection and identification in primary and identification in secondary with a probability of 50 percent. This would enable DNDO to identify the critical portion of the performance curve, that is the transition from correct to incorrect results from the ASP system and to confirm these calculations by measurements at NTS. The probability of each outcome can be tested at the NTS to confirm the accuracy of the models for select cases and either cause a re-evaluation of the models or build confidence.

The subset of configurations for physical testing to validate models would be chosen to test the cases where the expected results, based on simulations, are most sensitive (transition regions). In other words, the simulations would be used to predict the configurations that are in the detectors' performance transition (from high-confidence detection to low- or no-confidence detection), and the physical tests would be run to test that hypothesis. Each set of physical tests would be used to validate the performance of the models in different regions of the test space. Tests that DNDO has already done (including the pre-2008 tests, which used a wider range of source materials) could be used in this effort, despite their shortcomings as performance tests.

Performance testing takes place only at NTS, and DHS's operational testing of the ASPs is planned to take place at only one location: The Port of Long Beach. The committee believes that it is important to evaluate the effects of a variation in background intensity and spectra because significant variations are expected among the ports of entry across the United States. Computer modeling would be able to assist in the identification of limits of the algorithms' ability to differentiate threat materials from the background radiation.

There are many factors that can affect a radiation detector's capability, but it is not possible to test all of the possible variations to threat material configurations, background, shielding, and masking within the stream-of-commerce at all ports of entry. The current round of physical testing does not reflect realistic scenarios well, although it does provide important information about the response of the detectors to specific, controlled cases. A thorough consideration of the methods of concealment of nuclear and radiological material that could reasonably be expected from an adversary would better characterize the performance of ASPs for the cargo-screening mission. The models could better cover the full test space of scenarios that need to be evaluated, a goal that cannot be attained practically by physical testing alone.

The sample sizes were small and limit the confidence that can be placed in comparisons among the results

The time and resource constraints mentioned above limited the number of runs for each configuration (the sample size) severely: as few as 6 and as many as 12. With such small sample sizes, the uncertainties associated with the results are relatively large. This is mostly a concern in the performance transition range for the detectors (where the detection probability is neither 1 nor 0). The number of runs (sample size) for each configuration needs to be large enough that the uncertainties (error bars) are small enough for reasonable comparisons to be made to each other and to results of simulations. The size of the sample needed can depend on the results of the tests.

In its analysis, some of the performance metrics are not the correct ones for comparing operational performance of screening systems.

Test system performance usually is characterized in terms of detection probabilities, measuring the probability that the test system alarms (the test result is positive), given that the screened cargo truly contains threat material, or that it does not alarm (the test result is negative), given that the screened cargo does not contain threat material. Because measurement of the detection probabilities relies on true knowledge of the cargo contents, one can estimate those probabilities only from a designed experiment.

In real life, however, with real trucks, one observes only the result (alarm status) of the screening system. Either the system alarms or it does not, but one does not know the true state of the cargo. The result of an accurate system ("alarm" or "no alarm") would be a reliable indicator of the cargo contents (SNM or no SNM), but an inaccurate system would be an unreliable indicator. One is concerned especially with this question: Given that the test system did not alarm, what is the probability that the cargo contained SNM? That is, what risk does CBP take by allowing a "no-alarm" cargo to pass? This "false-negative rate" (FNR) has serious consequences. But translating from the measured probabilities to the false-negative rate and the false positive rate requires some mathematical manipulation and introduction of an additional parameter: the prevalence of threat material in cargo. Given that this parameter is neither known nor measurable, comparisons between the performance of two screening systems can best be measured by using ratios between the rates for the systems being compared. Such a metric will more accurately reflect the relative performance of the screening systems. This issue is described in detail in Appendix B.

Performance Testing Results and Evaluation

FINDING

Because they have large detectors and because of their configuration, ASPs would be expected to improve isotope identification, and provide greater consistency in screening each container, greater coverage of each container, and increased speed of screening over that of the PVT/RIID combination when used in secondary screening. Consequently, tests of ASPs in secondary screening are focused on confirming and quantifying that advantage for a variety of threat objects, cargos, and configurations.

The greater consistency, better coverage, and increased speed of secondary screening are the results of the configuration of the ASP systems. The ASPs have larger sodium iodide crystals than the RIIDs. That size results in higher gamma count rates than in a handheld RIID examining the same source, which compensates for the greater standoff distance and the shorter exposure time for the ASP. The ASPs have better coverage of the containers. The consistency of ASP screening depends on the speed of the truck through the portal. As noted elsewhere in this report, different CBP officers using the handheld RIID place it differently. Preliminary results from 2008 tests confirmed that this is true for the tested cases, but the physical tests could not demonstrate that ASPs are superior to the screening system currently in place over the whole operational envelope.

As noted above, when used for primary screening, an ASP system should be compared to the existing combined primary and secondary screening system (both PVT and RIID) because of differences in standard operating procedures for primary screening. DNDO's preliminary analysis appears to have accounted for this difference.

It is not clear to the committee how DNDO will interpret the performance test results in the context of the criteria for "significant increase in operational effectiveness. Each tested configuration is distinct, and averaging across configurations is not meaningful without applying normalization or weighting factors. DNDO could use the NYCT data as weighting factors, although there are two challenges associated with this approach: (1) the relevant features are multidimensional (gamma flux, radionuclides in cargo, density of attenuating material, composition of attenuating material) and (2) NYCT data reflect cargo passing through one large port at the time of the data collection, and cargo is different in different ports of entry and changes with time. Even if these challenges are addressed weighting factors may only be valid for evaluating likely referral rates, not performance against threat objects in containers in commerce. The configurations could be weighted according to their frequency in the actual stream of commerce (if that could be determined). However, there is no reason to think that malefactors will choose the configuration of a cargo container for smuggling a nuclear weapon randomly from configurations in the stream of commerce.

Finally, as noted above, there are large uncertainties in the results of these tests. The numbers of conveyances for each source were small and the uncertainty associated with a small sample is large. The costs of conducting larger sample tests with the same number of configurations may have been prohibitive, which simply highlights the need to select the physical test configurations carefully to maximize the information gained from those tests.

Operational Testing

The current plans call for operational testing of the ASP systems that is of short duration and limited breadth. ASP systems will be installed at only one site for three weeks. This limited testing and subsequent analysis does not allow DNDO to take full advantage of the opportunity to collect information about real-world stream-of-commerce effects on detector performance. While Pier A at the Port of Long Beach, the location for the test, does have a high volume of cargo traffic, it is a location where the weather generally does not vary a great deal, and the type of container coming through the terminal is predictable and not representative of all ports of entry (POEs). By limiting operational testing to the environment and the cargo mix at a single site, the curtailed field test is missing a prime opportunity to assess detector performance in the real world.

Operational testing is designed to determine if the system is effective and fully useful in field, operational settings and when operated by regular users, not just in a laboratory or test setting. Operational test and evaluation means the field test, under realistic operational conditions, of any equipment item or system intended for use by typical DHS users in defending the U.S. homeland; and the evaluation of the results of such tests. Realistic operational testing is intended to be independent from the contractor or developer of the system being tested, with the evaluation of the results also reported independently.

Realistic operational testing is intended to use production representative systems, operated by typical users who may not have the same training or expertise as the scientists and engineers who developed the system in the first place. To the extent possible, the system or equipment under test is to be operated under realistic stress and operational tempo, in an end-to-end manner, using the same procedures as would be expected in everyday use, in an operationally realistic environment, with the other interfacing systems with which the proposed system is to be interoperable on line. In the case of an RPM, the "threat" is to be as realistic as possible, including both the types of radioactive materials defined in the threat, and the naturally occurring radioactive materials that are found in routine commerce. If the system under test might be vulnerable to interferences, such as radio communications or other electromagnetic interference, those sources should be present in the test also. Finally, because it may not be practicable to conduct a statistically significant number of operational tests, the test challenges to the system are to be at the edges of the operating envelope and not only at the center of the operating envelope. Contractor involvement in these operational tests is to be strictly avoided to eliminate a possible source of bias, the effects of having a highly trained "golden crew" operating the system, and to gauge the effectiveness of the system when operated by expected users.

At the time that this Interim Report was written, the operational tests planned by DNDO had not been conducted, and the committee does not know whether the general guidelines for operational testing described above will be followed.

Changes to the DNDO Approach to Testing

RECOMMENDATION

For a more rigorous approach, DNDO should use theory and models of threat objects, radiation transport, and detector response to simulate performance, predicting outcomes, and use physical experiments to validate or critique the models' fidelity to reality and enable developers to refine the models iteratively. With validated models, DNDO can evaluate the performance of the ASP systems over a larger, more meaningful range of cases than is feasible with physical tests alone.

To make the testing and evaluation more scientifically rigorous, the committee recommends an iterative approach with modeling and physical testing complementing each other. As is noted earlier in the report, the threat space—that is, the set of possible threat objects, configurations, surrounding cargoes, and conditions of transport—is so large and multidimensional that DNDO needs an analytical basis for understanding the capabilities of detectors for screening cargo. DNDO's current approach is to physically test small portions of the threat space and to use other experimental data to interpolate within the threat space to test the identification algorithms in the detector systems.

Computer models are essential to the testing process: It is not feasible to examine all of the relevant permutations of cargo and threat materials with physical tests alone. Computer modeling can examine detector-system and algorithm behavior for a large number and breadth of cases with a relatively modest commitment of funds and time. However, the models need to be validated against results of physical tests that are carefully designed and selected to represent cases covering the test space (the full domain of configurations and compositions of cargo, masking material, shielding material, and threat objects). The injection studies that DHS and DOE have sponsored enable scientists to test the isotope identification algorithms, but the role of injection studies in the overall test plan is still very limited and does not establish an analytical basis for understanding the detector systems' capabilities, so a more full and more fully integrated approach to modeling and physical testing is needed.[34]

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[34] GAO describes a PNNL report that discusses the limitations of injection studies.

> According to a Pacific Northwest National Laboratory report submitted to DNDO in December 2006, injection studies are particularly useful for measuring the relative performance of algorithms, but their results should not be construed as a measure of (system) vulnerability. To assess the limits of portal monitors' capabilities, the Pacific Northwest National Laboratory report states that actual testing should be conducted using threat objects immersed in containers with various masking agents, shielding, and cargo. (GAO 2007b)

DHS and DOE are both deploying detectors that screen vehicles and cargo for nuclear and radiological material, and both have an interest in better understanding the capabilities of deployed and proposed detection systems. The committee recommends that DHS and DOE integrate the modeling and testing in a scientific, iterative approach: theory and models would be used to predict outcomes of tests; the test outcomes would then be used to validate or critique the models; and the models would be used to explore a variety of possible threats, the full range of which is very large and cannot be individually tested. This kind of interaction between computer models and physical tests is essential for building scientific confidence. DOE and its national laboratories have extensive experience with both detector development and iterative simulation and experimental validation of models, most prominently in the stockpile stewardship program. The performance tests conducted to date provide some validation points for modeling as well as some assessment of detection capability for parameters such as the effects of source, shielding, masking, speed, and background radiation level on ASP system performance. These existing results are a sensible starting point for validation, but large uncertainties remain in these parameters due to limited experimental conditions and small sample sizes.

For all of the reasons cited above about 2008 performance tests, DHS cannot conclude definitively whether ASPs will consistently outperform the current PVT-RIID systems in routine practice until the shortcomings are addressed. Better measurement and characterization are a necessary first step but may not be sufficient to enable DHS to conclude that the ASPs meet the criteria DHS has defined for achieving a "significant increase in operational effectiveness." The committee recommends modifications to the current DHS approach to the evaluation procedure. These modifications would influence subsequent procurement steps.

Recommended Approach to the ASP Procurement Process

RECOMMENDATION

DHS should develop a *process* for incremental deployment and continuous improvement, with experience leading to refinements in both technologies and operations over time, rather than a *single product purchase* to replace current screening technology.

In attempting to meet a procurement schedule, DNDO has approached the development of the ASP systems as a point goal rather than the beginning of a longer-term process of technological improvement. The DNDO approach limits the possibility of iterative improvements to the technology and could result in unnecessary constraints on the ability to deploy future nuclear detection systems that would have improved performance characteristics.

The committee agrees that injection studies and modeling cannot be seen as valid without physical tests with threat objects. Physical tests are needed for validation, as noted above, but they also can reveal engineering or manufacturing flaws. Modeling tells how a system should perform, assuming that the equipment as built matches the modeled detector, but confirmatory tests are needed with different units of the same equipment and under different conditions. The committee's recommendation above states that well validated models can and should be used in conjunction with well selected physical tests when it is impractical to do sufficiently comprehensive testing by physical tests alone.

The passive radiation screening of cargo at ports of entry is expected to operate for a long time. Although this capability may be enhanced with scanning or interrogation equipment,[35] Congress has directed CBP to deploy passive detectors as part of the screening procedures for cargo entering the United States. CBP has put RPMs in place at hundreds of ports of entry.

The threat environment, the composition of container cargo, technological and analytical capabilities, and the nature of commerce at the ports of entry have changed significantly over the last decade and are expected to evolve in both predictable and unpredictable ways in the coming years. Containerization changed the nature of shipping in recent decades. Patterns of flow in commerce continue to evolve as international trade changes, the world economy adjusts, and production shifts among different countries. Patterns of transport also shift in response to costs and incentives—for example, rail transport may increase relative to truck transport as pressures to reduce carbon emissions and other environmental impacts increase.

Rather than focusing on the single decision about the deployment of ASPs, the current testing should be viewed as a first step in a continuous process of improvement and adaptation of the systems. DHS should develop a process for continuous improvement able to address and exploit these changes, rather than a single product to replace current screening technology. This would enable the system to be updated continuously so that it is not outdated or obsolete by the time all of the systems are deployed.

RECOMMENDATION

DHS should deploy its currently unused low-rate initial production ASPs for primary and secondary inspection at various sites. This would allow extended operational testing with a small investment.

Such deployment, even on this limited scale, would provide additional data concerning their operation, reliability, and performance, and allow DHS to better assess their capabilities in multiple environments without investing in a much larger acquisition at the outset.

The committee has heard DNDO staff say that under current law such deployments are not permitted prior to certification. The committee did not examine this question and cannot offer a legal opinion, but the committee considers a phased deployment to be a sensible approach. The committee recommends that DNDO reexamine the perceived restrictions and, if DNDO concludes that such deployments are not permitted, ask for permission to go ahead with them.

RECOMMENDATION

DHS should match the best hardware to the best software (particularly the algorithms), drawing on tools developed for the competition and elsewhere, such as the national laboratories. This should be applied to ASPs and also to improved RIIDs.

The development of the hardware for radiation detection and the software for analyzing the signals from the detectors is separable. It has been useful to have a competitive approach for the systems and to see the results. However, as DHS moves forward, it should match the best hardware to the best software (particularly the algorithms). In doing so, DHS should draw on tools developed for the competition and elsewhere, such as the national laboratories.

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[35] Scanning is a process that actively irradiates the subject with x-rays or gamma rays to generate images of the interior of the container. Interrogation systems if deployed, would use pulsed neutrons or gamma rays to irradiate a container and would alarm on particular radiations from the irradiated cargo.

The NaI detectors used in the ASP are a mature technology but continued improvements in the detection and analysis algorithms can occur with research supported by DOE, DHS, and others. The vendors' algorithms are somewhat limited compared to algorithms developed at government expense. With data from the hardware in a standard format, it would be straightforward to later incorporate new and improved detection and analysis algorithms. Further, improved algorithms, or even current ASP algorithms, could be used to substantially improve the performance of handheld RIIDs.

ASPs will not eliminate the need for handheld detectors with spectroscopic capabilities. The greatest deficiency of the RIIDs currently in use is their software. Because some of the improvement in isotope identification offered by the ASPs over the RIIDs results from software improvements, the best software package should also be incorporated into improved handheld detectors. Newer RIIDs with better software might significantly improve their performance and expand the range and flexibility of deployment options available to CBP for cargo screening. If integration of improved software in hand-held devices is deemed impractical because of the computational limitations of a low-power, handheld device, the computational capabilities of a handheld device could be replaced or enhanced with a nearby desktop computer system that receives data from the handheld detector by wireless transmission. In 2006, DNDO rolled out a program to improve RIID software, called the Human Portable Radiation Detection System (HPRDS). However, the committee saw no evidence that this effort was linked to the ASP program or that potential improvements in the RIID were being considered in cost-benefit analyses (CBA). Linkage makes sense for the technology development, as noted above, and also for the CBA. If the HPRDS yields improved RIIDs in the next few years then the ASP performance tests will have compared the ASPs to outdated technology, which can lead to poor choices in cost-benefit tradeoffs.

By separating the software and hardware elements and engaging the broader science and engineering community,[36] DHS would have increased confidence in its procurement of the best product available with current technology, and simultaneously could advance the state of the art.

Correlation of Models and Simulations with Physical Test Results

In addition to operational testing to demonstrate the performance of the system under realistic conditions, one must develop faithful models and simulations to examine scenarios that may not have been attempted in the field. The process of validating these models and simulations will include predictions of systems performance under conditions that are well-defined and can be tested in the field. Only if the models and simulations actually predict observed performance under conditions that are amenable to testing (within statistical uncertainties) will DHS have confidence that the models and simulations might be dependable for describing other configurations. Even then, there may be some configurations which the models and simulations do not predict adequately. This would not be surprising. To minimize the number of potential non-conforming configurations in this set, physical testing needs to explore informative, challenging cases.

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[36] Even short of the innovation that might arise from broader scientific perspectives, better documentation and peer review of the algorithms would make it easier to compare the algorithms and to evaluate this critical part of the system.

The RPMs must be tested as a complete operational system (not just as components), and under conditions that reproduce a fully integrated installation under a range of conditions to demonstrate correlation between test results and models and simulations. Similarly, test objects must be selected to adequately represent the threat that the system is meant to address. If the threat is nuclear terrorism, then the test objects and configurations would include nuclear materials in the quantities, shapes, and intensities, along with shielding or masking materials designed to foil the RPM, such as might be expected from an inventive terrorist.

In addition to the improved understanding such testing affords, it can offer operational solutions to problems arising from the limitations of the detectors. If the threshold that would mask threat objects were known, then all cargo containers that are above that threshold could be referred to secondary screening and more thorough analysis. (As noted earlier in this chapter, DNDO revised its performance testing for 2008 to address this problem, and preliminary results suggest that the tests found the transition ranges.)

The committee believes that by approaching the test, evaluation, and future technology development as an iterative process, the limited deployment of the existing ASP systems could be a vital tool in improving the technology prior to blanket deployment at U.S. ports of entry. Distribution of the existing ASP systems to ports and border crossings in a variety of locations and environments (Port of LA/LB, NYCT, and Detroit for example), would provide information about the variables in the real-world system that could be fed back into models and could be used to develop future generations of the hardware, software, and analytical algorithms. At the very least, operational testing should be expanded to take advantage of some of these opportunities.

Other considerations

RECOMMENDATION

Scenarios identified by red-teaming efforts should be used in developing new models and physical tests of detection systems to learn ways of improving the technologies and their deployment.

DNDO already has a red-teaming capability that is applied to operations, and the test programs are already intended to identify systematically the detection capabilities of the ASP systems. Red teams suggested here as part of an on-going testing and development program could help DNDO (a) identify strategies that smugglers without detailed knowledge of the systems are more likely to try and what the adversaries' adaptation might look like; (b) identify new vulnerabilities that the new technologies and CONOPs introduce; and (c) identify what technological changes affect the effectiveness of the systems and their applications. Similarly, this approach is valuable in test design, ensuring that a realistic range of cases is examined and validating the testing protocols. The Special Tests (see Table 3.1) may have served some of this function, although they were designed for a slightly different purpose and appear not to have been as systematic as what one would expect from a red teaming effort.

As noted earlier in this report, DNDO, CBP, and DOE have similar and overlapping missions and needs for screening vehicles and cargo. They use and are considering procuring much of the same equipment. DNDO has consulted and cooperated with DOE on some aspects of the ASP development, but these efforts should be expanded. A wealth of experience dealing with algorithm development and archives of data relating to radioactive material and spectral analysis exists within the DOE national laboratories. A call to the labs and other agencies for a survey of past research and information, assistance, and collaboration could help DNDO tap into the expertise within those institutions.

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Cost-Benefit Analysis

A well-constructed cost-benefit analysis (CBA) is designed to provide insight about the effects of alternative decisions, whether the benefits of a given program exceed its costs, and which choices are most cost-effective. This provides a structure for analyzing whether a proposed action or program is reasonable and justified.

As part of the study task, the committee was asked to evaluate the Domestic Nuclear Detection Office's (DNDO's) CBA of the advanced spectroscopic portal (ASP) technology. As of February 2009, the committee had not seen DNDO's completed CBA, but was provided with briefings on the status of the CBA, most recently in October of 2008. At that point, much of the information in DNDO's CBA was described to the committee as still in draft form. There is no single definitive approach to doing analysis of such complex cost-risk tradeoffs. The committee has chosen to provide suggestions to guide DNDO in completing its CBA, with the understanding that DNDO's analysis will not be complete until after testing and technical evaluation are completed, in the hopes that they will help DNDO make the best case it can for each option, but recognizing that the result will still be subject to criticism.

In addition, the committee hopes that carrying out these analyses will lead DHS to reexamine assumptions, practices, and objectives to create a firm foundation for continuing to improve. For example, DHS ought to consider whether the version of the DOE guidance on threat quantities and configurations that DNDO is using is operationally realistic and relevant to the threat and the nature of commerce.

ASSESSING COSTS AND BENEFITS OF THE ASP PROGRAM

There could be two bases for saying that a decision to procure ASPs might meet cost-benefit criteria: (1) It might lead to a reduction in net dollar costs of procurement, deployment, and operation,[37] or (2) it might increase significantly the likelihood of detecting threat materials and increase the deterrent value of the systems at a reasonable cost. The preliminary analysis presented to the committee by DNDO suggests that the former (criterion 1) likely is not the case for ASP deployments.

FINDING

Because DNDO's preliminary estimates indicate that the cost increases from replacing the PVT/RIID combination with ASPs outweigh the cost reductions from operational efficiencies, it is important to consider carefully the conditions under which the benefits of deploying ASPs justify the program costs.

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[37] In standard accounting practices, costs that are assigned dollar values are associated with a relative time of expenditure for comparison and discounted appropriately to give net present value, or some other, similarly consistent discounting method is applied. It is the committee's understanding that DNDO is following standard practice for discounting.

When, where, and how terrorists might attempt to use a nuclear weapon is unknown. This uncertainty makes it difficult to decide whether or not to invest in a system for detecting nuclear weapons. The consequences of a successful nuclear detonation by a terrorist group could be catastrophic. The potential magnitude of the consequences is a major factor in justifying investments to reduce the risks from nuclear scenarios. The risk of such scenarios depends also on how likely it is that they might occur. However, because the likelihood of such an attack cannot be precisely specified it is difficult to estimate the risk from nuclear weapons and the extent to which this risk is reduced through defensive countermeasures. Despite this uncertainty, a structured CBA can help to guide decision-making in such a situation.

It is important to consider the standards used to measure ASP performance and whether meeting these standards is sufficient to warrant the program expenditure. A well-constructed cost-benefit analysis can aid in evaluating whether the criteria in DHS's definition of a "significant increase in operational effectiveness" (shown in Sidebar 3.1) add benefits sufficient to justify the cost of the ASP program.

FINDING

DHS' definition of "significant increase in operational effectiveness" is a modest set of goals: The increases in operational efficiency do not by themselves appear to outweigh the cost increases from replacing the PVT/RIID combination with ASPs, based on DNDO's preliminary estimates, and the criteria do not require significantly improved ability to detect special nuclear material in primary screening (see Sidebar 3.1).

If the ASPs meet the defined criteria and are able to detect the minimum quantities of nuclear threat material that DOE recommends (DOE guidance), DHS still will not know whether the benefits of the ASPs outweigh the additional costs associated with them, or whether the funds are more effectively spent on other elements of the Global Architecture.

In particular, to determine whether the benefits outweigh the costs, the following issues need to be addressed:

- The relative effect of the ASP system, relative to the existing PVT/RIID system, on reducing the probability that an adversary would try to smuggle nuclear material into the United States (deterrence);
- The relative effect of the ASP system, relative to the existing PVT/RIID systems, on the probability that an adversary would succeed in smuggling nuclear material into the United States.
- Whether any benefits identified in the above effects assessments and the improvements required by the SIOE criteria merit the cost of the improved technology deployment;

RECOMMENDATION

The CBA should provide a convincing narrative involving all relevant costs and benefits in order to justify spending funds on the ASP program.

Many of the costs and particularly the benefits involved in threat detection systems such as the ASPs are not easily quantifiable. However, the CBA should provide a convincing narrative involving the relevant costs and benefits in order to justify spending funds on the ASP program. This narrative should provide qualitative justifications and explanations where quantitative justifications are not available. It may be difficult to justify a threat detection program based only on easily quantifiable benefits such as such as the benefits of reduced man-hours spent scanning cargo. However, a major benefit of threat detection programs is an increase in security, and careful consideration needs to be given to addressing these benefits in a thorough way. The committee provides some guidance to DNDO on addressing security benefits later in this chapter.

In a structured CBA, several key elements need to be thoroughly addressed, quantitatively where possible, and qualitatively where necessary, as discussed above. These key elements have been defined by the United States Office of Management and Budget (OMB, 2003) as:

- *A clear statement of the objectives of the program,* which would address what the ASP technology is meant to accomplish relative to the polyvinyl toluene (PVT) technology and how it fits into the rest of the Global Architecture (defined in Chapter 1).
- *An assessment of meaningful alternatives*, which would address a full range of reasonable options and the benefits of the ASP program relative to these options, including a good baseline (typically a no-action alternative).
- *A comprehensive, credible and transparent analysis of benefits and costs as appropriate,* which would address a full range of qualitative and quantitative benefits, including security benefits, as thoroughly as possible.

In the following sections, the committee offers guidance to DNDO in these three areas.

STATEMENT OF THE PROGRAM OBJECTIVES

RECOMMENDATION

A cost-benefit analysis should clearly define the ASP program objectives, including:

- **Describing the new and unique capabilities of the ASPs in the context of their role in the Global Architecture; and**
- **Defining a realistic baseline alternative against which to compare the ASP deployment.**

A structured CBA begins with a clear description of the objectives of the program and the specific needs it is designed to meet. For the ASP program, the committee judges that the major issues to be addressed when stating the program objectives are:

- Describing the unique and new capabilities of the ASPs that will enable them to meet the program objectives and clarifying their role in the Global Architecture; and
- Defining a realistic baseline scenario, to give the program full credit for benefits and costs.

The following sections discuss some specific recommendations from the committee for DNDO's future work that concern a clear statement of the program objectives.

Describing new and unique capabilities and the role in the Global Architecture

RECOMMENDATION

The larger context of global security should be considered in the ASP program's cost-benefit analysis. In particular, DHS should consider tradeoffs and interactions among different elements of the Global Architecture. Alternative approaches can be used to prevent the smuggling of nuclear materials into the United States. Some are alternative approaches to the cargo screening problem, while others are outside the program scope (such as prevention of smuggling via rail, aircraft, or small boats).

It is important to show clearly the new and unique capabilities that deploying the ASPs will provide, relevant to stated goals and operational outcomes. In particular, this will involve considering how the ASP's capabilities contribute to the larger context of the threat detection system intended to prevent nuclear and radiological threat material from entering the United States, known as the "Global Architecture." Radiation portal monitors (RPMs) detect threat materials entering the United States in cargo containers on trucks via land border crossings and seaports, and constitute one piece of this system. The Global Architecture also encompasses screening for nuclear threat material brought across U.S. borders by plane, by personal watercraft, by rail, or that is transferred promptly to on-dock rail cars at seaports. In October 2008, DNDO presented the scope of its CBA as limited to the then-current deployment plans, which included ASP-C[38] (land and sea cargo) and ASP-D (the wide-load variant) but excluded rail deployments.[39] The committee had not seen any more recent information regarding the scope of DNDO's CBA as of the writing of this report (February 2009).

There are tradeoffs that need to be considered among the many programs that make up the Global Architecture. Given the limited resources available, investment used to strengthen the Global Architecture can be applied towards: (1) using different (newer) technologies to fill the same gap; or (2) filling different gaps, for example, different threats, different geographies, and different modes of transport. Furthermore, the preferred modes and routes of shipping and transportation are not static. Nor are threats. A more comprehensive evaluation of security benefits would factor in such trends For example, the enhanced capabilities provided by the ASP-C system are relevant to cargo containers entering the United States by truck, but not by rail. In the future, it is probable that less cargo will be brought directly into major U.S. seaports. Some of the fastest-growing ports in North America are in Canada and Mexico,[40] and it is expected that these ports will handle increasing amounts of cargo destined for the United States. Much of this cargo will be unloaded onto on-dock rail and will cross U.S. borders on rail.

The tradeoffs among different spending options need to be considered in the ASP CBA or in a higher level analysis about allocation of efforts and funds. Indeed, it may be more appropriate for such an analysis to be carried out at a higher level so that it can provide guidance and support for multiple programs in a coordinated fashion. The committee has, however, seen no evidence that the higher level tradeoff analysis has been done, and a recent report by the GAO

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[38] Anything that is legal to drive on a road can pass through the ASP-C variant.

[39] The ASP-D is considered a minor variant; however, DNDO informed the committee in October, 2008 that because the modifications needed to accommodate on-dock rail were significant, they would not be including on-dock rail as part of the program scope.

[40] Some of the fastest-growing ports in North America include Manzanillo, Lazaro Cardenas, and Vancouver. For further information, see http://aapa.files.cms-plus.com/PDFs/North_American_Container_Traffic.pdf.

(2009) tends to confirm this view. Furthermore, an ASP CBA should at the very least consider alternatives arising from work in the same office on the same mission (e.g., improved RIIDs).

Defining a good baseline

The benefits and costs of a program are defined in comparison with a clearly stated baseline, typically a "no-action" alternative. This is the type of baseline DNDO indicated to the committee that they had chosen as of October 2008: In this baseline, no ASPs would be deployed, and PVT deployment would be expanded. PVTs would continue to be used in both primary and secondary screening, and the handheld RIIDs would be used in secondary screening according to Custom and Border Protection's (CBP) current Concept of Operations (CONOPS).

It is important that the baseline option reflect the key features of the actual systems as they are deployed today, to ensure that costs and benefits are being accurately assigned to the ASP program. In considering DNDO's baseline scenario, one must take into account several assumptions about the current operations of the PVTs to give the ASPs appropriate benefit for providing increased security. In this case, a good baseline might include:

- Using the actual sensitivity settings of PVTs deployed in various ports; and
- Correctly accounting for the range of densities of typical materials in containers.

As of DNDO's October 2008 presentation to the committee, the baseline alternative in the CBA presumed that the PVTs at all ports were set to the same detection level and operated identically. As discussed earlier in this report, the PVTs signal a "detection" when the observed radiation exceeds a given level. When this occurs, the conveyance is pulled aside for a secondary screening using a second PVT (the truck passes through the detector at a slower rate) and a hand-held RIID operated by a CBP officer. However, cargo containing NORM (for example, granite countertops or porcelain toilets) can set off these detectors, which are unable to distinguish between NORM cargo and threat materials. If the PVT is set more sensitively (the system alarms when it detects lower levels of radiation) then more NORM cargo is diverted to secondary screening than if the PVT is set less sensitively.

If the alarm threshold is set too low (the system is too sensitive), the flow of commerce can be affected by the amount of NORM cargo sent to secondary screening. If the alarm threshold is set too high (the system is not sensitive enough) then material of concern could pass through without an alarm. More background regarding thresholds and sensitivity can be found in Chapter 2. To the extent that the ASPs allow detectors to be operated with a greater level of sensitivity, they would be expected to detect threat materials more reliably.

In addition, the baseline needs to recognize and account for (to the extent possible) the range of material densities in typical containers that is brought into a given port. Threat material could be shielded by cargo brought into the United States in ordinary commerce. An operationally realistic range of material densities can then be used to define the range for comparative evaluation between the ASPs and the PVT/RIID systems. At present, the DOE threat guidance uses a single value for cargo density, and that value does not represent the upper limit of the range of typical cargo densities. Lower density cargo provides less shielding and therefore a less challenging detection problem.

ASSESSMENT OF A RANGE OF MEANINGFUL ALTERNATIVES

RECOMMENDATION

A cost-benefit analysis for the ASP program should demonstrate that a full set of meaningful alternatives has been assessed, including alternative deployments, operations, and technologies.

A well-performed CBA demonstrates that a full set of meaningful alternative approaches to the proposed program has been assessed relative to the baseline. According to OMB Circular A-4 (OMB, 2003), a well-performed analysis "describe[s] the alternatives available and the reasons for choosing one alternative over another … [i]t is not adequate simply to report a comparison of the agency's preferred option to the chosen baseline."

DNDO informed the committee in October of 2008 that three potential deployment plans for the ASPs are currently being considered, in addition to a baseline plan, discussed above. These three plans include:

1. *Deployment in secondary:* expand the deployment of PVTs in primary screening, and deploy ASPs in secondary screening;
2. *Deployment in primary and secondary:* deploy ASPs in primary screening and secondary screening; and
3. *Hybrid deployment:* For primary screening, deploy some primarily in high traffic ports, and retain PVTs in other, lower-traffic ports. For secondary screening, install ASPs at all ports.

The committee was not shown assessments of other alternatives (apart from the baseline alternative) as of February 2009, although DNDO may have analyzed others. Increased security might be achieved without the deployment of ASPs, and a good CBA would clearly demonstrate that all reasonable possibilities have been assessed, or give reasons why these possibilities were not assessed.[41]

Several alternative approaches are possible. The comparative costs and benefits of changes to CBP's CONOPS could be assessed. For example, detection equipment could be deployed at every exit and CBP could select random nuisance alarms to be examined, potentially resulting in heightened deterrence effects; or secondary scanning times could be increased, providing time for high purity germanium (HPGe) detectors to perform Identifications. Another alternative could be to maintain current CONOPS, but deploy alternative technologies, such as improved RIIDs. The use of newly available RIIDs and associated software could improve the performance of secondary screening: newer, more sensitive models of RIIDs are available. Alternatively, software on the existing RIIDs could be improved.[42] This list is meant to be illustrative and not comprehensive. DNDO and CBP may have insights into alternatives of which the committee is not aware. At the same time, for practical reasons, the set has to be finite and relatively small, so the cases should be chosen carefully to represent the most promising alternatives.

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[41] In addition, note that CBP officers may prefer the use of handheld detectors, and some deployment of RIIDS may be needed even in the case that the ASPs are deployed in secondary.

[42] For example, RIIDs using high purity germanium detectors are available. Improvements to RIIDs and to the associated software are discussed in more detail in Chapter 3 of this report.

A COMPREHENSIVE, CREDIBLE, AND TRANSPARENT ANALYSIS OF BENEFITS AND COSTS

RECOMMENDATION

A cost-benefit analysis for the ASP program should include a comprehensive, credible and transparent analysis of benefits and costs, although the committee acknowledges that DNDO will not be able to perform a full, quantitative cost-benefit analysis.

DNDO's CBA is intended to provide guidance about whether the additional project costs associated with deploying the ASP systems are outweighed by the improvements in detection and other benefits. In October of 2008, DNDO presented a preliminary set of total life cycle cost estimates (LCCE) for the three ASP deployment scenarios outlined previously as well for a baseline scenario. However, the committee did not see a breakdown of these costs into categories such as design and development; procurement; deployment; maintenance; operations; or decommissioning, so it is unable to assess the validity of the projected costs. The approach that DNDO described to the committee for the ASP LCCE appeared to use a reasonable methodology. The committee did not see the details of this assessment; however, they suggest that it is essential to a valid CBA to supply uncertainties associated with the projected costs. The cost assessment should cover all phases of the acquisition life cycle in a manner that is independent of contractor or program office biases and assess the risk of cost escalation associated with the estimate. It is also possible that adoption of new technologies will lead to cost reductions, although this is less common in such procurements.

As of the writing of this report (February 2009), DNDO had not yet presented an assessment of the security benefits of the ASP program. DNDO had considered some benefits, such as the ability for CBP officers to be reassigned to other missions, time saved in secondary screening, and a reduced number of conveyances referred to secondary screening. However, according to DNDO (2008b) these benefits alone are unlikely to justify the costs of the ASP program, and other, more difficult to quantify benefits of will need to be taken into account, including security benefits. This is a point on which DNDO has asked for specific advice from the committee.

The committee recognizes the likely inability of the DNDO (or anyone else) to perform a full, quantitative cost-benefit analysis for the ASP program. Despite these difficulties, at minimum, a logical connection of the program effort to its goals needs to be presented.

A well-performed CBA that helps in procurement decisions for ASPs is not going to be a simple analysis following standard formulae commonly used in other kinds of procurements. DNDO expressed its difficulty in assessing two of the cost-risk elements in the cost-benefit analysis with respect to equipment performance: assessing the probabilities of failure to detect threat material, and factoring in potential consequences of such a failure. There are four probabilities involved in analyzing security benefits: P_{detect}, or the probability of detecting the threat material; $P_{identification}$, or the probability of correctly identifying the threat material; $P_{interdict}$, or the probability of interdicting the threat material; and $P_{encounter}$, the probability of an adversary attempting to smuggle threat material into the United States in the first place. The last probability is likely to be highly complex to evaluate, and indeed impossible to determine definitively. Although it is difficult to estimate such probabilities with high confidence, analysts need to understand what they can about these probabilities based on analytical tools and input from the intelligence community and other sources.[43]

The consequences are likewise uncertain, although in this case because of indeterminacy. The consequences of a successful nuclear or radiological attack could be assessed within reasonable uncertainty bounds if the nature of the weapon, its location, and all of the environmental conditions, including where the people are (e.g., is it rush hour?), were specified. But in a site-generic, time-independent assessment, the variability in the possible consequences is very broad. All of these factors make it quite difficult to consider avoided events in the cost-benefit analysis. However, that difficulty does not make it less important to consider these factors.

Security benefits can result from changes in any of the above probabilities. The benefits can take the form of higher detection, identification, and interdiction probabilities. They can also result from deflection (e.g. to overseas targets) or deterrence (effectively reducing the probability of encounter), so the security benefits associated with these factors also need to be considered. (Note, however, that deflection can push adversaries to use different avenues to the same target, as explained below.) The existence of some radiation monitoring at seaports and land border crossings may provide sufficient discouragement to potential adversaries from smuggling via this route. However, it may also increase the probability that the terrorist will focus on other gaps in the nation's security that are identified as easier targets. For these reasons, benefits from increased detection probabilities may be modest as long as there are significant gaps in the Global Architecture. Improved detection can be expected to become more beneficial as those gaps are filled.

There are several analytical approaches that may be useful to DNDO in performing an analysis of the security benefits of the different alternatives proposed for the ASP program. Below are three examples. Each of these options suffers a common shortcoming – they do not answer the question of whether the benefits of implementing ASP exceed the program's costs. However, each in a different way can provide insights that could help the Secretary weigh the merits of acquiring and deploying ASPs or alternative nuclear detection technologies.

A capability-based planning approach would provide a structured assessment of how alternative detection technologies or deployment strategies reduce the risk of a nuclear detonation in the United States. This approach has been applied in defense applications to compare and contrast a set of options for approaching a given operational challenge across a wide range of circumstances (Davis 2002). In the case of ASP, the operational challenge is to prevent a nuclear or radiological attack by detecting, identifying and interdicting materials or a weapon smuggled into the United States. The set of options could include alternative deployments of ASPs and PVTs, deployment of alternative RIIDs, or (depending on the scope of analysis) shifting emphasis between port-of-entry (POE) and non-POE detection. The circumstances considered would include relevant dimensions of the adversary capability and tactics, the operating environment, and the technologies themselves. For example, circumstances could include different types of nuclear materials, use of different shielding or masking methods, technology performance now or in the future, different operating environments, different numbers of weapons available to the adversary, or failure of primary and secondary inspection

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[43] Other parts of DHS have conducted expert elicitations of threat probabilities with members of the intelligence community. A recent report by the National Research Council cautioned about limitations of this approach for the bioterrorism risk assessment. The committee, however, sees value in factoring in what the intelligence community knows and suspects, accounting at the same time for the confidence that can be placed in that knowledge.

due to a common source of failure. Using a model that reflects the detection systems performance, the alternatives are then compared across multiple metrics appropriate for these circumstances (e.g., probability of detection of a representative threat object. The strength of a capabilities-based planning approach is that it can provide a rich comparison of the security benefits emphasizing the circumstances under which each option might be preferred. The weakness of this approach is that exploring the circumstances that affect the systems capability can quickly lead to large and complex analysis and judgment of the analysts is required to balance this complexity against and ability to draw salient insights about a systems capabilities.

Game theory could provide insight into the benefits from deterrence associated with the PVTs and ASPs. Studies in other areas have found that the simple presence of security can significantly deter individuals from choosing the action that the security is meant to protect against. For example, Ayres and Leavitt (1998) used game theory to predict that the ability of a criminal to observe security measures affects the deterrent ability of that security measure and validated this prediction with observations from vehicle theft statistics: An increase in the percentage of lojack-equipped[44] vehicles in a given area is associated with a substantial decline in auto theft.[45] In contrast, observable security devices against car theft tended to merely shift the risk of theft to other vehicles, but not lower overall rates of theft. In another example of game theory being used for security policy, Kunreuther (2005) demonstrated the public policy opportunity that exists in commercial aviation because of tipping effects that would lead to mass adoption of baggage screening technologies under the right policy incentives. Researchers who have used game theory to assess protection of critical infrastructure from terrorism are just beginning to explore the utility of these approaches to decisions about radiation portal monitors (Bier and Azaiez 2009; Dighe et al. 2009), as noted earlier. In the context of ASP procurement, one would have to look at the incremental benefit of installing new detectors. The general weakness of game theory is that if analysts are unable to estimate parameters of their model, they are only able to draw broad and conditional conclusions about adversary behavior. Examples of parameters from security applications that are difficult to estimate include the value to the adversary of different outcomes (i.e., what might constitute successes and what are the costs of being caught), the probability of attack, and the costs of the defender falsely suspecting an attack is occurring. In the absence of being able to establish values for model parameters, broad or conditional conclusions might or might not provide actionable advice to policymakers.[46]

Finally, cost-effectiveness analysis and break-even analysis are related approaches that have been used to assess costs and benefits when performing a complete cost-benefit analysis is difficult or impossible. Cost-effectiveness analysis is used when valuation of benefits is contentious and it is not possible to quantify benefits in monetary terms. Because the security goals of the ASP program may be difficult to value monetarily, comparing program alternatives using cost-effectiveness measures such as dollars per life saved or dollars per attack avoided could provide insights into their relative merits. In contrast, break-even analysis can be used

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[44] Lojack is a hidden radio-transmitter device used for retrieving stolen vehicles.

[45] This occurs without a drop in other types of crimes. (Ayres and Leavitt, 1998)

[46] Consider the case of deterrence. Partial screening (screening a fraction of the total number of containers entering the United States) may provide for effective deterrence (or deflection), if detection probabilities are sufficiently high and if smugglers cannot predict which containers will not be screened. This benefit quickly evaporates if adversaries are able to stage several smuggling attempts simultaneously because the chance of at least one attempt succeeding grows rapidly with the number of attempts (Bier and Haphuriwat, 2009). Like other game theoretic analyses, this enters a psychological realm, ascribing logical values to the adversary (e.g., that the threat material is a scarce and valuable asset and that the risk of discovery at a port of entry is not desired).

when it is difficult to even assess the magnitude of benefits in any units. Break-even analysis determines conditions that must be met for benefits to exceed costs. In security applications, these conditions could be a required reduction in overall risk (see Willis and LaTourrette 2008 analysis of the Western Hemisphere Travel Initiative) or a baseline estimate of a threat of attack that exists (see Martonosi et al. 2006 analysis of 100% container inspection). In some instances, framing the problem in this manner has proven useful because it also can provide a simple, yet fully parameterized model of the system being evaluated which a policymaker can explore to understand conditions that must be met for benefits to exceed costs (see von Winterfeldt and O'Sullivan analysis of acquisition of MANPADs defenses on commercial aviation). In cases where break-even analysis identifies meaningful bounds on decisions, that is threshold conditions that can easily be judged to exist or not exist, this approach can simplify decisionmaking. The downfall of break-even analysis is that these conditions do not always exist.

The committee reiterates that methods for evaluating security benefits, examples of which are provided above, can provide different insights based on their approach, and none is likely to provide fully quantitative and definitive results. But most policy decisions are made without fully quantitative and definitive results, so DNDO should incorporate these benefits to provide the most informative CBA it can.

The committee recommends that DHS not proceed with further procurement until it has addressed the findings and recommendations in this report and the ASP is shown to be a favored option in the cost-benefit analysis.

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Appendix A

The Joint Explanatory Statement and the Statement of Task

In the Joint Explanatory Statement for the 2008 Consolidated Appropriations Act (P.L. 110-161), Congress stated the following:

> The Committees on Appropriations appreciate the difficulties the Secretary faces in certifying the ASP systems and provide sufficient resources to allow DNDO to enter into an agreement with the National Academy of Sciences (NAS) to assist the Secretary in his certification decisions. NAS will help validate testing completed to date, provide support for future testing, assess the costs and benefits of this technology, and bring robustness and scientific rigor to the procurement process.

Working with the Domestic Nuclear Detection Office, the National Research Council, the operating arm of the National Academy of Sciences, developed the following statement of task for this effort.

> The chairman of the National Research Council will appoint a committee of experts to perform tasks addressing the Secretary of Homeland Security's requirements for certification of advanced spectroscopic portals (ASPs) for secondary screening and, to the extent possible, for primary screening. The committee will evaluate the Domestic Nuclear Detection Office's (DNDO's) ASP assessments, performance tests, and analyses. Specifically the committee will
>
> - Evaluate the adequacy of the DNDO's past testing and analyses of the ASP systems;
> - Evaluate the scientific rigor and robustness of DNDO's testing and analysis approach;
> - Evaluate DNDO's cost-benefit analysis of ASP technology.

Appendix B

Performance Metrics for ASPs and PVTs

> *"Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise."*
> – John W. Tukey (1962), "The Future of Data Analysis," *Annals of Mathematical Statistics* 33(1), p.1–67. (The citation appears on p.12.)

When evaluating the performance of instruments to identify the system most well suited to a given task, one needs to consider the correct metric for making the comparison. In the case of systems such as the Advanced Spectroscopic Portals (ASPs), conventional measures such as sensitivity and specificity provide useful information, but do not assess directly test performance in actual field operation. The metrics of interest concern the probabilities of making incorrect calls -- i.e., the probability that the cargo actually contained dangerous material when the test system allowed it to pass (a false negative call), and the probability that the cargo actually contained benign material when the test system alarmed it (a false positive call). In some contexts, the false negative call probability (FNCP) has been called the ``false non-discovery rate" and the false positive call probability (FPCP) has been called the ``false discovery rate" (see Note 1). This appendix describes the calculations leading to estimates of these probabilities, the uncertainties in these values, and how these estimated probabilities can be used to compare two systems under consideration.

Test system performance usually is characterized in terms of detection probabilities. The notation for these probabilities comes from the literature for comparing medical diagnostic tests, and we use the same notation here for radiation detection systems:

- Sensitivity (S) = probability that the test system alarms, given that the underlying cargo truly contains special nuclear material (SNM)
- Specificity (T) = probability that the test system does not alarm, given that the underlying cargo truly contained benign material (non-SNM)
- Prevalence (p) = probability that cargo contains SNM
- Positive predictive value (PPV) = probability that the underlying cargo truly contains SNM, given that the test system alarms
- Negative predictive value (NPV) = probability that the underlying cargo truly contains non-SNM, given that the test system did not alarm.

Because the definitions of sensitivity (S) and specificity (T) rely on true knowledge of the cargo contents, we can estimate a system's sensitivity (S) and specificity (T) only from a designed experiment. The experimenters insert into the cargo either SNM (true SNM) or benign material (true non-SNM), and then run the cargo through the test systems; the proportion of (true-SNM) runs that properly set off the test system alarm is an estimate of the test's sensitivity, and the proportion of (benign-SNM) runs that properly pass the test system is an estimate of the test's specificity.

In real life, however, we do not know the cargo contents. We see only the result of the test system: either the test system alarmed, or it did not alarm. Operationally, if the system alarms, SNM is suspected; if the system does not alarm, the cargo is allowed to pass. We are concerned especially with this question: Given that the test system did not alarm, what is the probability that the cargo contained SNM? That is, what risk do we take by allowing a "no-alarm" cargo to pass? From the standpoint of practical operational effectiveness, this probability (the probability that the cargo contains SNM, given that the test system did not alarm) has grave consequences. As shown below by Bayes' Theorem, it is a function of sensitivity (S) and specificity (T), as well as of prevalence (p) (i.e., how likely a positive – here, a cargo containing SNM – is likely to occur), but a comparison between two test systems on the same scenario (i.e., the same threat) involves the same prevalence, so prevalence does not enter into the comparison of effectiveness for the two test systems. So accurate estimation of sensitivity (S) and specificity (T) is important, in that it allows us to compare accurately the performance of two test systems using the relevant, practically meaningful metric.

The probability of making a false negative call (FNCP) is the probability that the cargo truly contains SNM, given that the test system did not alarm; it is exactly the same as 1 – NPV.[47] Unfortunately, we cannot estimate NPV from real life runs of the radiation test system, because in real life, we don't know the true state of the cargo. We *can*, however, estimate S and T from designed studies, such as those conducted at the Nevada test site, because we know the cargo contents in the tests. We also can derive confidence limits on S and T from such designed experiments, and hence we can estimate (1–NPV) and associated confidence intervals. More importantly, we can compare the two systems via a ratio, say $(1\text{-}NPV_1)/(1\text{-}NPV_2)$; a ratio whose lower confidence limit exceeds 1 indicates preference for test system 2, while a ratio whose upper confidence limit falls below 1 indicates preference for test system 1. Note that these ratios may differ for different scenarios; a table of these ratios may suggest strategies for associating the ratios with the threat levels presented by different scenarios.

Notice also that the probability of making a false positive call (FPCP) is likewise of interest for purposes of evaluating costs and benefits: too many false positive calls can also be costly (e.g., slowing down commerce, diverting CBP personnel from potential threats as they spend time investigating benign cargo, etc.). Two detection systems that have exactly the same probability of a false negative call (1–NPV) for a given scenario, but substantially different values of the probability of making a false positive call, may indicate a preference for one system over the other. The probability of making a false positive call equals 1–PPV.

We illustrate these calculations from hypothetical data below. Suppose we have 24 trucks, into 12 of which we place SNM and leave only benign material in the remaining 12 trucks. We run all 24 trucks through two test systems, and observe the following results:

	Test System 1			**Test System 2**		
	Alarm	**No Alarm**	**Total Runs**	**Alarm**	**No Alarm**	**Total Runs**
SNM in cargo	10	2	12	11	1	12
Non-SNM in cargo	4	8	12	2	10	12
	14	10	24	13	11	24

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[47] The literature (see references) refers to "false discovery rate" and "false non-discovery rate" which are related to (1–PPV) and (1–NPV), respectively, but their definitions are slightly different (see Note 1).

Sensitivity is the probability that the system alarmed, given the presence of SNM in the cargo: among the 12 trucks that contained SNM, 10 alarmed for test system 1 (estimated sensitivity S_1 = 10/12) and 11 alarmed for test system 2 (estimated S_2 = 11/12). Similarly, we estimate specificity for the two test systems as 8/12 and 10/12, respectively (number of "no alarm" results out of the 12 non-SNM trucks). Because we specified the number of runs in each condition (n_1=12 for SNM runs and n_2=12 for non-SNM runs), we can estimate the uncertainties in these probabilities using the conventional binomial distribution. In this case, lower 95% confidence bounds determined from the binomial distribution based on $n_1 = n_2 = 12$ are:

	Test System 1	**Test System 2**
Estimated Sensitivity	0.833 (10/12)	0.917 (11/12)
95% confidence interval	(0.562, 1.000)	(0.661, 1.000)
Estimated Specificity	0.667 (8/12)	0.833 (10/12)
95% confidence interval	(0.391, 1.000)	(0.562, 1.000)

(The wide intervals result from the small sample sizes.)

More importantly, the negative predictive value (NPV, the probability that the truck truly did not contain SNM, given that the alarm did not sound) is 8/10 for test system 1 and 10/11 for test system 2, and hence we estimate the probability of making a false negative call for the two systems as

- proportion of cases where test system 1 did not alarm (10 cases) but actually contained SNM cargo (2 cases) = 2/10 = 0.20
- proportion of cases where test system 2 did not alarm (11 cases) but actually contained SNM cargo (1 case) = 1/11 = 0.09

Clearly, test system 1 appears to be less reliable than test system 2. The calculation of the lower bounds on these estimated probabilities is not as straightforward as using the binomial distribution, as was done for sensitivity and specificity, because the denominator (10 in the outcome of the performance tests of system 1 and 11 in the outcome of the performance tests on system 2) arose from the test results, not from the number of trials set by the study design. That is, the denominator "10" for test system 1 (and "11" for test system 2) is the sum of two numbers that might differ if the test were re-run. Confidence bounds can be obtained as a function of sensitivity (S) and specificity (T) (see Note 2).

In formal notation, we estimate the probability of a false negative call from estimates of sensitivities and specificities, we use the following notation. Let A and B denote two events, say

A = cargo contains SNM
B = Test system alarms
A^c = The complement of A, cargo contains no SNM (benign)
B^c = The complement of B, test system does not alarm

The FNCP is the probability that event A occurs (cargo truly contains SNM), given that event B^c occurred (test system *does not* alarm). We write this probability as $P\{A|B^c\}$. (The event after the vertical bar "|" is the event on which the probability is conditioned; i.e., the event that exists.)

Bayes' rule (Navidi, 2006) states:

$$P\left\{A \mid B^c\right\} = P\left\{B^c \mid A\right\} \times P\left\{A\right\} / [(P\left\{B^c \mid A\right\} \times P\left\{A\right\}) + (P\left\{B^c \mid A^c\right\} \times P\left\{A^c\right\})]$$

(1)

where

P{$A|B^c$} = probability that event A occurs, given confirmation that event B has occurred (here, P{cargo contains SNM | test system does not alarm} = 1 – NPV)

P{$B^c|A$} = probability that event B^c occurs, given confirmation that event A has occurred (here, P{test system does not alarm | cargo contains SNM} = 1 – S)

P{$B^c|A^c$} = probability that event B occurs, given confirmation that event A^c has occurred (here, P{test system does not alarm | cargo contains no SNM} = T).

Recall that sensitivity is the probability that the test system alarms, given SNM was in the cargo; i.e., P{$B|A$} = sensitivity (S). Both S and T can be estimated from the experimental test runs (where we *know* what the cargo contained). Denoting by p, the probability that cargo contains SNM, we have:

$$\text{FNCP} = \frac{(1-S)p}{[(1-S)p + T(1-p)]} = \frac{1}{1+y}, \qquad (2)$$

where $y = [T/(1-S)] \times [(1-p)/p]$. We prefer systems with lower values of this probability; i.e., with higher values of y.

Denoting by S_1, T_1, S_2, T_2 the sensitivities and specificities of systems 1 and 2, respectively, we prefer system 1 to system 2 if $FNCP_1 < FNCP_2$; i.e., if

$$y_1 > y_2$$

i.e., if

$$\left(\frac{T_1}{1-S_1}\right)\left(\frac{1-p}{p}\right) > \left(\frac{T_2}{1-S_2}\right)\left(\frac{1-p}{p}\right)$$

which is the same as either

$$\frac{T_1}{1-S_1} > \frac{T_2}{1-S_2} \qquad (3)$$

or

$$\frac{T_1}{T_2} > \frac{1-S_1}{1-S_2}. \qquad (4)$$

That is, a comparison of FNCP for test system 1 (FNCP_1) with that for test system 2 (FNCP_2) reduces to a comparison of [(1-sensitivity)/(specificity)] for the two systems. We can estimate uncertainties on our estimates of sensitivity and specificity (based on the binomial distribution; see above discussion). Hence, we can approximate the uncertainty in $[(1 - S)/(T)]$, and ultimately the uncertainty in the ratio of false negative call probabilities (see Note 2) — *which does not involve assumptions on p* (likelihood of the threat). Notice that test system 1 is always preferred if $T_1 \geq T_2$ and $S_1 \geq S_2$, because $T_1 \geq T_2$ implies that the left-hand side of (4) exceeds or equals 1, and $S_1 \geq S_2$ implies that the right-hand side of (4) is less than or equal to 1; hence (4) is satisfied. (If $T_1 = T_2$ and $S_1 = S_2$, then the test systems are equivalent, in terms of sensitivity, specificity, and false negative call probability, so either can be selected.) In real situations, however, one test system may have a higher test sensitivity may but a lower specificity. For example, if $T_1 = 0.70$ and $T_2 = 0.80$ (test system 2 is more likely to remain silent on truly benign cargo than test system 1), but $S_1 = 0.950$ and $S_2 = 0.930$ (test system 1 is slightly more likely to alarm if the cargo truly contains SNM), then (4) says that test system 1 is preferred, because $T_1/T_2 = 0.875$ and $(1\text{-}S_1)/(1\text{-}S_2) = 0.05/0.07 = 0.714$. The FNCP for the two systems are

$$FNCP_1 = \frac{1}{\left[1+\left(\frac{T_1}{1-S_1}\right)\left(\frac{1-p}{p}\right)\right]} = \frac{1}{\left[1+\frac{14.00\cdot(1-p)}{p}\right]}$$

$$FNCP_2 = \frac{1}{\left[1+\left(\frac{T_2}{1-S_2}\right)\left(\frac{1-p}{p}\right)\right]} = \frac{1}{\left[1+\frac{11.43\cdot(1-p)}{p}\right]}$$

so clearly $FNCP_1 < FNCP_2$.

Calculations for this example ($S_1 = 0.95$, $S_2 = 0.93$, $T_1 = 0.70$, $T_2 = 0.80$), for different threat levels p, are:

- $p = 0.10$: $FNCP_1 = 0.007874$ and $FNCP_2 = 0.009629$ (ratio = 0.81777);
- $p = 0.05$: $FNCP_1 = 0.003745$ and $FNCP_2 = 0.004584$ (ratio = 0.81701);
- $p = 0.01$: $FNCP_1 = 0.000721$ and $FNCP_2 = 0.000883$ (ratio = 0.81646);
- $p = 0.001$: $FNCP_1 = 0.7150´10^{-4}$ and $FNCP_2 = 0.8758´10^{-4}$ (ratio = 0.81634);
- $p = 0.0001$: $FNCP_1 = 0.7142´10^{-5}$ and $FNCP_2 = 0.8751´10^{-5}$ (ratio = 0.81633).

The prevalence p has little effect on the ratio of FNCPs, but its effect on the absolute rate (magnitude) of the FNCP is noticeable. Regardless of its value, however, the probability of a FNC will be very small whenever the probability of a threat is small (e.g., less than 0.1).

When the differences in sensitivities are much higher, the FNCPs also are quite different. Consider the case when $S_1 = 0.90$, $S_2 = 0.30$, $T_1 = 0.70$, $T_2 = 0.90$, for the same threat levels:

- $p = 0.10$: $FNCP_1 = 0.015625$ and $FNCP_2 = 0.079545$ (ratio = 0.19643);
- $p = 0.05$: $FNCP_1 = 0.007463$ and $FNCP_2 = 0.038326$ (ratio = 0.18977);
- $p = 0.01$: $FNCP_1 = 0.001441$ and $FNCP_2 = 0.007795$ (ratio = 0.18485);
- $p = 0.001$: $FNCP_1 = 0.000143$ and $FNCP_2 = 0.000780$ (ratio = 0.18379);

- $p = 0.0001$: $FNCP_1 = 0.1429'10^{-4}$ and $FNCP_2 = 0.7778'10^{-4}$ (ratio = 0.18369).

Here, even with a higher specificity, the increase in sensitivity from 0.3 (test 2) to 0.9 (test 1) results in a five-fold decrease in the FNCP. With either test, the FNCP is small, even when the threat level is 0.01 (1 in 100 trucks carry threatening cargo).

Calculations for the probability of a false positive call (FPCP, 1-PPV) are similar. Again from Bayes' Theorem:

$$P\{A \mid B^c\} = P\{B^c \mid A\} \times P\{A\} / [(P\{B^c \mid A\} \times P\{A\}) + (P\{B^c \mid A^c\} \times P\{A^c\})] \quad (5)$$

where

A^c = complement of A = event that cargo does not contain SNM

B^c = complement of B = event that test system does not alarm

P$\{A^c|B\}$ = probability that event A^c occurs even though B occurred(here, P{cargo contains no SNM | test system alarms} = 1 – PPV)

P$\{B^c|A^c\}$ = probability that event B occurs, given confirmation that event A^c has occurred (here, P{test system does not alarm | cargo contains no SNM} = T).

P$\{B^c|A\}$ = probability that event B^c occurs, given confirmation that event A has occurred (here, P{test system does not alarm | cargo contains SNM} = 1 – S)

$FPCP = (\bar{1}T)(\bar{1}p)/[(\bar{1}T)(\bar{1}p)+Sp] = 1/(1+z)$ where $z = [S/(\bar{1}T)]\square[p/(\bar{1}p)]$.

So test system 1 would be preferred, in these terms, over system 2, if

$$\left(\frac{S_1}{1-T_1}\right)\left(\frac{p}{1-p}\right) > \left(\frac{S_2}{1-T_2}\right)\left(\frac{p}{1-p}\right)$$

i.e., if

$$\left(\frac{1-T_1}{S_1}\right) < \left(\frac{1-T_2}{S_2}\right).$$

To calculate the magnitude of FPCP (not just the ratio of the probabilities for the two systems), consider that p is likely small and that S_1 (or S_2) may not be orders of magnitude large r than (1-T_1) (or (1-T_2). In this case, the "1 +" in the denominator does matter for the *absolute* magnitude of this FPCP. For the example above, where $S_1 = 0.95$, $S_2 = 0.93$, $T_1 = 0.70$, $T_2 = 0.80$, the corresponding FPCP for p=0.10, p= 0.05, p = 0.01, p = 0.001, p = 0.0001 are:

- p = 0.10: $FPCP_1 = 1/[1 + 0.31579(1/9)] = 0.96610$, $FPCP_2 = 0.97666$ (ratio = 0.9892)
- p = 0.05: $FPCP_1 = 0.98365$, $FPCP_2 = 0.98881$ (ratio = 0.99478)
- p = 0.01: $FPCP_1 = 0.99682$, $FPCP_2 = 0.99783$ (ratio = 0.99899)
- p = 0.001: $FPCP_1 = 0.99968$, $FPCP_2 = 0.99978$ (ratio = 0.99990)
- p = 0.0001: $FPCP_1 = 0.99997$, $FPCP_2 = 0.99998$ (ratio = 0.99999).

For these examples, the chance of having to re-inspect every sounded alarm, only to find benign material, is virtually identical in both systems (and very close to 1 for both). The same is true when $S_1 = 0.90$, $S_2 = 0.30$, $T_1 = 0.60$, $T_2 = 0.80$:

- $p = 0.01$: $FPCP_1 = 0.95294$, $FPCP_2 = 0.93103$ (ratio = 1.02353)
- $p = 0.05$: $FPCP_1 = 0.97714$, $FPCP_2 = 0.96610$ (ratio = 1.01143)
- $p = 0.01$: $FPCP_1 = 0.99553$, $FPCP_2 = 0.99331$ (ratio = 1.00223)
- $p = 0.001$: $FPCP_1 = 0.99956$, $FPCP_2 = 0.99933$ (ratio = 1.00022)
- $p = 0.0001$: $FPCP_1 = 0.99996$, $FPCP_2 = 0.99993$ (ratio = 1.00002).

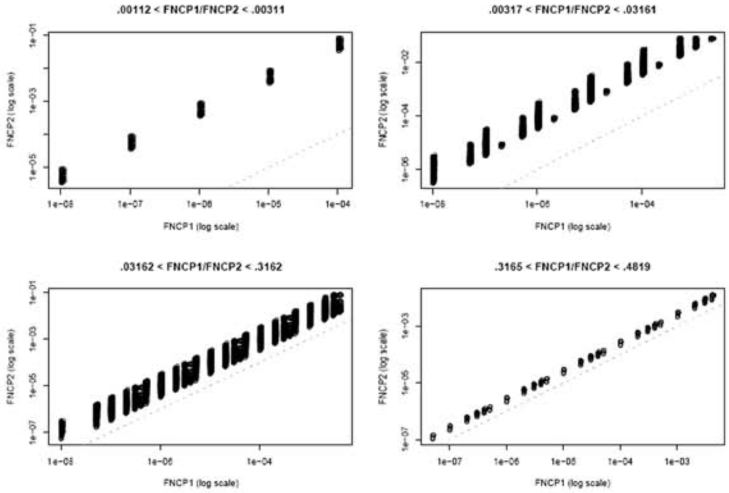
The DNDO criteria for "significant improvement in operational effectiveness" involve comparisons of sensitivity and specificity. As noted above, a test system that has higher sensitivity and higher specificity will have a lower false negative rate. But the above calculations also demonstrate that "nearly equal" sensitivities and specificities result in nearly equivalent systems, and hence offer rather limited benefit for the cost. For completeness, we re-write the DNDO criteria for "significant improvement in operational testing" (see Box 2, pp 40–41) using the S, T notation (for sensitivity and specificity).

Let $S_A^{(1)}(SNM, noNORM)$ denote the sensitivity of the ASP system in primary (1) screening when the cargo truly contains SNM and no NORM; i.e., $S_A^{(1)}(SNM, noNORM)$ = P{ASP alarms | cargo contains SNM, no NORM}. Likewise, let $S_P^{(1)}(SNM, noNORM)$ denote the sensitivity of the current (PVT+RIID) system in primary (1) screening when the cargo truly contains SNM and no NORM; i.e., $S_P^{(1)}(SNM, noNORM)$ = P{PVT alarms in primary screening | cargo contains SNM, no NORM} Using T to denote specificity, let $T_P^{(2)}(SNM, noNORM)$ = P{PVT/RIID does not alarm in secondary screening | cargo contains no SNM, but possibly NORM} (specificity).

Denote by $S_A^{(1)}$ and $S_P^{(1)}$ the sensitivities of ASP and PVT+RIID combination, respectively, in primary screening, and $T_A^{(1)}$ and $T_P^{(1)}$ the specificities of ASP and PVT+RIID, respectively; superscript (2) indicates secondary screening. DNDO has specified its criteria for "operational effectiveness" as follows:

1. $S_A^{(1)}(SNM, noNORM) \geq S_P^{(1)}(SNM, noNORM)$
2. $S_A^{(1)}(SNM + NORM) \geq S_P^{(1)}(SNM + NORM)$ (different version of criterion 1 above)
3. $T_A^{(1)}(MI - Iso) \geq T_P^{(1)}(MI - Iso)$ (where "MI-Iso" indicates "licensable medical or industrial isotopes).
4. $1 - T_A^{(1)}(NORM) \leq 0.20[1 - T_P^{(1)}(NORM)]$
   $\Rightarrow 0.8 \leq T_A^{(1)}(NORM) - 0.2(T_P^{(1)}(NORM))$.
5. $1 - S_A^{(2)}(SNM) \leq 0.5 S_P^{(1)}(SNM) \Rightarrow 0.5 \leq S_A^{(1)}(NORM) - 0.5(S_P^{(1)}(NORM))$.
6. Time in secondary for ASP ≤ time in secondary for RIID (no connection to sensitivity/specificity).

Since criterion 4 is more stringent than criterion 3 and criterion 5 is more stringent than criterion 1, we concentrate on values of sensitivity and specificity that satisfy criteria 4 and 5. When these two conditions are satisfied (i.e., $T_A \geq 0.8 + 0.2T_P$ and $S_A \geq 0.5 + 0.5S_P$), the ratio of false negative call probabilities (A to B) can be as small as 1:900 – almost 1000 times smaller. For such improvements, the ratio of both the sensitivities and the specificities must be on the order of 0.99/0.10 or 0.95/0.10; in such cases, the false negative call probabilities are on the order of (10^{-8} to 10^{-5}). Tables of values of the probabilities of both false negative calls and false positive calls were calculated when T_A, S_A, T_P, and S_P were set equal to 0.1, 0.2, ..., 0.8, 0.9, 0.95, 0.99; of the $11^4 = 14{,}641$ combinations, only 858 satisfied criteria 4 and 5. These 858 combinations were set along with 5 different values of $p = 0.01$ (cargo is present in 1 of 100 trucks), 0.001, 0.0001, 0.00001, 0.000001 (1 in 1,000,000 trucks). A plot of the smaller false negative call probability (denoted FNCP_2 in the figure) versus the larger one (denoted FNCP_1) is shown in Figure B.1. (the red dashed line corresponds to the line where the two false negative call probabilities are equal). The upper left corner shows the cases where the FNCPs are most different ($0.00112 < FNCP_1 / FNCP_2 < 0.00311$), which occurred in 26 of the 858 cases (26□5 points are shown, corresponding to 5 values of p). More frequently, the ratio is less dramatic ($0.00317 < FNCP_1 / FNCP_2 < 0.03161$ for 257 of the 858 cases; $0.0316 < FNCP_1 / FNCP_2 < 0.3162$ for 535 of the 858 cases; $0.3165 < FNCP_1 / FNCP_2 < 0.4819$ for 40 of the 858 cases). In each case, the absolute magnitudes of the false negative call probabilities are quite small, and the ratios of the false positive call probabilities are almost 1.


.00112 < FNCP1/FNCP2 < .00311

.00317 < FNCP1/FNCP2 < .03161

.03162 < FNCP1/FNCP2 < .3162

.3165 < FNCP1/FNCP2 < .4819

Figure B.1: Plot of $FNCP_2$ versus $FNCP_1$ for cases satisfying the criteria $T_A \geq 0.8 + 0.2T_P$ and $S_A \geq 0.5 + 0.5S_P$, for different levels of p (1×10^{-2}, 1×10^{-3}, 1×10^{-4}, 1×10^{-5}, 1×10^{-6}). The red dashed line corresponds to $FNCP_1 = FNCP_2$. The results are stratified by magnitude of the ratio $FNCP_1 / FNCP_2$ (specifically, rounded values of the common logarithm of the ratio: –3, –2, –1, 0, respectively, for the four plots).

Note 1: *A comment on notation*

We denoted by FNCP the probability of making a false positive call and by FPCP the probability of making a false positive call; i.e.,

$$\text{FNCP} = \text{P}\{\text{ true } + \mid \text{test calls ``}-\text{''} \}$$
$$\text{FPCP} = \text{P}\{\text{ true } - \mid \text{test calls ``}+\text{''} \}\ .$$

We related these probabilities to the following generic two-way table of test outcomes (notation from Benjamini and Hochberg 1995, p.291, is in parentheses):

: Truth	Test calls "Positive"	Test calls "Negative"	Total Tests
True POSITIVE	$N_{++}(V)$	$N_{+-}(U)$	$N_{+} \equiv m - m_0$
True NEGATIVE	$N_{-+}(S)$	$N_{--}(T)$	$N_{-} \equiv m_0$
Total calls	R	$m–R$	m

We estimated the false negative call probability via the proportion of negative-call tests ($\tilde{m}R$) that were in fact positive (N_{+-}), or $U/(m–R)$ in BH95 notation. Similarly, we estimated the false positive call probability via the proportion of positive-call tests (R) that were in fact negative (N_{-+}), or V/R in BH95 notation. BH95 address the situation known as "multiple testing," where one is conducting many hypothesis tests (e.g., hundreds or thousands of tests as occurs in gene expression experiments), and wants to control the frequency with which one declares as "significant" (e.g., "positive") tests which in fact are negative. Hence Benjamini and Hochberg (1995) define the *expected* proportion of false positive calls, $E(V/R)$, as the "false discovery rate," or *FDR*. They provide a procedure based on the *m* p-values from the *m* tests so that one has assurance that, on average, the proportion of "declared significant" tests that in fact are not significant remains below a pre-set threshold (e.g., 0.05). If we estimate the FPCP as V/R, we can think of this estimated FPCP as an estimate of Benjamini and Hochberg's FDR. In analogy with $E(V/R)$=*FDR*, some have termed $E(U/(\tilde{m}R))$ the "false non-discovery rate."

Our situation differs from the multiple testing situation in two ways. First, our two-way table arises from a designed experiment where values of m_0 and m are set by design. Second, our bigger concern lies not with false *positive* calls but rather with false **negative** calls; i.e., with the probability that a cargo declared "safe" (negative) actually is dangerous (true positive). The table suggests that we can estimate FNCP as $U/(\tilde{m}R)$. Some authors have called the expected value of this ratio, $E(U/(\tilde{m}R))$, the "false non-discovery rate" (see Genovese and Wasserman 2004; Sarkar 2006). But with both FNCP and FPCP, one needs further information about the frequency of true "positives" and true "negatives" (in the form of p = probability that cargo contains SNM or other threatening material) beyond the *m* tests given in the design. In fact, as further tests are conducted, better estimates of FNCP and FPCP can be obtained by incorporating better estimates of sensitivity and specificity, as well as *p*, into the formulas for FNCP and FPCP. For that reason, we have chosen to derive the relevant probabilities using Bayes' formula, rather than using the terms "false discovery rate" and "false non-discovery rate," which often are estimated from only the table of outcomes from multiple tests. For further information, see the references below.

Note 2: *Uncertainty in the ratio* $FNCP_1/FNCP_2$

The uncertainty in the ratio $FNCP_1/FNCP_2$»$[(1\text{-}S_1)/T_1]/[(1\text{-}S_2)/T_2] = [(1\text{-}S_1)/(1\text{-}S_2)][T_2/T_1]$ can be approximated using propagation of error formulas. Let $ratio = N/D$ denote a generic ratio (*N = Numerator, D = Denominator*).

$$SE(ratio) = SE(N/D) \approx ratio \times \sqrt{\frac{Var(N)}{N^2} + \frac{Var(D)}{D^2}}$$

When T and S have binomial distributions, $Var(T_1)=T_1(1\text{-}T_1)/n_1$, $Var(S_1)=S_1(1\text{-}S_1)/n_1$ and likewise for $Var(T_2)$ and $Var(S_2)$, where n_1 $[n_2]$ is the number of trials on which S_1 and T_1 $[S_2$ and $T_2]$ are estimated (in experimental runs at Nevada Test Site, $n_1 \approx n_2 \approx 12$ or 24). Hence, the standard error (square root of the variance) of $(1\text{-}S_1)/T_1$ is approximately

$$[1 - S_1] \times \sqrt{\frac{S_1}{n_1(1 - S_1)} + \frac{1 - T_1}{n_1 T_1}}$$

so the standard error of the ratio of false negative call probabilities (when p is tiny) is approximately

$$SE\left(\frac{FNCP_1}{FNCP_2}\right) \approx \left(\frac{FNCP_1}{FNCP_2}\right)\sqrt{\frac{Var(FNCP_1)}{FNCP_1^2} + \frac{Var(FNCP_2)}{FNCP_2^2}}.$$

So,

$$SE(FNCP_1 / FCNP_2) \approx \frac{T_2(1 - S_1)}{T_1(1 - S_2)}\sqrt{\left[\left(\frac{S_1}{1 - S_1} + \frac{1 - T_1}{T_1}\right)\Big/ n_1\right] + \left[\left(\frac{S_2}{1 - S_2} + \frac{1 - T_2}{T_2}\right)\Big/ n_2\right]}.$$

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Appendix C

The Value of Factorial Experiments

Factorial experiments are extremely useful designs when outcomes are needed for a variety of test conditions. For example, consider the following factors that could affect test performance (e.g., probability of an alarm, or probability of no alarm):

- Masking (absent, present)
- Shielding (absent, present)
- Mask location (front, middle)
- Mask height (front, middle)
- Shield location (front, middle)
- Shield height (front, middle)
- SNM (none, some)
- NORM (none, some)

More than 8 factors could be envisioned (e.g., cargo density, ambient temperature, ambient humidity, background radiation level), and more than just 2 levels for each factor could be considered. For example, the masking and shielding factors could have levels labeled "absent," "front," and "middle;" and the SNM and NORM factors could have four levels labeled "none," "small," "medium," and "large," resulting in a 3x3x4x4 design (a total of 144 test conditions). This appendix illustrates the value of factorial designs (and a way to reduce the number of test conditions) with the above design simply for ease of illustration. The same concepts apply to more complex designs. But even with only these 8 factors at these levels, the testing of all 2 x 8 = 16 single-factor tests would not be informative. For example, what happens if a cargo contains some SNM and some NORM with much shielding and some masking placed in the middle of the truck? None of the 16 test runs would answer this question. One might also want to know if the probability of detecting SNM is affected by the combined presence of masking and shielding of different magnitudes—a question that likewise would not be answered by any of the 16 runs.

The benefits of running test combinations can be seen already with the following (simpler) test design with these hypothetical results:

		shielding	
		present	absent
masking	present	0.20	0.95
	absent	0.80	0.99

If one tested only "masking present" and "masking absent" in the absence of shielding, one might conclude that masking has some effect on SNM detection (0.95 vs. 0.99), but not as great as the effect of shielding in the absence of masking (0.80 vs. 0.99). One needed 3 runs to ascertain this conclusion. But with only one more run (masking and shielding both present), one sees that their combined effect is devastating to the probability of detection (0.20)—far lower than with either factor singly. The effect of different combinations of factors can be especially illuminating; hence the value of experimental designs with *combinations* of factors or "factorial designs."

Unfortunately, testing all 2x2x2x2x2x2x2x2 = 2^8 = 256 combinations would be infeasible, especially since the outcome of each test is a "probability of detection"; i.e., (number of runs that sounded alarm)/(total number of runs). To minimize the uncertainty in this estimated probability, several runs must be conducted at each test scenario. With only n=6 or n=12 runs, one would have to conduct 256x6 = 1536 or 256x12 = 3072 test runs, and, even then, the uncertainty in the estimated probability could be as high as 30%-40% (95% confidence). For example, a perfect test of 6 correct actions (6/6) would yield an approximate 95% confidence interval for the true probability of detection as $[(1-0.95)^{1/n}, 1] = (0.61, 1.00)$ if n = 6 or $[(1-0.95)^{1/n}, 1] = (0.78, 1.00)$ if n = 12. Clearly some reduction in the number of test scenarios is needed.

Fractional factorial experiments are factorial experiments with only a fraction of the total number of runs. Consider, for ease of illustration, only 4 factors, denoted A, B. C, D, each at 2 levels ("present", "absent"). Sixteen test scenarios would cover all combinations, as follows:

	Factor levels				Product (Mod 2)
Scenario	A	B	C	D	ABCD
1	1	1	1	1	1
2	1	1	1	0	0
3	1	1	0	1	0
4	1	1	0	0	1
5	1	0	1	1	0
6	1	0	1	0	1
7	1	0	0	1	1
8	1	0	0	0	0
9	0	1	1	1	0
10	0	1	1	0	1
11	0	1	0	1	1
12	0	1	0	0	0
13	0	0	1	1	1
14	0	0	1	0	0
15	0	0	0	1	0
16	0	0	0	0	1

"1" = "present", "0" = "absent"; "Product (Mod 2)" = 1 with even numbers of 1's, 0 with odd numbers of 1's

Consider the rows whose last column value is 1:

Run #	A	B	C	D
1	1	1	1	1
4	1	1	0	0
6	1	0	1	0
7	1	0	0	1
10	0	1	1	0
11	0	1	0	1
13	0	0	1	1
16	0	0	0	0

Notice that exactly 4 runs have A absent and 4 runs have A present; the same is true of B, C, or D. Moreover, when A is present (first 4 runs), exactly 2 of the 4 runs have B present and 2 have B absent; the same is true for C and D, and any two of the four factors (A and C, A and D, etc.). In fact, all 8 runs for any combination of 3 factors (A, B, C; A, B, D; B, C, D) are included. So this design allows us to evaluate:

- The effect of A (present vs. absent)
- The effect of B
- The effect of C
- The effect of D
- The effect of A and B together
- The effect of A and C together
- The effect of A and D together
- The effect of B and C together
- The effect of B and D together
- The effect of C and D together
- The effect of A, B, and C together
- The effect of A, B, and D together
- The effect of B, C, and D together

The only effect that we cannot assess is the 4-way interaction, ABCD. But we have reduced the number of runs from 16 to 8, a big savings.

The same principle applies with 8 factors. If resources allow us to run only 64 scenarios, then we sacrifice the ability to estimate the interactions that involve 5 or more factors at once—e.g., ABCDEFGH, all 7-factor interactions (ABCDEFG, …, BCDEFGH)—but we can estimate all other main effects and 2-way, 3-way, and 4-way interactions. (Usually interactions involving 4 or more factors are hard to interpret anyway.) If we can run only 32 scenarios, we sacrifice the ability to estimate not only these high-order interactions, but also some ability to resolve some two-factor interactions; but we can still assess the main effects (A alone, ..., H alone) and most two-factor interactions (AB, ..., GH)—all with just 32 runs, a huge savings.

The designs that NIST provided to DNDO for their test runs followed this principle. The only limiting factors are n, the number of test runs, and the inability to conduct the "SNM present" tests as blind tests. The former can be improved by increasing n; the latter can be addressed by hiring "actors" to pretend to act as security agents, with only DNDO personnel aware of the true SNM test scenarios. The effect of bias when tests are run unblinded has been documented extensively in the medical literature; unblinded tests must be viewed with great caution and even skepticism.

Appendix D

Brief Biographies of Committee Members

Robert C. Dynes, chairman of the committee, is a professor of physics at the San Diego and Berkeley campuses of the University of California, where he directs laboratories that focus on superconductivity. From 2003 until 2008, he served as the 18th president of the University of California (UC) and before that as chancellor of UC San Diego. As a professor, he founded an interdisciplinary laboratory in which chemists, electrical engineers, and private industry researchers investigated the properties of metals, semiconductors, and superconductors. Prior to joining the UC faculty, he had a 22-year career at AT&T Bell Laboratories, where he served as department head of semiconductor and material physics research and director of chemical physics research. Dr. Dynes received the 1990 Fritz London Award in Low Temperature Physics, was elected to the National Academy of Sciences in 1989, and is a fellow of the American Physical Society, the Canadian Institute for Advanced Research, and the American Academy of Arts and Sciences. He serves on the Executive Committee of the U.S. Council on Competitiveness. A native of London, Ontario, Canada, and a naturalized U.S. citizen, Dr. Dynes holds a bachelor's degree in mathematics and physics and an honorary doctor of laws degree from the University of Western Ontario, and master's and doctorate degrees in physics and an honorary doctor of science degree from McMaster University. He also holds an honorary doctorate from L'Université de Montréal.

Richard E. Blahut is the Henry Magnuski Professor of Electrical and Computer Engineering at the University of Illinois and the head of that department. He also holds the title of research professor in the Coordinated Science Laboratory. From 1964 to 1994, Blahut was employed in the Federal Systems Division of IBM, where he had general responsibility for the analysis and design of coherent signal processing systems, digital communications systems, and statistical information processing systems. He was responsible for the original development of passive coherent location systems, now a major technique used in the U.S. Department of Defense. Other contributions to industry include the development of error-control codes for the transmission of messages to the Tomahawk missile, codes to protect text data transmitted via the U.S. public broadcasting network, and the design of a damage-resistant bar code for the British Royal Mail. Dr. Blahut has authored a series of advanced textbooks and monographs in error-control coding, information theory, and signal processing, including ten books either published or in manuscript form. Dr. Blahut served as president of the Information Theory Society of the Institute of Electrical and Electronics Engineers (IEEE) in 1982, and was editor-in-chief of the IEEE Transactions on Information Theory from 1992 until 1995. He was elected to the National Academy of Engineering in 1990. He is a fellow of the IEEE. He is the recipient of the IEEE Alexander Graham Bell Medal, the IEEE Claude E. Shannon Award, the Tau Beta Pi Daniel C. Drucker Eminent Faculty Award, and an IEEE Millennium Medal. He received his Ph.D. degree in electrical engineering from Cornell University.

Robert R. Borchers, a physicist and expert in computation, is chief technology officer for the Maui High Performance Computing Center at the University of Hawaii. Prior to joining the University of Hawaii, he served eight years at the National Science Foundation as director of the

Division of Advanced Computational Infrastructure and Research. Earlier in his career, he was a professor of physics before holding several high-level management positions in universities and laboratories, including associate director for computation at Lawrence Livermore National Laboratory, vice chancellor for academic affairs at the University of Colorado – Boulder and the University of Wisconsin, Madison, and director of the Physical Sciences Laboratory at Madison. Dr. Borchers has received numerous awards and is a fellow of the American Physical Society. Dr. Borchers received his B.S. degree from the University of Notre Dame and M.S. and Ph.D. degrees from the University of Wisconsin, Madison, all in physics.

Philip E. Coyle III served as assistant secretary of defense and director, operational test and evaluation, in the Department of Defense (DoD). In this capacity, he was the principal advisor to the secretary of defense and the under secretary of defense for acquisition, technology and logistics on test and evaluation in the DoD. Mr. Coyle has 30 years experience in testing and test-related matters. From 1959 to 1979, and again from 1981 to 1993, Mr. Coyle worked at Lawrence Livermore National Laboratory where he served as an associate director of the Laboratory. During the Carter Administration, Mr. Coyle served as principal deputy assistant secretary for defense programs in the Department of Energy. In this capacity he had oversight responsibility for the nuclear weapons testing programs of the Department. The International Test and Evaluation Association awarded Mr. Coyle the Allan R. Matthews Award, its highest award, for his contributions to the management and technology of test and evaluation. Mr. Coyle was awarded the Defense Distinguished Service Medal by Defense Secretary William Perry, and the Bronze Palm of the Defense Distinguished Service Medal by Defense Secretary William Cohen. Mr. Coyle graduated from Dartmouth College with a B.A. degree and an M.S. degree in mechanical engineering.

Roger L. Hagengruber is the director of the Office for Policy, Security and Technology (OPS&T) and the Institute for Public Policy (IPP) and a research professor (political science and physics) at the University of New Mexico. Previously, he served as chief security officer and chief cyber security officer for Los Alamos National Laboratory and as a senior vice president at Sandia National Laboratories and directed Sandia's primary mission in nuclear weapons during the transition following the end of the Cold War. Dr. Hagengruber spent much of his 30-year career at Sandia in arms control and non-proliferation activities including several tours in Geneva as a negotiator. In recent years, he has focused on the nuclear transition in the former Soviet Union and on security issues associated with counter-terrorism and has chaired or served on numerous panels that have addressed these issues. His work at the University of New Mexico includes directing the IPP work in public surveys including sampling of U.S. and European views on a wide range of security issues. The OPS&T creates multidisciplinary teams from labs and universities to explore policy options for issues in which security and technology are interrelated. He previously served on the Nuclear and Radiological Panel of the National Research Council's Committee on Science and Technology for Countering Terrorism. He received his Ph.D. degree in experimental nuclear physics from the University of Wisconsin and is a graduate of the Industrial College of the Armed Forces.

Carl N. Henry retired from Los Alamos National Laboratory in December 2001, where he worked for over 40 years. Following retirement, he did part-time consulting for Sandia National Laboratories at U.S. Department of Energy headquarters in 2006. From 1994 to 2001, Henry worked on foreign nuclear weapons intelligence and counter-intelligence analysis. In 1997, he received the Intelligence Community Seal Medallion for meritorious service. From 1975 until 1994, he worked on the Nuclear Emergency Search Team (NEST) Program. During that time he served many roles including staff member, group leader, and program manager. Over his career Henry has participated in search and diagnostics activities, real deployments and exercises, and led the planning for one major exercise. In addition, he has conducted nuclear safeguards research as part of a team using active analysis of nuclear material with a Cockcroft-Walton accelerator and neutron and ray detectors for portal monitoring applications.

John M. Holmes is deputy executive director of operations at the Port of Los Angeles, overseeing the operations of the Los Angeles Port Police, the Homeland Security Division, emergency preparedness planning, the construction and maintenance department, and the Port Pilot Service. Before his current position, he most recently served as a principal and chief operating officer of the Marsec Group, a full service security consulting firm specializing in supply chain security, technology and operations. Prior to forming the Marsec Group, Captain Holmes held the position of vice president and director of business development for Science Applications International Corporation (SAIC), where he assisted government and commercial customers in the development of technological solutions to homeland security challenges, with emphasis on port, border and military security solutions. Captain Holmes retired from the United States Coast Guard in 2003 with 27 years of service as commanding officer, officer in charge of marine inspection and captain of the Port for the Los Angeles-Long Beach port complex. While in the Coast Guard, he also served as deputy chief of the Coast Guard Office of Congressional Affairs, was attached to the staff of the governor of American Samoa and the U.S. ambassador to the Republic of Singapore, and also served as delegate and committee chairman at the International Maritime Organization in London. Captain Holmes received bachelor's degrees in English and education from Boston College, and an M.B.A. degree from the John M. Olin School of Business at Washington University in St. Louis.

Karen Kafadar is the Rudy Professor of Statistics in the College of Arts and Sciences, Indiana University, Bloomington. Her research focuses on robust methods, data analysis, and characterization of uncertainty in the physical, chemical, biological, and engineering sciences. Prior to joining the Indiana faculty in 2007, she was chancellor's scholar and professor of statistics and director of the Statistical Consulting Service at the University of Colorado, Denver. Earlier appointments include National Institute of Standards and Technology (NIST), Hewlett Packard, and the National Cancer Institute. She is currently serving as chair of the NRC's Committee on Applied and Theoretical Statistics (CATS) and on the Board of Mathematical Sciences and their Applications (BMSA). She has served as Editor or Associate Editor on several editorial review boards and on the governing boards of the American Statistical Association (ASA), the Institute of Mathematical Statistics, and the International Statistical Institute (ISI). Dr. Kafadar is a fellow of the ASA and the ISI, and has authored over 80 journal articles and book chapters. She received her B.S. in mathematics and M.S. in statistics from Stanford in 1975 and her Ph.D. in statistics from Princeton in 1979.

C. (Charles) Michael Lederer is a research chemist and deputy director emeritus of the University of California Energy Institute, where he is responsible for the planning and management of the Energy Institute's grant programs. For 20 years, he was a lecturer teaching courses in radiation detection and measurement, and chemical methods in nuclear technology in the Department of Chemistry and the Department of Nuclear Engineering at the University of California at Berkeley. Prior to joining the Energy Institute, Dr. Lederer was head of the Information and Data Analysis Department and director of the Isotopes Project at Lawrence Berkeley Laboratory. He is most widely known as co-author of the 6th and 7th editions of the Table of Isotopes, for which he evaluated nuclear structure and decay data for all known nuclides and computerized the Isotopes Project. Dr. Lederer received an A.B. degree in chemistry from Harvard University and a Ph.D. degree in nuclear chemistry from the University of California at Berkeley.

Keith W. Marlow is a nuclear physicist who specializes in the detection and identification of nuclear materials and devices. He has been associated with the Sandia National Laboratories as an employee, consultant and contractor since 1984 and was employed by the US Naval Research Laboratory from 1951 to 1984. He has more than 50 years of experience in detection and analysis of nuclear radiation, beginning with the development of methods of detection for nuclear weapon testing in Nevada and Eniwetok in 1952. Dr. Marlow participated in the design of a nuclear reactor, brought the reactor critical for the first time and used the nuclear reactor to develop techniques in neutron activation analysis, neutron radiography and to produce radioactive nuclides for his basic research. This was followed by a lengthy period of research and development in neutron and gamma-ray sensors and data analysis for the U.S. Navy and other government agencies. The sensors were deployed in various environments, including air, maritime, terrestrial and space. He also contributed to development and techniques for the INF and START treaties to verify treaty compliance, to confirm compliance with potential dismantlement treaties, and to confirm the presence of weapons and weapon components for accountability purposes at the Pantex Plant. He received the E. O. Hulburt Annual Science Award from the Naval Research Laboratory in 1981 and the Intelligence Community Seal Medallion in 2000 from the Director of Central Intelligence. Dr. Marlow received his Ph.D. degree in nuclear physics from the University of Maryland.

John W. Poston, Sr., is a nationally recognized expert in health physics and shielding, occupational dosimetry, and health effects of radiation releases from accidents and terrorist events. He is professor and past chair of the Department of Nuclear Engineering and a consultant at the Veterinary Teaching Hospital at Texas A&M University. His dosimetry research is supported by the Department of Energy's Office of Nuclear Energy, and he consults with Sandia National Laboratories and a Texas nuclear utility on operational safety issues. He chaired the National Council on Radiation Protection and Measurements committee that produced the 2001 report "Management of Terrorist Events Involving Radioactive Material," and he served as a peer reviewer for the American Association of Railroads on a risk assessment for rail transport of spent nuclear fuel. He was employed at Oak Ridge National Laboratory from 1964-1977, finishing as head of the Medical Physics and Internal Dosimetry Section of the Health Physics Division. Dr. Poston is president emeritus of the Health Physics Society and is a member of the American Nuclear Society, the National Council on Radiation Protection and Measurements, and Sigma Xi, the Scientific Research Society. He received his B.S. degree in mathematics from Lynchburg College and M.S. and Ph.D. degrees in nuclear engineering from the Georgia Institute of Technology.

Henry H. Willis is a professor of policy analysis at the Pardee RAND Graduate School and policy researcher at RAND Corporation. His research has applied risk analysis tools to resource allocation and risk management decisions in the areas of public health and emergency preparedness, terrorism and national security policy, energy and environmental policy, and transportation planning. He is the author of dozens of publications, book chapters and op-ed pieces and has testified before Congress as an expert on applying risk analysis to terrorism security policy. Dr. Willis' recent research has involved: assessing the costs and benefits of terrorism security measures like the Western Hemisphere Travel Initiative and container screening at U.S. ports and evaluating the impact of emergency preparedness grant programs like the Cities Readiness Initiative. He serves on the Editorial Board of the journals *Risk Analysis* and *Behavioral Sciences of Terrorism and Political Aggression*. Dr. Willis earned his Ph.D. degree from the Department of Engineering and Public Policy at Carnegie Mellon University and holds degrees in chemistry and environmental studies from the University of Pennsylvania (B.A.) and in environmental science from the University of Cincinnati (M.A.).

HEARING ON THE SCIENCE OF SECURITY, PART II: TECHNICAL PROBLEMS CONTINUE TO HINDER ADVANCED RADIATION MONITORS

TUESDAY, NOVEMBER 17, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 1:05 p.m., in Room 2310 of the Rayburn House Office Building, Hon. Brad Miller [Chairman of the Subcommittee] presiding.

Subcommittee on Investigations and Oversight

Hearing on

The Science of Security, Part II: Technical Problems Continue to Hinder Advanced Radiation Monitors

Tuesday, November 17, 2009
1:00 p.m. – 3:00 p.m.
2318 Rayburn House Office Building

Witness List

Mr. Gene Aloise
Director, Natural Resources and Environment
Government Accountability Office

Accompanied by
Dr. Timothy M. Persons
Chief Scientist
Government Accountability Office

Mr. Todd C. Owen
Acting Deputy Assistant Commissioner
Office of Field Operations
U.S. Customs and Border Protection
Department of Homeland Security

Dr. William K. Hagan
Acting Deputy Director
Domestic Nuclear Detection Office
Department of Homeland Security

HEARING CHARTER

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

The Science of Security, Part II: Technical Problems Continue to Hinder Advanced Radiation Monitors

TUESDAY, NOVEMBER 17, 2009
1:00 P.M.–3:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

The Subcommittee on Investigations and Oversight meets on November 17, 2009, to examine continuing problems with the Department of Homeland Security's (DHS) efforts to acquire its next generation radiation monitors known as Advanced Spectroscopic Portals (ASPs). This is a follow-up to the hearing the Subcommittee held on June 25, 2009, titled: *The Science of Security: Lessons Learned in Developing, Testing and Operating Advanced Radiation Monitors*. Since the Domestic Nuclear Detection Office (DNDO), a DHS component, was created in 2005 they have been responsible for researching, developing, testing and managing the program.

The ASP program is estimated to cost $2-to-$3 billion and has been under scrutiny since 2006 for failing to have clear-cut requirements, an adequate test plan, sufficient timelines, development milestones or a transparent and comprehensive cost benefit analysis. These problems have been identified by the Government Accountability Office, National Academy of Sciences, the Homeland Security Institute, a Federally Funded Research and Development Center for DHS, and the National Institute of Standards and Technology.

In July, one month after the Subcommittee's last hearing, the ASPs went through a second round of Field Validation Tests. During the tests the ASPs exhibited several "false positive" alarms for special nuclear material that did not exist. In another disturbing incident during the tests, one ASP monitor stopped working altogether yet the system operator remained unaware of this malfunction. Two dozen cargo trucks were permitted to go through the non-functioning portal monitor in order to be screened for potential radioactive and nuclear material until the problem became apparent. DNDO considered this a "Mission Critical Failure." No new plans have yet been scheduled to re-test the ASPs for the third time. The Subcommittee will examine the results from the most recent tests, continuing technical problems with the ASPs, supply shortages of a key component for radiation monitors that may hinder the eventual deployment of the ASPs and further drive up its potential cost, and potential enhancements to the current fleet of radiation monitors in use today.

Background

Since the September 11, 2001 terrorist attacks, protecting the Nation from a nuclear or radiological attack has been a top national security priority. In 2002, to help address this threat, the U.S. Customs and Border Protection (CBP) agency began deploying radiation monitors at U.S. border sites and ports of entry to screen the more than 23 million cargo containers that enter the country every year for radiological and nuclear materials.

Polyvinyl toluene (PVT) radiation portal monitors have been used to screen this cargo since then. They are able to *detect* the presence of radioactive sources, but unable to *identify* the type of radiation present. The PVT monitors, while relatively inexpensive, robust and highly reliable, are unable to distinguish between radioactive sources that might be used to construct a nuclear bomb, such as Highly Enriched Uranium (HEU), and non-threatening naturally occurring radiological materials (NORM) contained in ceramic tiles, zirconium sand or kitty liter, for instance. As a result, any time a PVT detects a radioactive source the cargo is sent to "secondary" screening where CBP agents verify the detection of the source with a second PVT monitor and use hand-held Radioactive Isotope Identification Devices called RIIDs to help *identify* the source of radiation.

This method of operation leads to many "secondary" inspections for naturally occurring radioactive material or radioactive material intended for benign purposes, such as radioactive medical isotopes. At the Los Angeles/Long Beach port of entry, for instance, PVT monitors routinely send up to 600 conveyances of cargo to secondary inspection each day. In addition, the RIIDs used in secondary inspections are limited in their abilities to locate and identify potential radioactive material in large cargo containers.

In order to help improve the flow of commerce by eliminating many of the unnecessary alarms that send cargo for secondary screening and to more accurately identify radioactive or nuclear material, the Department of Homeland Security (DHS) began developing Advanced Spectroscopic Portals (ASPs) in 2004. The ASPs were intended to both *detect* and *identify* radioactive material. In April 2005, the Domestic Nuclear Detection Office was created by National Security Presidential Directive-43/Homeland Security Presidential Directive-14 to, among other things, research, develop, test and acquire radiation detection equipment to be used by CBP and other federal agencies.

In July 2006, then-Secretary of Homeland Security Michael Chertoff and the former Director of DNDO, Vayl Oxford, announced contract awards to three companies worth an estimated $1.2 billion to develop the ASPs, including the Raytheon Company and the Thermo Electron Company (now called Thermo Fisher Scientific Inc.) both headquartered in Waltham, Massachusetts and Canberra Industries from Connecticut. Canberra is no longer a contractor on the DNDO program.

ASP Requirements/Criteria

One of the key reasons for replacing the existing radiation monitors with newly developed ASPs in the first place, as articulated by Secretary of Homeland Security, Michael Chertoff in July 2006 was to "have fewer false positives." In September 2007, Vayl Oxford, then the director of DNDO reiterated that point in testimony to Congress where he emphasized that the ASPs would reduce the number of false alarms from the nearly 600 experienced each day by the PVTs at the port of Long Beach in California, for instance, to 20-to-25 per day with the new ASP monitors. That was the hope, but it has not been the reality during testing of the ASPs and other serious security questions about the performance reliability of the ASPs have emerged in the most recent round of tests.

As the House Committee on Appropriations has said in the past, procurement of the Advanced Spectroscopic Portal monitors should not proceed until they are deemed to add a "significant increase in operational effectiveness" over the current PVT system already in place. In July 2008, CBP, DNDO and the DHS management directorate jointly issued criteria for determining this increase in effectiveness in both "primary" and "secondary" screening. In primary screening the criteria requires ASPs to detect potential threats as well as or better than PVTs, show improved detection of Highly Enriched Uranium and reduce innocent alarms. In secondary screening the criteria requires ASPs to reduce the probability of misidentifying special nuclear material (HEU or plutonium) and reduce the average time to conduct secondary screenings. The Secretary of Homeland Security must certify to Congress that the ASPs have met these criteria before funding for full-scale procurement of the ASPs goes forward. The criteria to measure this improvement, however, are weak and rather vague.

Testing Regime

Significant hurdles remain before ASPs can be certified and fully deployed. Both contractors have passed "integration testing." They must now successfully make it through Field Validation Tests where they operate at ports of entry in tandem with PVT units. So far, only one of the two ASP vendors has made it to this stage. The one vendor that has made it to this stage will need to make its third attempt to successfully pass the Field Validation Tests before it can move forward. If and when they successfully pass this stage of testing they will then go to "Solo Operations," where they will be tested at a port-of-entry operating independently of the PVTs. If they pass those two critical tests, then the DHS Directorate of Science & Technology which has been mandated the Operational Testing Authority (OTA) of the ASPs will put them through a separate series of tests to ensure they meet the specified requirements, do not suffer from technical glitches and operate efficiently. Once that testing is completed and the S&T Directorate signs off on the performance and reliability of the ASPs then the DHS Secretary must make a determination about whether the costs of the ASPs and the capabilities they provide justifies a decision to invest in their full scale deployment. Along the way DNDO is supposed to provide a final cost-benefit-analysis of the ASP program to help inform the Secretary's decision. This document has been promised many times but not yet completed.

Masking & Shielding

If terrorists were to try to smuggle nuclear or radiological materials into the U.S. via containerized cargo they would likely try to shield and/or mask those materials in an attempt to make it more difficult to detect, identify and locate the material of concern. Shielding requires that lead or other types of metal enclose the radioisotopes to hide its radioactive signature. Potential terrorists may also attempt to "mask" threatening radioactive material by placing it together with or alongside other non-threatening material that has a natural radioactive signature, such as ceramic material, kitty liter or even bananas. Most nuclear security experts believe smuggled radioactive or nuclear material would be both shielded and masked in order to conceal it from being located and properly identified. These efforts would make it harder to detect.

Many of DNDO's previous tests of the ASPs have been criticized for being less than realistic. In one series of tests the ASP portals did prove more effective than the PVTs in detecting HEU materials concealed by "light shielding." However, differences between the ASPs and PVTs became less notable when shielding was slightly increased or decreased. In other tests there was virtually no difference in the performance of the two machines with regard to detecting other kinds of radioactive isotopes, such as those used for medical or industrial purposes, according to the GAO, except in one case where the ASPs performed worse than the PVTs. In the most recent round of tests in July DNDO says the ASPs detected one radioactive source that the PVTs missed.

In previous attempts to detect HEU during tests, the ASPs performed better only in one narrowly defined scenario, which many experts see as an unrealistic portrayal of a true attempted nuclear smuggling incident. None of the tests run by DNDO, for instance, included scenarios that utilized both "shielding" and "masking" as a means of attempting to smuggle radioactive or nuclear material. In addition, only one of the vendors has made it to field validation testing. But as the contractor has attempted to fix problems that occurred during previous tests new, more serious technical issues have emerged.

Field Validation Tests

The Raytheon ASPs went through their first round of field tests last February, but technical issues hampered their performance. They had a large number of false alarms on several radioactive isotopes. Overall, in fact, the ASPs sent more cargo for secondary inspection than the currently operating PVTs did. Adjustments were made to prepare them for another round of field tests. Since the Subcommittee's last hearing on the ASP program in June, the ASPs have gone through a second Field Validation Test at four U.S. ports of entry in L.A. Long Beach, California; the New York Container Terminal in Newark, New Jersey; Port Huron, Michigan; and Laredo, Texas.

On average, the PVTs refer one out of every 40 cargo containers to secondary inspection placing a large a burden on the staffing resources of CBP. The ASPs are required to send only one out of every 1,000 inspections to secondary inspection in order to help lessen that logistical burden. This is one of the key requirements that must be met in order for the Secretary of Homeland Security to permit full scale production of the ASPs to proceed. During the Field Validation Testing last February, however, the ASPs sent more than five times that number of cargo conveyances to secondary inspection based on false alarms. During the most recent Field Validation Tests in July the ASPs reportedly reduced the number of false alarms compared to the PVTs by 69 percent bringing them much closer to the 80 percent reduction in false alarms that they are required to meet. But new, more serious problems also emerged during the field validation tests in July.

During this second round of field tests the ASPs again failed to perform as expected. This time they falsely identified several cargo conveyances as having special nuclear material, when they actually had none. This is a critical issue, since the actual smuggling of special nuclear material presents a serious threat. If it is detected at a port-of-entry Customs and Border Protection officers have extensive response requirements they must implement. DNDO and the contractor are still unclear why the ASPs falsely identified special nuclear material during these tests. Their intended fix to this problem has been to decrease the sensitivity of the ASP monitors to specific radioactive isotopes. The hope is that this will correct the problem, reduce the number of false alarms and still ensure that the ASPs are able to detect these isotopes. It is a delicate and difficult balance. It also decreases the ostensible advantage of having the ASPs replace the PVTs in the first place.

Most unsettling, in one instance during the July tests one ASP monitor stopped working altogether yet the system operator remained unaware of this malfunction. Two dozen cargo trucks were permitted to go through the ASP in order to be screened for potential radioactive and nuclear material while it was not operating. DNDO considered this a "Mission Critical Failure." Fortunately, during these tests all trucks that went through the ASP also went through a PVT monitor. If this had occurred during "solo" testing of the ASPs or during actual deployment of the ASPs, cargo carrying radiological or nuclear threat material could have sailed past port security and into the United States unchecked. The cause of this problem has reportedly been rectified by the contractor.

Energy Windowing

Many experts believe significant improvements can be made to the existing fleet of PVT radiation monitors without investing billions of dollars into new ASPs. Energy windowing is a mathematical algorithm that can help improve the sensitivity of PVT radiation monitors, enhancing their ability to detect radioactive sources resulting in improved operations and capabilities. The technology is currently used in some radiation monitors. Both GAO and CBP believe that DNDO should much more aggressively invest in this research to improve the performance of the currently operating radiation detection monitors. Although energy windowing may only lead to modest enhancements in the performance of PVTs, that improvement could be significant in terms of improving their performance to be more on par with what ASPs are supposed to be capable of and at a far less financial cost. Reducing the sensitivity of the ASPs to certain types of special nuclear material, which was done to resolve the problems that emerged during the July tests, should not prevent them from alarming for isotopes that were not there in the first place. The only result would be to reduce the odds that the ASPs will identify those isotopes when they are actually present.

A Dwindling Supply of Helium-3 (He-3)

The future deployment of both PVT and ASP monitors is dependent on the supply of Helium-3 (He-3), a non-radioactive gas that is a byproduct of tritium decay. Tritium is a critical component in nuclear weapons used to boost the yield of nuclear warheads. Helium-3 gas is used in neutron detector tubes, a component of both PVT and ASP radiation portal monitors used to help identify plutonium. He-3 is also used in medical imaging, such as MRI machines, the oil and gas industry and for high energy research. During the cold war the U.S. had a steady supply of He-3 as a result of its nuclear weapons production operations. With the end of the cold war the production of nuclear weapons ceased and this supply diminished. At the same time, since 9/11 the demand for radiation monitors skyrocketed and demand for He-3 soon out-paced the supply.

There are no readily available alternatives to He-3. In addition, no other technology matches the stability, sensitivity, and ability to detect neutron radiation that He-3 neutron tubes currently offers. DNDO has estimated that the anticipated supply-to-demand ratio of Helium-3 in coming years is expected to be 1-to-10. Costs for the rare isotope have already begun to rise. By one estimate, a few years ago the cost of He-3 was around $100 per liter. Today, He-3 is estimated to cost as much as $2,000 per liter. According to a recent Department of Energy report, new ASP radiation monitors will use nearly *three times* more He-3 as current PVT monitors do, about 132 liters compared to 44 liters. These facts should be carefully considered by the Secretary of DHS when making cost-benefit decisions about whether or not to proceed with producing the ASPs.

Cost Benefit Analysis

Even if the technical abilities of the ASPs are proven, their relative technical capabilities and increased costs must be carefully weighed in comparison to the existing radiation monitoring system in place today. Replacing a proven, less-costly system that has the confidence of its operators, must be given careful consideration. The DNDO has not yet provided an updated cost-benefit-analysis that would validate a decision to procure the multi-billion dollar ASP equipment.

Virtually any high-technology research and development program experiences bumps in the road, technical troubles and occasional set-backs. However, well managed programs have clear technical requirements and strategic goals. They ensure that the new technology being developed is thoroughly tested and adequately integrated into the operational plans and procedures of those who must operate them in the field. When these vital components are short changed, when the test plan is insufficient and the program's research, development and testing methods are marred by scanty scientific rigor then the technical tools being developed are bound to suffer as a result. Cutting critical corners in the development process serves no one's interests. Yet, at the start of the ASP program many of the DNDO leaders seemed more interested in fielding this technology then in effectively validating its performance and effectiveness. At the July 2006 press conference unveiling the contractors on the ASP program, Vayl Oxford then the Director of DNDO said: "the priority for the first year . . . is to get units out immediately." Three years later, none of the ASPs have yet cleared field validation tests.

Witnesses:

Mr. Gene Aloise, *Director, Natural Resources and Environment, Government Accountability Office (GAO)*

Dr. Timothy M. Persons, *Chief Scientist, Government Accountability Office (GAO)*

Mr. Todd Owen, *Executive Director for Cargo and Conveyance Security, U.S. Customs and Border Protection (CBP), Department of Homeland Security (DHS)*

Dr. William Hagan, *Acting Deputy Director, Domestic Nuclear Detection Office (DNDO), Department of Homeland Security (DHS)*

Chairman MILLER. Welcome to today's hearing entitled *The Science of Security, Part II: Technical Problems Continue to Hinder Advanced Radiation Monitors.*

Soon after the September 11 attacks, Customs and Border Protection, CBP, began operating radiation portal monitors to screen cargo entering the United States for radiological and nuclear material. They have purchased approximately 1,500 polyvinyl toluene monitors and deployed them at ports and border crossings throughout the United States. Mercifully, polyvinyl toluene monitors are generally referred to as PVTs.

PVTs indicate the presence of a radiation source, but they cannot identify the nature of the source. As a result, any cargo container that provokes a warning from a PVT is then sent to a secondary inspection where customs officers use other technology and information to determine what sort of material is in the container. There are plenty of innocent sources of radiation: kitty litter, medical isotopes, ceramics, bananas, and many of these secondary inspections can be handled quickly. However, some secondary inspections require that the container be opened, and even emptied, in the search for a source. That is time consuming, but the PVT seems to be working well to meet customs' dual mission to keep us safe while maintaining a steady flow of commerce.

The Department of Homeland Security (DHS) has been developing a new radiation portal monitor, championed by the Domestic Nuclear Detection Office, DNDO, that advocates believe should replace the PVTs. The new monitor, the Advanced Spectroscopic Portal monitor, or ASP, would detect the presence of radiation in cargo, but it would also identify the type of radiation. That would allow more harmless cargo to pass unimpeded through the port and require far fewer secondary referrals. If it worked as advertised, the ASPs would be more likely to identify highly enriched uranium or other materials of concern and enhance the flow of commerce while freeing up customs officers to tend to other duties besides secondary inspections.

Despite a $230 million investment of taxpayer dollars thus far for development, the ASPs haven't performed as expected, and the results from recent tests are still worrisome. Last June we learned of problems in the first field test in February 2009. At our June hearing we heard that those issues had been fixed and that the July field test would allow the department to move forward towards a cost-benefit analysis and certification decision for the Secretary. So far, we have seen neither.

The July test highlighted yet another problem with the ASPs. The devices detected nuclear materials when none were present.

The ASPs had numerous false positive hits for special nuclear material in July, each one of which would have resulted in the implementation of mandated security responses by Customs, potentially shutting down port operations. Fortunately, Customs was also running the PVTs which saw no radiation presence, and there was none, and cleared up the issue in secondary fairly quickly.

DNDO has told our staff that they intend to fix this new problem by changing the sensitivity of the ASPs to detect uranium, but it isn't clear why that should be reassuring, changing the sensitivity setting. If we lower the sensitivity setting to the very materials the

ASP is supposed to be better at monitoring or detecting, would the ASP still be better than PVTs at detecting those materials? And would we have to go back to the Nevada Test Site to prove that you can still detect levels of special nuclear material more accurately than the PVTs can?

Second, if the machines detect special nuclear material when there is none there, how does changing the sensitivity make any difference at all? Detecting ghost isotopes is a problem with the operating system, not with the sensitivity level, it would appear anyway.

Since the taxpayers have spent $200,000 for each of the 1,500 PVTs that are deployed now, the case for ASPs, which will run about $800,000 per unit, a total cost of $2 to $3 billion, needs to be clear both in terms of better detection performance and better support for Customs operations. Add to that greater acquisition cost, an annual operating expense of ASPs that is at least five times more expensive per unit than PVTs, and the need for a convincing case is even greater. As it stands, it is hard to see why ASPs should be more than a secondary inspection tool.

In fact, that is the role they play in the Department of Energy's Megaport program. The DOE already runs a program that inspects cargo leaving 27 major foreign ports for destinations anywhere in the world. DOE, which developed portal radiation detection technology, uses PVTs for primary inspection and then uses the ASPs for secondary inspection to help identify the type of isotope to which the PVT responded in the first place. The Department of Energy's approach to identifying radiation should be instructive to DHS.

I want to thank all of our witnesses for appearing today. I particularly want to thank GAO for continuing their work on this matter and for their continued assistance to this committee and Congress, and the Appropriations Committee as well. It is very helpful for the Appropriations Committee to be asking the right questions, and you have helped them and helped us ask the right questions. I suspect that this will not be the last time that we gather on this subject—we do seem to come back to the same subjects again and again—nor the last time we hear from witnesses that we still face a long list of tests and validations before we can think about replacing the PVTs with the ASPs.

I would now recognize the Ranking Member, Dr. Broun, for his opening comment.

[The prepared statement of Chairman Miller follows:]

PREPARED STATEMENT OF CHAIRMAN BRAD MILLER

Soon after the September 11 attacks, Customs and Border Protection (CBP) began operating radiation portal monitors to screen cargo entering the United States for radiological or nuclear material. They have purchased approximately 1,500 polyvinyl toluene (PVT) monitors and deployed them at ports and border crossings throughout the United States.

PVTs indicate the presence of a radiation source, but they cannot identify the nature of the source. As a result, any cargo container that provokes a warning from a PVT is then sent to a "secondary" inspection where Customs officers use other technology and information to determine what sort of material is in the container. There are plenty of innocent sources of radiation—from kitty litter to medical isotopes—and many of these secondary inspections can be handled quickly. However, some secondary inspections require that the container be opened, and even emptied, in the search for a source. While this is time consuming, the PVT seems to be working well to meet Customs' dual mission to keep us safe while maintaining a steady flow of commerce.

The Department of Homeland Security has been developing a new radiation portal monitor, championed by the Domestic Nuclear Detection Office (DNDO), that advocates believe should replace the PVTs. This new monitor—the Advanced Spectroscopic Portal monitor or ASP—would detect the presence of radiation in cargo, but it would also identify the type of radiation. This would allow more harmless cargo to pass unimpeded through the port and require far-fewer secondary referrals. If it worked as advertised, the ASPs would be more likely to identify highly enriched uranium and other materials of concern and enhance the flow of commerce while freeing up Customs officers to tend to other duties besides secondary inspections.

Despite a $230 million investment of taxpayer dollars for development, the ASPs haven't performed as expected, and the results from recent field tests are worrisome. Last June we learned of problems in the first field test of February 2009. At our June hearing we heard that those issues had been fixed and that the July field test would allow the Department to move towards a cost-benefit analysis and certification decision for the Secretary. To date, we have seen neither.

The July field test highlighted yet another problem with the ASPs: *the devices detected nuclear materials when none were present.*

The ASPs had numerous false positive hits for special nuclear material in July—each one of which would have resulted in the implementation of mandated security responses by Customs, potentially shutting down port operations. Fortunately, Customs was also running the PVTs (which properly saw no radiation present) and cleared up the issue in secondary.

DNDO has told our staff that they intend to fix this new problem by changing the sensitivity of the ASPs to detecting uranium, but it isn't clear that should be reassuring. If you lower the sensitivity to the very materials the ASP was supposed to be better at detecting, why would the ASP will still be better than PVTs at detecting those materials? Would you have to go back to the Nevada Test Site to prove that you can still detect levels of special nuclear material more accurately than the PVTs can?

Second, if the machines detect special nuclear material where it doesn't exist, why should changing the sensitivity make any difference at all? Detecting ghost isotopes is a problem with the operating system itself, not with the sensitivity level for a particular isotope.

Since the taxpayers have spent $200,000 for each of the 1,500 PVTs already deployed, the case for ASPs, which will run approximately $800,000 per unit—for a total cost of $2–3 billion—needs to be clear both in terms of better detection performance and better support for Customs operations. Add to this greater acquisition cost, an annual operating expense of ASPs that is at least five times more expensive per unit than PVTs, and the need for a convincing case is even greater. As it stands, it is hard to see why ASPs should be more than a secondary inspection tool.

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I want to thank our witnesses for attending today. I particularly want to thank GAO for their continuing work on this matter and for their continuing assistance to this committee and Congress. I suspect that this will not be the last time we gather on this subject, nor the last time we hear from witnesses that we still face a long list of tests and validations before we can even speak sensibly about replacing PVTs with ASPs.

Mr. BROUN. Thank you, Mr. Chairman. I want to welcome the witnesses here today and thank you all for participating in our follow-up hearing on the Department of Homeland Security's Advanced Spectroscopic Portal program. It is hard for a Southerner to say quickly.

This afternoon we will be brought up to date on the Department's ongoing development of the next generation radiation portal monitors and get an update from the GAO on their continuing work. As I said in our earlier hearing this past summer, this program is certainly not out of the woods. The latest field validation tests reveal additional problems that will have to be overcome before moving forward. I hope DNDO will be able to give us some insight today on what we can expect from this program in terms of the future paths forward. With considerable taxpayer money on the line, questionable improvements over current capabilities and outstanding cost benefit analysis and a confusing acquisitions history that unfortunately has morphed the R&D with procurement, this program is rapidly approaching a point where the Federal Government has to decide whether it wants to fish or cut bait. I am concerned with the fact that considerable public funding has been expended on developing a technology that the private sector was developing in parallel on its own dime. DHS as a whole, and DNDO, CBP, DHS, S&T individually, should be focusing on long-term, high-risk, high-reward technology, not providing seed money for commercial, off-the-shelf equipment. That being said, I realize that DHS's mission is vastly different from DOE's, the Department of Defense's and that they have additional requirements that demand a more robust system. GAO and the Academy made several recommendations over the past few years. I trust that DNDO and CBP will be able to update this committee on how they are responding to those recommendations and where they plan to go from here. The Nation expects a lot from the Department, and I hope that we aren't developing tunnel vision by focusing too much on one method of conveyance and not seeing the forest for the trees. The Department has an enormous task of securing our borders and not just at points of entry but all along our borders. Spending billions of dollars to secure the front door of our house doesn't seem very rational if we are just going to leave the back door open and all the windows and have a gaping hole in the walls, too. That is not to say that we should do nothing at all, but rather, everything we do should be put in context of a well-thought-out global nuclear detection architecture.

As I said earlier this summer, many of these issues we are dealing with today could have been prevented by engaging the end-users earlier in the process. Clearly defining the requirements, developing clear architectural priorities and simply following a clear acquisition process. This Committee is no stranger to programs that have set aside these best practices for working in expediency's sake.

I look forward to working with the Department and the Majority to make sure any decision that is made is in the best interest of our nation's security, the taxpayer and our economy.

With that, Mr. Chairman, I yield back my time and I thank you.

[The prepared statement of Mr. Broun follows:]

PREPARED STATEMENT OF REPRESENTATIVE PAUL C. BROUN

Thank you, Mr. Chairman. I want to welcome the witnesses here today, and thank them for participating in our follow-up hearing on the Department of Homeland Security's (DHS) Advanced Spectroscopic Portal (ASP) program. This afternoon we will be brought up to date on the Department's ongoing development of next generation Radiation Portal Monitors and get an update from the General Accountability Office (GAO) on their continuing work.

As I said at our earlier hearing this past summer, this program is certainly not out of the woods. The latest Field Validation Test revealed additional problems that will have to be overcome before moving forward. I hope DNDO will be able to give us some insight today on what we can expect from this program in terms of future paths forward. With considerable. taxpayer money on the line, questionable improvements over current capabilities, an outstanding cost-benefit analysis, and a confusing acquisitions history that unfortunately has morphed Research and Development (R&D) with procurement, this program is rapidly approaching a point where the Federal Government has to decide to "fish or cut bait."

I'm also concerned with the fact that considerable public funding has been expended on developing a technology that the private sector was developing in parallel on its own dime. DHS as a whole (and DNDO, CBP, and DHS S&T individually) should be focusing on long-term high-risk high-reward technology, not providing seed money for Commercial Off-The-Shelf (COTS) equipment. That being said, I realize that DHS' mission is vastly different from the Department of Energy's (DOE) and the Department of Defense's (DOD), and that they have additional requirements that demand a more robust system.

GAO and the Academy made several recommendations over the last few years. I trust that DNDO and CBP will be able to update this committee on how they are responding to those recommendations, and where they plan to go from here. The Nation expects a lot from the Department, and I hope that we. aren't developing tunnel vision by focusing too much on one method of conveyance and not seeing the forest through the trees. The Department has an enormous task of securing our borders, not just at points of entry, but all along our borders. Spending billions of dollars to secure the front door or our house, doesn't seem very rational if we are just going to leave the back door open: That is not to say we should do nothing at all, but rather everything we do should be put in the context of a well thought out Global Nuclear Detection Architecture.

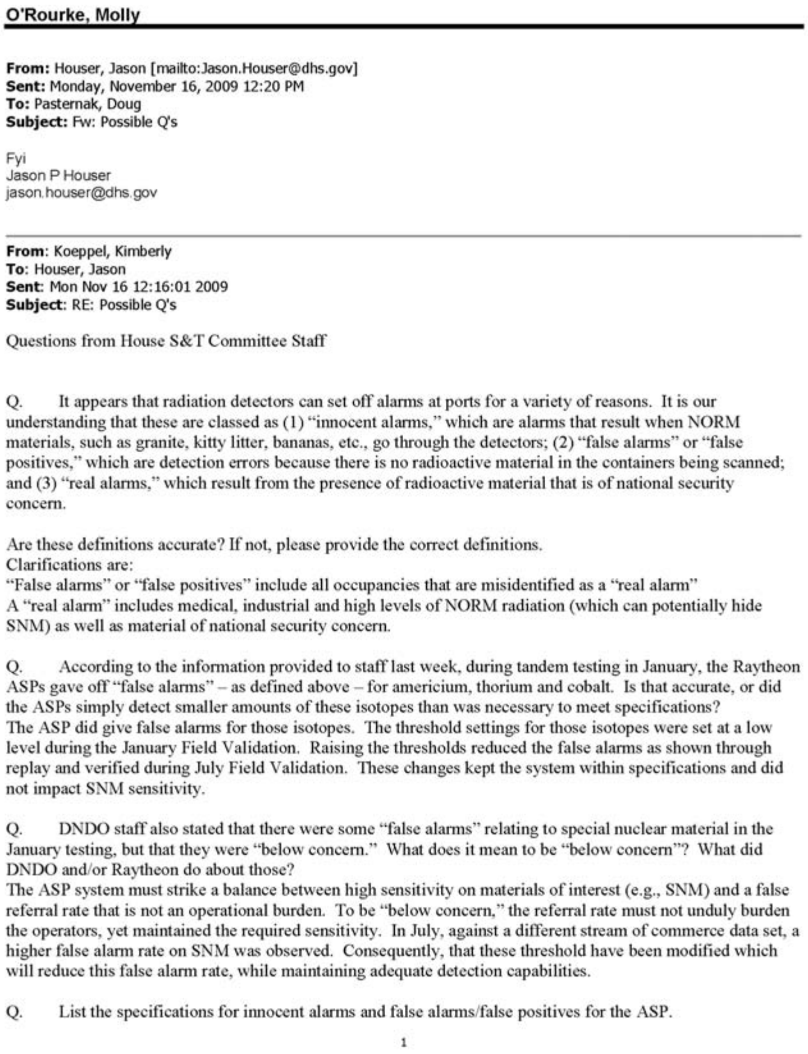
As I said earlier this summer, many of the issues we are dealing with today could have been prevented by engaging the end-users earlier in the process, clearly defining requirements, developing clear architectural priorities, and simply following a clear acquisition process. This committee is no stranger to programs that have set aside these best practices for expediency's sake. I look forward to working with the Department and the majority to make sure any decision made is in the best interest of our nation's security, the taxpayer, and our economy.

With that, Mr. Chairman, I yield back my time.

Thank you.

Chairman MILLER. Thank you, Dr. Broun. I ask unanimous consent that all additional opening statements submitted by Members be included in the record. Without objection, it is so ordered. Also, there has been an e-mail exchange between our staff and the staff of DNDO, Kimberly Koeppel, and without objection, I move that the printed versions of the e-mailed questions and answers also be entered into the record. Without objection, so ordered.

[The information follows:]



O'Rourke, Molly

From: Houser, Jason [mailto:Jason.Houser@dhs.gov]
Sent: Monday, November 16, 2009 12:20 PM
To: Pasternak, Doug
Subject: Fw: Possible Q's

Fyi
Jason P Houser
jason.houser@dhs.gov

From: Koeppel, Kimberly
To: Houser, Jason
Sent: Mon Nov 16 12:16:01 2009
Subject: RE: Possible Q's

Questions from House S&T Committee Staff

Q. It appears that radiation detectors can set off alarms at ports for a variety of reasons. It is our understanding that these are classed as (1) "innocent alarms," which are alarms that result when NORM materials, such as granite, kitty litter, bananas, etc., go through the detectors; (2) "false alarms" or "false positives," which are detection errors because there is no radioactive material in the containers being scanned; and (3) "real alarms," which result from the presence of radioactive material that is of national security concern.

Are these definitions accurate? If not, please provide the correct definitions.
Clarifications are:
"False alarms" or "false positives" include all occupancies that are misidentified as a "real alarm"
A "real alarm" includes medical, industrial and high levels of NORM radiation (which can potentially hide SNM) as well as material of national security concern.

Q. According to the information provided to staff last week, during tandem testing in January, the Raytheon ASPs gave off "false alarms" – as defined above – for americium, thorium and cobalt. Is that accurate, or did the ASPs simply detect smaller amounts of these isotopes than was necessary to meet specifications?
The ASP did give false alarms for those isotopes. The threshold settings for those isotopes were set at a low level during the January Field Validation. Raising the thresholds reduced the false alarms as shown through replay and verified during July Field Validation. These changes kept the system within specifications and did not impact SNM sensitivity.

Q. DNDO staff also stated that there were some "false alarms" relating to special nuclear material in the January testing, but that they were "below concern." What does it mean to be "below concern"? What did DNDO and/or Raytheon do about those?
The ASP system must strike a balance between high sensitivity on materials of interest (e.g., SNM) and a false referral rate that is not an operational burden. To be "below concern," the referral rate must not unduly burden the operators, yet maintained the required sensitivity. In July, against a different stream of commerce data set, a higher false alarm rate on SNM was observed. Consequently, that these threshold have been modified which will reduce this false alarm rate, while maintaining adequate detection capabilities.

Q. List the specifications for innocent alarms and false alarms/false positives for the ASP.

Definition of INNOCENT Alarm, taken from Spec v4.10:

{ASP-1370} GREEN = Innocent notification – Used to indicate that only NORM radionuclides have been identified. Generally does NOT select vehicle for additional inspection unless other negative factors are present.

From Appendix 3 (Alarm Definitions) of the spec:

Correct Dismissal – Correct Negative

A correct dismissal is defined as properly releasing non-threat cargo into the stream-of-commerce without further inspection. For ASP, the GREEN (Innocent) and WHITE (No radioactivity) indications result in NO diversion to secondary for further investigation.

...and also...

e. Innocent Alarm State

For the ASP, an innocent alarm state (GREEN) is produced by conditions defined by the user to over-ride specified gamma gross-count alarm states.

For example, an innocent alarm state exists when an over-threshold gross-count alarm identified as NORM without SNM occurs, and the user has set a condition to block the gross count alarm notification. The "innocent alarm state" vehicle is not diverted to secondary screening and does not produce a false alarm because the potential gross-count false alarm was automatically cleared based on spectral information. It is desirable for potential "nuisance false alarm" vehicles to process as innocent alarm states. However, it is possible for SNM cargo to be passed as an innocent alarm state which is a false negative error. There is real risk that a simple portal or handheld spectrometer with only a small NaI crystal can readily respond to NORM cargo, but not be sensitive to threat materials surrounded by cargo. Therefore, rigorous testing to establish adequate sensitivity to SNM surrounded by cargo is required for any sensor system incorporating an innocent alarm state feature or being used to clear false alarms.

In secondary screening, one desires sensitivity to NORM cargo and thus the ability to readily identify NORM causes of gamma gross count alarms generated by a PVT RPM in primary. The ASP identification a potential reason for a gamma gross count alarm is more than release on NORM excuse, because the ASP is capable of identifying threat radionuclides and these were not found during the ASP survey.

Definition of False Alarm, taken from Spec v4.10:

(relative to gamma detector)

{ASP-313} Gross counting alarm threshold shall be set with a statistical false alarm rate of < 0.1%.

(relative to neutron detector)

{ASP-391} Gross counting alarm threshold shall be set with a false alarm rate of < 0.1%.

From Appendix 3 (Alarm Definitions) of the spec:

False Alarm – False Positive Error

In the context of vehicle surveys, a false alarm is defined as any threat alarm or diversion of a non-threatening vehicle from primary screening to secondary screening not due to a threat material. In statistical terms, this is a false positive error. A false alarm is due to one of the following:

1) Due to either a statistical fluctuation defined as a statistical false alarm.

2) Due to physical causes defined as a systematic false alarm.

This false alarm discussion is in the framework of a radiation measurement producing a count value (e.g., gross count, energy-window count, or peak-region count).

The systematic and statistical components of the measurement uncertainty are added in quadrature to produce an aggregate uncertainty.

a. Statistical False Alarm

Statistical false alarms are a result of random statistical fluctuations in a measurement or count value. For Poisson statistics, the purely statistical standard error in the count value equals the square root of the count value. Whenever the statistical component dominates, the standard error scales with the square root of the product of the sensor area and measurement time. For spectral algorithms, the peak region `is generally counted starved and the statistical component dominates.

b. Systematic False Alarm

Systematic false alarms are a result of changes or uncertainties in count rates due to physical causes. A nearby radiation source is a common cause of systematic false alarms. The systematic component is not readily estimated from a statistical model but can be empirically determined. The survey scenario includes some empirical distribution related to the number of vehicles carrying radiation sources and the size for those radiation sources. Physical causes may include NORM cargo, medical radiation sources, industrial radiation shipments, radon plumes, and variable shielding scenarios. Some radiation sources are associated with the surveyed vehicle and others with the surrounding environment. During vehicle surveys, most gross-count false alarms are systematic and are due to a physical cause from a radiation source within the vehicle. In this case, the systematic false alarm rate is not reduced by increasing the sensor size or the measurement time. Spectral and temporal characteristics can identify and eliminate some undesirable physical cause scenarios. For gross counting, the systematic component dominates vehicle surveys, and the false alarm rate will not be reduced by increasing sensor size.

c. Nuisance False Alarm

For vehicle surveys, a nuisance false alarm is a systematic false alarm associated with some actual radiation source carried within the vehicle (e.g., NORM cargo or medical radionuclide in a vehicle). If medical and industrial sources are included in the threat definition, they should not be considered a false alarm cause. The declaration of an ASP GREEN (Innocent) indication or alarm for NORM-cargo does not result in diversion to secondary or count as a false alarm, because the ASP algorithm recognized the radiation source as acceptable for commerce. The declaration of a PVT or gross count GAMMA alarm due to NORM-cargo results in diversion to secondary and counts as a false alarm, because there was no indication that the radiation source is acceptable for commerce. To be defined as a nuisance or innocent false alarm, the actual radiation source causing the false alarm must be within the acceptable limits of normal commerce. Acceptable radiation sources can be considered innocent or benign. Vehicles causing these systematic false alarms are cleared by secondary inspection and returned to the stream-of-commerce with no enforcement action. Thus, nuisance or innocent refers to the radiation content of the vehicle or physical cause of the alarm.

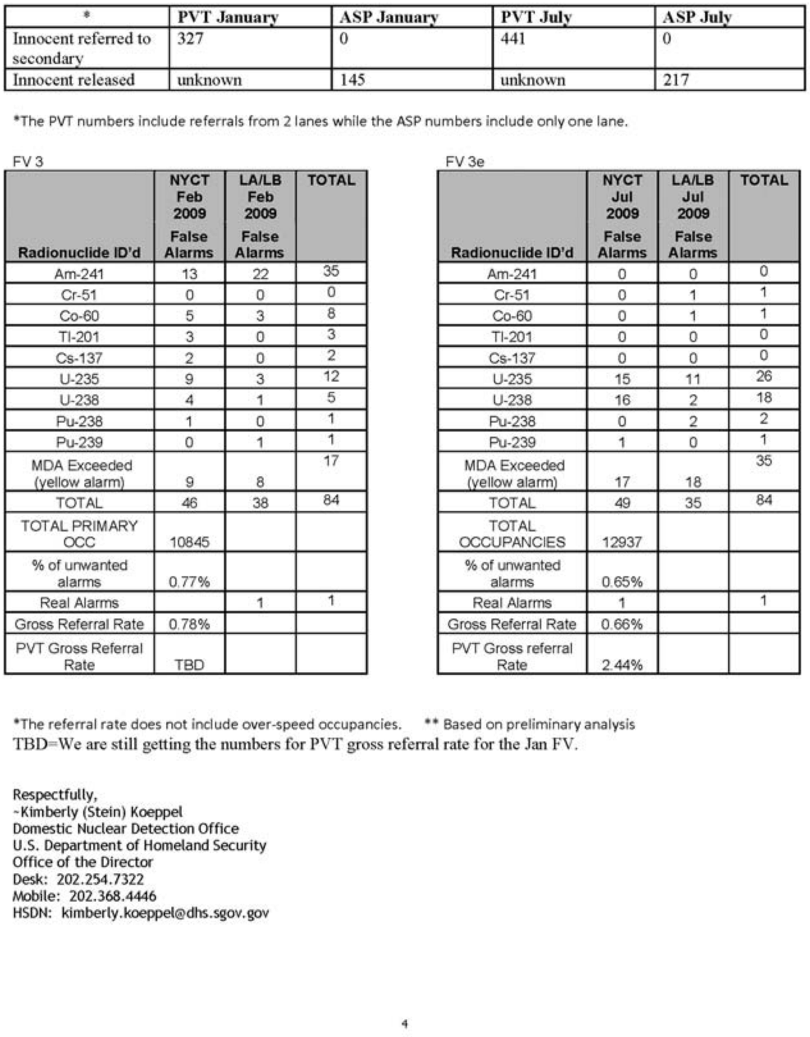
... and later ...

f. Non-Vehicle False Alarm

A non-vehicle false alarm is defined as any false alarm caused by sources external to the portal with a vehicle within the portal. Some surveys may produce a false alarm without any physical cause being present within the surveyed vehicle but the cause is a strong source located in the vicinity of the portal. Examples include a hot medical source in a nearby vehicle (i.e., cross-talk), a radon plume, and a nearby radiographic source.

Q. Please provide side-by-side data for both the PVTs and ASPs for the January and July tests for the following categories:

1. Total number of innocent alarms; how many would be released at primary screening, and how many would have gone to secondary under a solo ASP system.
2. Number of false alarms and/or false positives for special nuclear material.
3. Number of real alarms that require referral to secondary screening.



*	PVT January	ASP January	PVT July	ASP July
Innocent referred to secondary	327	0	441	0
Innocent released	unknown	145	unknown	217

*The PVT numbers include referrals from 2 lanes while the ASP numbers include only one lane.

FV 3

Radionuclide ID'd	NYCT Feb 2009 False Alarms	LA/LB Feb 2009 False Alarms	TOTAL
Am-241	13	22	35
Cr-51	0	0	0
Co-60	5	3	8
Tl-201	3	0	3
Cs-137	2	0	2
U-235	9	3	12
U-238	4	1	5
Pu-238	1	0	1
Pu-239	0	1	1
MDA Exceeded (yellow alarm)	9	8	17
TOTAL	46	38	84
TOTAL PRIMARY OCC	10845		
% of unwanted alarms	0.77%		
Real Alarms		1	1
Gross Referral Rate	0.78%		
PVT Gross Referral Rate	TBD		

FV 3e

Radionuclide ID'd	NYCT Jul 2009 False Alarms	LA/LB Jul 2009 False Alarms	TOTAL
Am-241	0	0	0
Cr-51	0	1	1
Co-60	0	1	1
Tl-201	0	0	0
Cs-137	0	0	0
U-235	15	11	26
U-238	16	2	18
Pu-238	0	2	2
Pu-239	1	0	1
MDA Exceeded (yellow alarm)	17	18	35
TOTAL	49	35	84
TOTAL OCCUPANCIES	12937		
% of unwanted alarms	0.65%		
Real Alarms	1		1
Gross Referral Rate	0.66%		
PVT Gross referral Rate	2.44%		

*The referral rate does not include over-speed occupancies. ** Based on preliminary analysis
TBD=We are still getting the numbers for PVT gross referral rate for the Jan FV.

Respectfully,
~Kimberly (Stein) Koeppel
Domestic Nuclear Detection Office
U.S. Department of Homeland Security
Office of the Director
Desk: 202.254.7322
Mobile: 202.368.4446
HSDN: kimberly.koeppel@dhs.sgov.gov

Chairman MILLER. It is my pleasure to introduce our witnesses at this time. Mr. Gene Aloise is the Director of Natural Resources and Environment at the Government Accountability Office, GAO. He is an expert in international nuclear proliferation and safety issues and holds degrees in political science, economics and public administration. Mr. Aloise is a recipient of GAO's Meritorious Service and Distinguished Services Awards and has served several Congressional committees and offices within GAO. This is not the first time he has appeared before us on this topic.

With Mr. Aloise is Dr. Timothy Persons, GAO's Chief Scientist. Before entering GAO, before joining GAO, Dr. Persons was the Technical Director of the Intelligence Advanced Research Projects Activity, I–ARPA, and previously served as a technical director at the National Security Agency. Mr. Persons, if people ask you at a cocktail party what you did for a living, did you just say you worked for the government? He holds degrees in nuclear physics, computer science and biomedical engineering and has been involved in evaluations of many high-tech U.S. Government programs and projects, including GAO's work on the Advanced Spectroscopic Portals, ASP monitors. We look forward to hearing his testimony today as well.

Mr. Todd C. Owen is the Acting Deputy Assistant Commissioner of the Office of Field Operations for the U.S. Customs and Border Protection, Department of Homeland Security. Also a mouthful. He also served as the Executive Director of the Cargo and Conveyance Security Office, Office of Field Operations, since May of 2006. Mr. Owen began his career with the Customs and Border Protection in 1990 and has previously held the positions of Area Port Director in New Orleans and Director of the Customs Trade Partnership Against Terrorism, C–TPAT Program.

And then finally, Dr. William Hagan is the Acting Deputy Director of the Domestic Nuclear Detection Office at the Department of Homeland Security. Dr. Hagan holds degrees in physics and nuclear engineering as well as three patents. He spent 30 years with the Science Applications International Corporation before coming to DNDO and serving as the Assistant Director of the Transformational Research and Development Directorate.

I think all of our witnesses would need to use small print for their business cards.

As our witnesses should know, you will each have five minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When you all have completed your spoken testimony, we will begin with questions. Each Member will have five minutes to question the panel. It is the practice of this subcommittee to receive testimony under oath. This is an Investigations and Oversight Subcommittee. Do any of you have an objection to taking an oath? Let the record reflect that none of the witnesses had any objection. You also have the right to be represented by counsel. Do any of you have counsel here? Let the record reflect that all of the witnesses said no. We ask you these questions to put you at ease.

Would you all now please stand and raise your right hand?

Mr. BROUN. And we are not going to water board them.

Chairman MILLER. Well, that would be the next hearing. Please stand and raise your right hand. Do you swear to tell the truth and nothing but the truth? Let the record reflect that each of the witnesses did take the oath.

We will begin with Mr. Gene Aloise. Mr. Aloise, please begin.

STATEMENT OF MR. GENE ALOISE, DIRECTOR, NATURAL RESOURCES AND ENVIRONMENT, U.S. GOVERNMENT ACCOUNTABILITY OFFICE (GAO)

Mr. ALOISE. Mr. Chairman and Members of the Subcommittee, I am pleased to be here today to discuss DHS's plans to develop and test advanced portal monitors, known as ASPs, for use at the Nation's borders to prevent nuclear materials from being smuggled into the United States. My testimony today focuses on the results of DNDO's testing of the ASPs, including the July 2009 field testing.

According to DHS, the current system of radiation detection equipment, the PVTs, is effective and does not impede the flow of commerce. However, DHS wants to improve the capabilities of the existing equipment with ASPs. One of the major drawbacks of the ASP, as you know, is a substantially higher cost compared to the existing equipment. We estimated that the life cycle cost of each standard cargo version of the ASP to be about $822,000 compared to about $308,000 for the PVT standard cargo portal and that the total program cost would be about $2 billion.

Earlier this year I testified before this subcommittee on DNDO's 2008 round of ASP performance testing at the Nevada Test Site. That testing showed that the ASPs performed better than the PVTs in detecting certain nuclear materials and met DOE's threat guidance. However, the ASP's performance rapidly deteriorated once shielding was slightly increased. These test results showed what we reported in 2006, that any increase in detection of certain nuclear materials would be marginal.

While the ASP may have met DOE's threat guidance for shielded nuclear material, the threat guidance is not a realistic approximation of how a terrorist might shield nuclear material to successfully smuggle it undetected across our borders.

The latest round of field testing conducted in July revealed two critical performance problems with ASPs that the Chairman mentioned. First, the ASPs had an unacceptably high number of false positives for the detection of high-risk nuclear material. In other words, the ASP was seeing nuclear material that wasn't there and alarming. CBP officials told us that any alarm for this type of nuclear material is very disruptive to a port or border crossing and could effectively shut down operations until the source of the alarm is found. Furthermore, repeated false alarms for nuclear materials could have the undesired effect of causing CBP officers to doubt the reliability of the ASPs and be skeptical about the credibility of future alarms.

The second critical failure of the ASPs noted in the July testing stemmed from a problem with the key component of the equipment which led an ASP to in essence shut down. Of great concern was the fact that the ASP did not alert the CBP official that it had shut down and was not scanning cargo. If this were not a controlled test, the CBP officer would have allowed the cargo to enter the United States thinking it had been scanned when it had not.

DNDO's proposed solutions to these critical failures raise questions about whether the ASPs will provide any meaningful increase in the ability to detect certain nuclear materials. Specifically, to address the problem of false positives, DNDO is modifying the ASP to make it less sensitive to certain nuclear materials. While this may fix the problem of false alarms, it diminishes even further the ASP's ability to detect the nuclear material we are most concerned about.

To address the second failure, DNDO plans to, among other things, install an indicator light on the ASP that will alert CBP officials that the ASP has a mission-critical failure. In our view, an indicator light is not the solution. The ASP must be stable and secure enough to avoid these shut-downs.

Furthermore, DNDO has not completed efforts to improve the PVTs to detect high-risk material through energy windowing. CBP has repeatedly urged the completion of this research, because an improved PVT could be the more cost-effective way to improve detecting certain nuclear materials and have a similar performance to a working ASP.

In closing, the concerns raised by the results of the July 2009 field testing provide even greater reason for DNDO to implement our recommendations from our May 2009 report. In particular, our recommendation that DNDO assess whether the ASPs meet the criteria for significant increase in operational effectiveness based on a valid comparison with the PVT's full performance. This is especially relevant given that ASPs seemingly will no longer be as effective in detecting certain nuclear materials.

Mr. Chairman, that concludes my remarks. Dr. Persons and I would be happy to respond to any questions you may have.

[The prepared statement of Mr. Aloise follows:]

PREPARED STATEMENT OF GENE ALOISE

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss GAO's work on the Department of Homeland Security's (DHS) testing of advanced spectroscopic portal (ASP) radiation detection monitors. One mission of U.S. Customs and Border Protection (CBP), an agency within DHS, includes screening cargo and vehicles coming into this country for smuggled nuclear or radiological material that could be used in an improvised nuclear device or radiological dispersal device (a "dirty bomb"). To screen cargo at ports of entry, CBP conducts primary inspections with radiation detection equipment called portal monitors—large stationary detectors through which cargo containers and vehicles pass as they enter the United States. When radiation is detected, CBP conducts secondary inspections using a second portal monitor to confirm the original alarm and a hand-held radioactive isotope identification device to identify the radiation's source and determine whether it constitutes a threat.

The polyvinyl toluene (PVT) portal monitors CBP currently uses for this screening can detect radiation but cannot identify the type of material causing an alarm. As a result, the monitors' radiation alarms can be set off even by shipments of bananas, kitty litter, or granite tile because these materials contain small amounts of benign, naturally occurring radioactive material. To address the limitations of current-generation portal monitors, DHS's Domestic Nuclear Detection Office (DNDO) in 2005 began to develop and test ASPs, which are designed to both detect radiation and identify the source.[1] DNDO hopes to use the new portal monitors to replace at least some PVTs currently used for primary screening, as well as PVTs and hand-held identification devices currently used for secondary screening.

Since 2006, we have been reporting on issues associated with the cost and performance of the ASPs and the lack of rigor in testing this equipment. For example, we found that tests DNDO conducted in early 2007 used biased test methods that enhanced the apparent performance of ASPs and did not use critical CBP operating procedures that are fundamental to the performance of current hand-held radiation detectors.[2] In addition, in 2008 we estimated the life cycle cost of each standard cargo version of the ASP (including deployment costs) to be about $822,000, compared with about $308,000 for the PVT standard cargo portal, and the total program cost for DNDO's latest plan for deploying radiation portal monitors—which relies on

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[1] DNDO was established within DHS in 2005; its mission includes developing, testing, acquiring, and supporting the deployment of radiation detection equipment at U.S. ports of entry. CBP began deploying portal monitors in 2002, prior to DNDO's creation, under the radiation portal monitor project.

[2] *Combating Nuclear Smuggling: Additional Actions Needed to Ensure Adequate Testing of Next Generation Radiation Detection Equipment.* GAO–07–1247T, (Washington, D.C.: Sept. 18, 2007).

a combination of ASPs and PVTs and does not deploy radiation portal monitors at all border crossings—to be about $2 billion.[3]

Concerned about the performance and cost of the ASP monitors, Congress required the Secretary of Homeland Security to certify that the monitors will provide a "significant increase in operational effectiveness" before DNDO obligates funds for full-scale ASP procurement.[4] In response, CBP, DNDO, and the DHS management directorate jointly issued criteria for determining whether the new technology provides a significant increase in operational effectiveness. The primary screening criteria require that the new portal monitors detect potential threats as well as or better than PVTs, show improved performance in detection of highly enriched uranium (HEU), and reduce by 80 percent the number of innocent alarms that are sent to secondary inspection. To meet the secondary screening criteria, the new portal monitors must reduce the probability of misidentifying special nuclear material (e.g., HEU and plutonium) and the average time to conduct secondary screenings.

DNDO designed and coordinated a new series of tests, originally scheduled to run from April 2008 through September 2008, to determine whether the new portal monitors meet the certification criteria and are ready for deployment. Key phases of this round of testing include concurrent testing led by DNDO of the new and current equipment's ability to detect and identify threats and of ASPs' readiness to be integrated into operations for both primary and secondary screening at ports of entry; field validation testing led by CBP at four northern and southern border crossings and two seaports; and an independent evaluation, led by the DHS Science and Technology Directorate at one of the seaports, of the new portal monitors' effectiveness and suitability.

In May 2009, we reported on the results of the then-current round of ASP testing.[5] The findings from that report were based on completed tests and preliminary results available at the time. Testing on ASPs has continued since that report was issued. Today my testimony will (1) discuss the principal findings and recommendations from our May report and (2) update those findings based on the results of DNDO's July 2009 ASP field validation testing. The findings we are presenting today are based on our previous ASP reports and updated with information collected during interviews with DNDO and CBP officials. We also reviewed testing results in a report on the July 2009 tests from the ASP Field Validation Advisory Panel, a panel made up of officials from CBP, DNDO, and a national laboratory established to examine testing results and provide recommendations. On November 12, 2009, we briefed DHS, CBP, and DNDO officials on the findings of our updated work. During the briefing, CBP and DNDO officials provided oral comments and offered additional information and clarifications we included in this testimony as appropriate. Both our prior work and our updated work were conducted in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to produce a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our statement today.

Improved Testing Rigor Discussed in Our May 2009 Report Demonstrates Limitations of ASPs

Our May 2009 report on the then-current round of ASP testing found that DHS increased the rigor of ASP testing over that of previous tests, and that a particular area of improvement was in the performance testing at the Nevada Test Site, where DNDO compared the capability of ASP and current-generation equipment to detect and identify nuclear and radiological materials. For example, unlike in prior tests, the plan for the 2008 performance test stipulated that the contractors who developed the equipment would not be involved in test execution. This improvement addressed concerns we previously raised about the potential for bias and provided increased credibility to the results. Nevertheless, based on the following factors, in our

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[3] *Combating Nuclear Smuggling: DHS's Program to Procure and Deploy Advanced Radiation Detection Portal Monitors Is Likely to Exceed the Department's Previous Cost Estimates.* GAO–08–1108R, (Washington, D.C.: Sept. 22, 2008).

[4] *Consolidated Appropriations Act,* 2008, Pub. L. No. 110–161, 121 Stat. 1844, 2069 (2007); *Consolidated Security, Disaster Assistance, and Continuing Appropriations Act,* 2009, Pub. L. No. 110–329, 121 Stat. 3574, 3679 (2008); *Department of Homeland Security Appropriations Act,* 2010, Pub. L. No. 111–83, 123 Stat. 2142, 2167 (2009).

[5] *Combating Nuclear Smuggling: DHS Improved Testing of Advanced Radiation Detection Portal Monitors, but Preliminary Results Show Limits of the New Technology,* GAO–09–655 (Washington, D.C.: May 21, 2009).

report we questioned whether the benefits of the new portal monitors justify the high cost:

- *The DHS criteria for a significant increase in operational effectiveness.* Our chief concern with the criteria is that they require only a marginal improvement over current-generation portal monitors in the detection of certain weapons-usable nuclear materials during primary screening. DNDO considers detection of such materials to be a key limitation of current-generation portal monitors. The marginal improvement required of ASPs to meet the DHS criteria is problematic because the detection threshold for the current-generation portal monitors does not specify a level of radiation shielding that smugglers could realistically use. Officials from the Department of Energy (DOE), which designed the threat guidance DHS used to set the detection threshold, and national laboratory officials told us that the current threshold is based not on an analysis of the capabilities of potential smugglers to take effective shielding measures but rather on the limited sensitivity of PVTs to detect anything more than certain lightly shielded nuclear materials. DNDO officials acknowledge that both the new and current-generation portal monitors are capable of detecting certain nuclear materials only when unshielded or lightly shielded. The marginal improvement in detection of such materials required of ASPs is particularly notable given that DNDO has not completed efforts to fine-tune PVTs' software using a technique called "energy windowing" that could improve the PVTs' sensitivity to nuclear materials. DNDO officials expect they can achieve small improvements in sensitivity through energy windowing, but DNDO has not yet completed efforts to fine-tune the PVTs' software. In contrast to the marginal improvement required in detection of certain nuclear materials, the primary screening requirement to reduce the rate of innocent alarms by 80 percent could result in hundreds of fewer secondary screenings per day, thereby reducing CBP's workload. In addition, the secondary screening criteria, which require ASPs to reduce the probability of misidentifying special nuclear material by one-half, address the limitations of relatively small hand-held devices in consistently locating and identifying potential threats in large cargo containers.
- *Results of performance testing and field validation.* The results of performance tests that DNDO presented to us were mixed, particularly in the ASPs' capability to detect certain shielded nuclear materials during primary screening. The results of performance testing at the Nevada Test Site showed that the new portal monitors detected certain nuclear materials better than PVTs when shielding approximated DOE threat guidance, which is based on light shielding. In contrast, differences in system performance were less notable when shielding was slightly increased or decreased: both the PVTs and ASPs were frequently able to detect certain nuclear materials when shielding was below threat guidance, and both systems had difficulty detecting such materials when shielding was somewhat greater than threat guidance. With regard to secondary screening, ASPs performed better than hand-held devices in identification of threats when masked by naturally occurring radioactive material. However, the differences in the ability to identify certain shielded nuclear materials depended on the level of shielding, with increasing levels appearing to reduce any ASP advantages over the hand-held identification devices. Other phases of testing uncovered multiple problems in meeting requirements for successfully integrating the new technology into operations at ports of entry. Of the two ASP contractors participating in the current round of testing, one has fallen behind due to severe problems encountered during testing of ASPs' readiness to be integrated into operations at ports of entry ("integration testing"); the problems may require that the vendor redo previous test phases to be considered for certification. The other vendor's system completed integration testing, but CBP suspended field validation testing in January 2009 after two weeks because of serious performance problems resulting in an overall increase in the number of referrals for secondary screening compared with existing equipment.
- *DNDO's plans for computer simulations.* As of May 2009, DNDO did not plan to complete injection studies—computer simulations for testing the response of ASPs and PVTs to simulated threat objects concealed in cargo containers—prior to the Secretary of Homeland Security's decision on certification even though delays to the ASP test schedule have allowed more time to conduct the studies. According to DNDO officials, injection studies address the inability of performance testing to replicate the wide variety of cargo coming into the United States and the inability to place special nuclear material and

other threat objects in cargo during field validation. DNDO had earlier indicated that injection studies could provide information comparing the performance of the two systems as part of the certification process for both primary and secondary screening. However, DNDO subsequently decided that performance testing would provide sufficient information to support a decision on ASP certification. DNDO officials said they would instead use injection studies to support effective deployment of the new portal monitors.

- *Lack of an updated cost-benefit analysis.* DNDO had not updated its cost-benefit analysis to take into account the results of ASP testing. An updated analysis that takes into account the testing results, including injection studies, might show that DNDO's plan to replace existing equipment with ASPs is not justified, particularly given the marginal improvement in detection of certain nuclear materials required of ASPs and the potential to improve the current-generation portal monitors' sensitivity to nuclear materials, most likely at a lower cost. DNDO officials said they were updating the ASP cost-benefit analysis and planned to complete it prior to a decision on certification by the Secretary of Homeland Security.

Our May report recommended that the Secretary of Homeland Security direct DNDO to (1) assess whether ASPs meet the criteria for a significant increase in operational effectiveness based on a valid comparison with PVTs' full performance potential and (2) revise the schedule for ASP testing and certification to allow sufficient time for review and analysis of results from the final phases of testing and completion of all tests, including injection studies. We further recommended that, if ASPs are certified, the Secretary direct DNDO to develop an initial deployment plan that allows CBP to uncover and resolve any additional problems not identified through testing before proceeding to full-scale deployment. DHS agreed to a phased deployment that should allow time to uncover ASP problems but disagreed with GAO's other recommendations, which we continue to believe remain valid.

Results from July 2009 Testing Raise Continuing Issues

The results of DNDO's most recent round of field validation testing, which it undertook in July 2009, after our May report was released, raise new issues. In July 2009, DNDO resumed the field testing of ASPs at four CBP ports of entry that it initiated in January 2009 but suspended because of serious performance problems. However, the July tests also revealed ASP performance problems, including two critical performance deficiencies. First, the ASP monitors had an unacceptably high number of false positive alarms for the detection of certain high-risk nuclear materials. According to CBP officials, these false alarms are very disruptive in a port environment in that any alarm for this type of nuclear material would cause CBP to take enhanced security precautions because such materials (1) could be used in producing an improvised nuclear device and (2) are rarely part of legitimate or routine cargo. Furthermore, once receiving an alarm for this type of nuclear material, CBP officers are required to conduct a thorough secondary inspection to assure themselves that no nuclear materials are present before permitting the cargo to enter the country. Repeated false alarms for nuclear materials are also causes for concern because such alarms could eventually have the effect of causing CBP officers to doubt the reliability of the ASP and be skeptical about the credibility of future alarms.

Secondly, during the July testing the ASP experienced a "critical failure," which stemmed from a problem with a key component of the ASP and caused the ASP to shut down. Importantly, during this critical failure, the ASP did not alert the CBP officer that it had shut down and was no longer scanning cargo. As a result, were this not in a controlled testing environment, the CBP officer would have permitted the cargo to enter the country thinking the cargo had been scanned, when it had not. According to CBP officials, resolving this issue is important in order to assure the stability and security of the ASP.

In addition to these key performance problems, the ASP was not able to reduce referrals to secondary inspection by 80 percent as required by the DHS criteria for a significant increase in operational effectiveness. According to the report from the ASP Field Validation Advisory Panel, a panel made up of officials from CBP, DNDO, and a national laboratory, the ASP was able to reduce referrals to secondary inspection by about 69 percent rather than the 80 percent as required by the DHS criteria.

While the performance of the ASP during the July field validation testing raises issues about its potential readiness for deployment, DNDO's proposed solutions to address these performance problems raise additional questions about whether this equipment will provide any meaningful increase in the ability to detect certain nuclear materials. Specifically, to address the problem of false positive alarms indicating the presence of certain nuclear materials, according to DNDO officials, DNDO has modified the ASP to make this equipment less sensitive to these nuclear materials. While this may address the issue of false positive alarms, it will also diminish the ASP capability of detecting a key high-risk nuclear material. Since the ASP modification, DNDO conducted computer simulations using a vendor-provided system called a "replay tool" to examine the effect of the modification on the ASP's performance. According to DNDO officials, the replay tool demonstrated that the modified ASP will still be able to detect certain nuclear materials better than the PVT. However, at this point, DNDO does not plan to retest the ASP at the Nevada Test Site where it can examine the effects of these modifications using actual nuclear materials. As we reported earlier this year, the results of the testing at the Nevada Test Site demonstrated that the ASPs represented a marginal improvement in detecting certain nuclear materials. By reducing the sensitivity to these materials and not retesting the modified ASPs against actual nuclear materials, it is uncertain exactly what improvement in detecting certain nuclear materials these costly portal monitors are providing.

While DNDO is reducing the sensitivity of ASPs to certain nuclear materials, it has yet to complete efforts to improve the PVT's ability to detect these same materials through energy windowing. For several years, CBP officials have repeatedly urged DNDO officials to complete this research. However, it was not apparent from our discussions with DNDO officials if this effort is making meaningful progress with the development of energy windowing or when it will be completed. Furthermore, CBP officials stated that, depending on the outcome of this research, energy windowing could be the more cost effective way to improve detection of certain nuclear materials. In our view, ASPs being modified to diminish their capabilities to detect certain nuclear materials raises questions about whether energy windowing might be able to achieve a similar level of performance against these same materials from the PVTs that are already in place.

Beyond reducing the sensitivity of ASPs to certain nuclear materials, DNDO also plans to address the issue of critical failures by, among other things, installing an indicator light on the ASP that will alert CBP officers that the ASP has experienced a mission-critical failure and is no longer scanning cargo. While this should address the issue of CBP officers not knowing that the ASP has suffered a critical failure, CBP officials stressed to us the need for the ASP to be stable and secure enough to avoid these shutdowns.

In closing, the issues raised by the results of the July 2009 field validation tests provide even greater reason for DNDO to address recommendations from our May 2009 report. In particular, we reiterate the importance of our prior recommendation for DNDO to assess whether ASPs meet the criteria for a significant increase in operational effectiveness based on a valid comparison with PVTs' full performance potential, given that the ASPs will no longer be as effective in detecting certain nuclear materials.

Mr. Chairman, this completes my prepared statement. I would be happy to respond to any questions that you or other Members of the Subcommittee may have at this time.

Staff Acknowledgments

Dr. Timothy Persons (Chief Scientist), Ned Woodward (Assistant Director), Joseph Cook, and Kevin Tarmann made key contributions to this testimony. Kendall Childers, Karen Keegan, Carol Kolarik, Jonathan Kucskar, Omari Norman, Alison O'Neill, and Rebecca Shea also made important contributions.

BIOGRAPHY FOR GENE ALOISE

Gene Aloise is a Director in the Natural Resources and Environment team at GAO. He is GAO's recognized expert in international nuclear nonproliferation and safety issues and completed training on these subjects at the University of Virginia and Princeton University. His work for GAO has taken him to some of Russia's closed nuclear cities and the Chernobyl reactor in Ukraine as well as numerous nuclear facilities around the world and in the United States. Mr. Aloise has had years of experience developing, leading, and managing GAO domestic and international engagements. His diverse experience includes assignments with congressional committees as well as various offices within GAO. He has received numerous awards for his leadership and expertise including GAO's Meritorious Service and Distinguished Service Awards. Mr. Aloise received his Bachelor's degree in political science/economics from Rowan University and holds a Master of Public Administration from Temple University. Mr. Aloise is also a graduate of the Senior Executive Fellows Program, John F. Kennedy School of Government, Harvard University.

STATEMENT OF DR. TIMOTHY M. PERSONS, CHIEF SCIENTIST, U.S. GOVERNMENT ACCOUNTABILITY OFFICE (GAO)

Chairman MILLER. Thank you, Mr. Aloise. Dr. Persons. I think I said Parsons earlier. Persons. You are here to answer questions but the testimony of Mr. Aloise is your testimony as well?

Dr. PERSONS. That is correct.

BIOGRAPHY FOR TIMOTHY M. PERSONS

Dr. Timothy M. Persons was appointed the Chief Scientist of the United States Government Accountability Office (GAO—the investigative arm of the U.S. Congress) in July of 2008. In this role he is an expert advisor and chief consultant to the GAO, Congress, and other federal agencies and government programs on cutting-edge science and technology (S&T), key highly-specialized national and international systems, engineering policies, best practices, and original research studies in the fields of engineering, computer, and the physical and biological sciences to ensure efficient, effective, and economical use of science and technology in government programs. The Chief Scientist also works with GAO's Chief Technologist to lead the production of Technology Assessments for the U.S. Congress.

Prior to joining GAO, Dr. Persons was the Technical Director of the Intelligence Advanced Research Projects Activity (IARPA) from November 2002 to July 2008. IARPA's mission is to invest in high-risk/high-payoff research with potential to revolutionize the business of intelligence collection, processing, analysis, and dissemination. From July 2001 to November of 2002, he served as the Technical Director for the National Security Agency's (NSA) Human Interface Security Group which researches, designs, and tests next-generation biometric identification and authentication systems. He has also served as a radiation physicist with the University of North Carolina at Chapel Hill.

Dr. Persons is a 2007 Director of National Intelligence S&T Fellow whose research focuses on computational imaging systems. He was also selected as the James Madison University (JMU) Physics Alumnus of 2007. He received his B.Sc. (Physics) from JMU, a M.Sc. (Nuclear Physics) from Emory University, and a M.Sc. (Computer Science) and Ph.D. (Biomedical Engineering) degrees from Wake Forest University. He is a senior member of the Institute for Electrical and Electronic Engineers, Association for Computing Machinery, and the Sigma Xi research honor society and has authored an array of journal, conference, and technical articles. He is also a Ruling Elder in the Presbyterian Church in America and lives happily in Maryland with his wife Gena and their two children.

Chairman MILLER. Okay. Mr. Owen.

STATEMENT OF MR. TODD C. OWEN, ACTING DEPUTY ASSISTANT COMMISSIONER, OFFICE OF FIELD OPERATIONS, U.S. CUSTOMS AND BORDER PROTECTION, DEPARTMENT OF HOMELAND SECURITY

Mr. OWEN. Chairman Miller, Ranking Member Broun, distinguished Members of the Subcommittee, I am honored to be here this afternoon to provide an update on the role that U.S. Customs and Border Protection plays in protecting our nation from the illicit introduction of radiological or nuclear materials in cargo containers, and on the future role that Advanced Spectroscopic Portal technology would have on CBP operations.

I would like to begin by expressing my gratitude to Congress for its continued support toward CBP initiatives. Among the numerous priorities that were recognized in the *American Recovery and Reinvestment Act of 2009,* Congress provided CBP with $100 million of stimulus funding toward upgrading and adding non-intrusive inspection equipment. This funding will allow CBP to upgrade and expand its successful NII program and more effectively inspect containers and vehicles crossing our border, allowing them to enter our country and its commerce in a safe and prompt manner.

Everyday over 57,000 maritime containers, truck trailers and rail cars cross our border. CBP uses a multi-layered approach to ensure the integrity of supply chains from points of stuffing through arrival at U.S. ports of entry. This multi-layer defense is built upon interrelated initiatives which include the 24-Hour Rule and the *Trade Act of 2002,* the Automated Targeting System, Non-Intrusive Inspection (NII) equipment and radiation portal monitors, the Container Security Initiative and the Customs Trade Partnership Against Terrorism, C–TPAT program. These complementary layers enhance security and protect our nation.

Prior to 9–11, not a single radiation portal monitor and only 64 large-scale NII systems were deployed to our nation's borders. By October of 2002, CBP had deployed the first RPM to the Ambassador Bridge in Detroit, and today CBP has just under 1,400 RPMs and 232 large-scale NII systems deployed nationwide, and that is an increase of almost 200 more RPMs and five additional large-scale NII systems since I last testified before this subcommittee in June.

NII technology allows the officers to detect possible anomalies, anomalies which may indicate the presence of weapons of mass effect or some other contraband. In Fiscal Year 2009, CBP conducted over 5.2 million examinations using NII technology, allowing CBP to meet our twin goals of enhance security and trade facilitation.

In addition to the significant strides made in the area of NII equipment, the CBP also continues to deploy first-generation radiation portal monitors to our nation's ports of entry. Since last testifying before this subcommittee, CBP and DNDO have now completed deployments of RPMs along the northern border and now scan 100 percent of trucks and passenger vehicles arriving from Canada, 100 percent arriving from Mexico and 98 percent of arriving sea containers for the presence of nuclear radiological materials. Since the first RPM was deployed in 2002, CBP officers have scanned over 404 million conveyances for the presence of radiation and 2.2 million radiological alarms have been successfully adjudicated with minimal or no impact on the flow of legitimate trade and travel. CBP continues to closely coordinate with key stakeholders to ensure the impacts of this activity causes minimal disruption on port operations.

The first generation RPM systems, although very sensitive, do have limitations. While they alert the CBP officers to the presence of radiation, a secondary exam is necessary to positively identify the specific isotope causing the alert. In the event that a CBP officer is unable to positively resolve the alarm, scientific reach-back is available 24 hours a day, seven days a week.

The ASP is expected to enhance our detection capability while significantly reducing the number or secondary examinations. This is due to its ability to distinguish between actual threats and natural or medical radiation sources that are not security threats. CBP has worked closely with the DNDO in the development and operational testing of ASP, has provided DNDO with functional requirements and has been actively engaged in every step of systems evaluation. CBP will continue to work with DNDO, and with the DHS Science and Technology Directorate, S&T, toward Secretarial Certification, and is also working with DHS to ensure that any future acquisition and deployment decisions are consistent with DHS priorities. The decision to purchase and deploy ASPs in the operational arena will be based on CBPs mission needs and operational requirements, a comprehensive cost benefit analysis to include a full understanding of the maintenance and operational cost and analysis of alternatives and other considerations.

Mr. Chairman and Members of the Subcommittee, today I have addressed CBP's commitment to investing in new and emerging detection technology aimed at enhancing cargo security. We must continue to maintain our tactical edge by integrating new technology into our ports of entry.

Thank you again for the opportunity to testify. I would be happy to answer any questions.

[The prepared statement of Mr. Owen follows:]

PREPARED STATEMENT OF TODD C. OWEN

Chairman Miller, Ranking Member Broun, esteemed Members of the Subcommittee, it is a privilege and an honor to appear before you today to discuss the work of U.S. Customs and Border Protection (CBP), particularly the detection of radioactive and nuclear material in cargo containers and the potential future role that the Advanced Spectroscopic Portal (ASP) program will have on our operations. CBP is responsible for ensuring the security of cargo entering the United States at our borders and facilitating the flow of legitimate trade and travel. As part of this process, over 98 percent of all arriving maritime containerized cargo is currently scanned for radiation through radiation portal monitors.

I want to begin by expressing my gratitude to Congress for its continued support for the mission and people of CBP. It is clear that Congress is committed to providing CBP the resources we need in order to increase and maintain the security of our borders. We appreciate your efforts and assistance.

CBP is the largest uniformed federal law enforcement agency in the country. We station over 21,000 CBP officers at access points around the Nation, including air, land, and sea ports. We have deployed over 20,000 Border Patrol agents between the ports of entry. These forces are supplemented with 1,266 Air and Marine agents, 2,392 agricultural specialists, and other professionals.

CBP's responsibilities include stemming the illegal flow of drugs, contraband and people, protecting our agricultural and economic interests from harmful pests and diseases, protecting American businesses from theft of their intellectual property, enforcing textile agreements, tracking import safety violations, regulating and facilitating international trade, collecting import duties, facilitating legitimate travel, and enforcing U.S. trade laws. CBP facilitates lawful immigration, welcoming visitors and new immigrants, while making certain those entering this country are indeed admissible and taking appropriate action when an individual fears being persecuted or tortured if returned to their home country. At the same time, our employees maintain a vigilant watch for terrorist threats. In FY 2009, CBP processed more than 361 million pedestrians and passengers, 109 million conveyances, 25.8 million trade entry summaries, examined 5.2 million sea, rail, and truck containers, performed over 26.8 million agriculture inspections, apprehended over 732,000 illegal aliens between our ports of entry, encountered over 224,000 inadmissible aliens at the ports of entry, and seized more than 2.8 million pounds of illegal drugs.

We must perform our important security and trade enforcement work without stifling the flow of legitimate trade and travel that is so important to our nation's economy. These are our twin goals: border security and facilitation of legitimate trade and travel.

CBP OVERVIEW

I am pleased to appear before the Subcommittee today to highlight the continued progress on radiation detection technology. I would also like to take this opportunity to bring attention to CBP's holistic cargo security programs that are applied to all environments. CBP has made tremendous progress toward securing the supply chains that bring goods into the United States from around the world, and preventing their potential use by terrorist groups, by: using cutting-edge technology to increase the ability of front-line CBP Officers to successfully detect and interdict illicit importations of nuclear and radiological materials; moving resources where they are most needed; integrating all CBP offices; sharing information, including actionable intelligence, across all aspects of CBP; and utilizing a multi-layered approach to ensure the integrity of the supply chain from the point of stuffing, through arrival at a U.S. port of entry. This multi-layered approach includes the following comprehensive cargo security programs that are applied to all modes of transportation:

- Advance Information
    - ○ *24-Hour Rule*
    - ○ *Automated Targeting Systems*
    - ○ *Importer Security Filing (commonly known as "10+2")*
- The Customs Trade Partnership Against Terrorism (C–TPAT) and Free and Secure Trade (FAST)
- Container Security Initiative (CSI)
- Secure Freight Initiative
- Use of non-intrusive inspection technology and mandatory exams for all high risk shipments.

I will discuss each one of these layers in greater detail with particular focus on our radiation and nuclear detection capabilities.

ADVANCE INFORMATION

CBP requires advanced electronic cargo information, as mandated in the *Trade Act of 2002,* for all inbound shipments in all modes of transportation. This advanced cargo information is evaluated using the Automated Targeting System (ATS) before the cargo arrives in the United States.

ATS provides decision support functionality for CBP officers working in Advanced Targeting Units at our ports of entry and Container Security Initiative ports abroad. The system provides uniform review of cargo shipments for identification of the highest threat shipments, and presents data in a comprehensive, flexible format to address specific intelligence threats and trends. Through rules, the ATS alerts the user to data that meets or exceeds certain pre-defined criteria. National targeting rule sets have been implemented in ATS to provide threshold targeting for national security risks for all modes of transportation: sea, truck, rail, and air. The DHS Science and Technology Directorate is exploring additional methodologies for conducting risk assessment.

The Importer Security Filing interim final rule, also more commonly known as "10+2," went into effect earlier this year and has already yielded promising results. This program will increasingly provide CBP timely information about cargo shipments that will enhance our ability to detect and interdict high risk shipments. Comments on aspects of this rule were accepted until June 1, 2009, and implementation using informed compliance will continue until January of next year. Shipments determined by CBP to be high-risk are examined either overseas as part of our Container Security Initiative, or upon arrival at a U.S. port.

CUSTOMS TRADE PARTNERSHIP AGAINST TERRORISM (C–TPAT)

CBP works with the trade community through the Customs Trade Partnership Against Terrorism (C–TPAT) to better secure goods moving through the international supply chain. C–TPAT has enabled CBP to leverage supply chain security throughout international locations where CBP has no regulatory reach. Under the C–TPAT program, a prospective member submits basic company information and a security profile via an Internet-based portal system. CBP conducts records checks on the company in its law enforcement and trade databases and evaluates the security profile, ensuring the company meets the security criteria for its particular business sector. Members who pass initial vetting are certified into the program. Using a risk-based approach, CBP Supply Chain Security Specialists conduct on-site visits of foreign and domestic facilities to confirm that the security practices are in place and operational.

C–TPAT is a voluntary public-private partnership program wherein CBP works with the trade community in adopting tighter security measures throughout their international supply chain. In return for making these enhancements members are afforded benefits to include reduced exams, dedicated cargo lanes (FAST), Stratified Exam, an assigned Supply Chain Security Specialist (SCSS). Potential members initially complete an online application. The SCSS then conducts internal record checks and evaluates the security profile provided. Upon completion of vetting the company then becomes a Certified member who will then be physically validated within a year of certification.

In 2009, CBP continued to expand and strengthen the C–TPAT program and ensure that certified member companies are securing their goods moving through the international supply chain to the United States. Teams of Supply Chain Security Specialists conducted validations and re-validations of C–TPAT members' supply chains to ensure that security protocols are reliable, accurate, and effective.

As C–TPAT has evolved, we have steadily increased both the rigor of the program and program membership. CBP has strengthened the C–TPAT program by clearly defining the minimum security requirements for all categories of participants wishing to take part in the program. As of Nov. 6, 2009, there were 9,509 companies certified into the C–TPAT program. CBP's goal is to validate all partners within one year of certification, re-validate all companies not less than once every three years, and re-validate all U.S./Mexico highway carriers on an annual basis, due to the risks of compromise of trailers associated with the Southern Border Highway Carrier sector of C–TPAT.

C–TPAT's 9,509 Certified Partners include 4,330 importers, 2,583 carriers, 821 brokers, 784 consolidators/third party logistic providers, 56 Marine Port Authority and Terminal Operators and 935 foreign manufacturers. C–TPAT has conducted 13,246 on-site validations of manufacturing and logistics facilities in 90 countries. 301 C–TPAT importer partners have been designated Tier 3, meaning they have exceeded the minimum security criteria and have been granted the highest level of program benefits.

CONTAINER SECURITY INITIATIVE

Because of the sheer volume of sea container traffic, containerized shipping is uniquely vulnerable to terrorist exploitation. To prevent terrorists and their weapons from entering the United States, CBP has also partnered with foreign governments through our Container Security Initiative (CSI). CSI, which is the first program of its kind, was announced in January 2002 and is currently operational in 58 foreign seaports—covering more than 80 percent of the maritime containerized cargo shipped to the United States. The program enables CBP to identify and inspect high-risk cargo containers at foreign ports before they are shipped to our seaports and pose a threat to the United States and to global trade. CSI stations multidisciplinary teams of CBP officers to work with host country counterparts to identify and examine containers that are determined to pose the highest risk for terrorist activity.

CBP officers stationed at foreign CSI ports review 100 percent of the manifests originating and/or transiting those foreign ports for containers that are destined for the United States. In locations where the tremendous volume of bills prevents the CSI team at the port itself from performing 100 percent review, or during port shutdowns, CSI targeters at the National Targeting Center provide additional support to ensure that 100 percent review is accomplished. Utilizing the overseas CSI team and the CSI targeters at our National Targeting Center, CBP is able to achieve 100 percent manifest review for the CSI program. In FY 2009, CBP officers stationed at CSI ports reviewed over nine million bills of lading and conducted over 56,000 exams in conjunction with their host country counterparts.

SECURE FREIGHT INITIATIVE

The Secure Freight Initiative (SFI) is an effort to build upon existing port security measures by enhancing the U.S. Government's ability to scan containers for nuclear and radiological materials in seaports worldwide and to better assess the risk of inbound containers. SFI provides carriers of maritime containerized cargo greater confidence in the security of the shipment they are transporting, and increases the likelihood of an uninterrupted and secure flow of commerce. This initiative is the culmination of our work with other U.S. Government agencies, foreign governments, the trade community, and vendors of leading-edge technology.

CBP will prioritize future deployments of scanning systems to locations of strategic importance by identifying seaports where non-intrusive imaging and radiation detection data would be most practical and effective in deterring the movement of weapons of mass destruction via containerized cargo. The additional scan data provided by SFI will enhance DHS' risk-based and layered approach to securing maritime containerized cargo. We will continue to work with Congress to enhance the safety of our nation's ports and the security of incoming cargo.

NON INTRUSIVE INSPECTION/RADIATION DETECTION TECHNOLOGY

The deployment of imaging systems and radiation detection equipment has contributed tremendously to CBP's progress in ensuring that supply chains bringing goods into the United States from around the world are secure against exploitation by terrorist groups. Non-Intrusive Inspection (NII) technology serves as a force multiplier that allows officers to detect possible anomalies between the contents of a container and the manifest. CBP relies heavily on the use of NII, as it allows us to work smarter and more efficiently in recognizing potential threats.

Prior to 9/11, not a single Radiation Portal Monitor (RPM), and only 64 large-scale NII systems were deployed to our nation's borders. By October 2002, CBP had deployed the first RPM at the Ambassador Bridge in Detroit. Today, CBP uses RPMs to scan 99 percent of all cargo arriving in the U.S. by land and sea. CBP, in partnership with the DHS Domestic Nuclear Detection Office (DNDO) and Pacific Northwest National Laboratory (PNNL), has deployed 473 RPMs at northern border land ports of entry; 385 RPMs at southern border land ports of entry; 433 RPMs at seaports; and 55 RPMs at mail facilities. Currently, CBP has 232 large-scale NII systems deployed and 5,816 small-scale NII units. Additionally, CBP has deployed 1,515 Radiation Isotope Identifier Devices (RIIDs) and 19,365 Personal Radiation Detectors (PRDs). These devices allow CBP to examine 100 percent of all identified high-risk cargo. To date, CBP has used the deployed systems to conduct over 38 million examinations, resulting in over 8,300 narcotic seizures, with a total weight of over 2.6 million pounds, and over $28.6 million in undeclared currency seizures. Since RPM program inception in 2002, CBP has scanned over 404 million conveyances for radiological contraband resulting in over 2.2 million alarms. CBP's Laboratories and Scientific Services spectroscopy group at the National Targeting Center has responded to some 21,599 requests from the field for technical assistance in resolving alarms. To date 100 percent of all alarms have been successfully adjudicated as innocent.

CBP is pleased to report that the final installation of RPMs along our shared northern border was commissioned on Oct. 29 at the Trout River, N.Y., port of entry. This milestone represents another critical step in the Department's efforts to strengthen the interconnected U.S. border security network by deploying technology and personnel to key border locations to meet modern-day security needs. This recent milestone provides CBP with the ability to utilize radiation detection technologies to scan 100 percent of trucks and personally owned vehicles arriving through both northern and southern border ports, and 98 percent of arriving sea containers. In addition, CBP officers now use hand-held radiation identification devices to scan 100 percent of private aircraft arriving in the U.S. from foreign destinations.

The first generation RPM systems, although very sensitive, do have limitations. While they alert CBP officers to the presence of radiation, a secondary exam is necessary to identify the location and specific isotope causing the alert. In the event that a CBP officer is unable to positively resolve the alert, scientific reach back is available on a 24/7 basis through the National Targeting Center and CBP's Laboratory & Scientific Services Division located in the northern Virginia area.

Understanding these limitations and the need for more precise radiological detection architecture, DNDO was created in 2005 to focus on radiological and nuclear threats and develop new technologies that will improve the Nation's ability to detect and identify radiological and nuclear weapons and material. One of these new technologies is the next generation RPM, or the Advanced Spectroscopic Portal (ASP).

The ASP is able to distinguish between actual threats and natural or medical radiation sources that are not security threats. In doing so, the ASP would enhance our detection capability, while significantly reducing the burden of responding to the numerous benign alarms that are mostly generated by everyday products. This would allow CBP to focus our staffing and resources on high-risk shipments and other border security initiatives.

CBP COORDINATION WITH DNDO

In our collaboration with DNDO, CBP brings knowledge of how our ports work, of the needs of our front-line officers, and of the operational requirements for new technologies that must work consistently in a broad array of environments. Additionally, CBP is attuned to critical factors such as throughput and capacity as we seek to maintain an appropriate balance between security and the facilitation of cross-border travel and trade.

CBP has worked closely with DNDO in the developmental and operational testing of the ASP. A complete, independent operational testing and evaluation will be conducted by the DHS Science and Technology Directorate's Test and Evaluation and

Standards Division, along with the Director of Operational Test and Evaluation, when the system completes the current course of testing. CBP's objective for operational testing is to ensure that systems are suitable and effective in our operational environments. CBP provided DNDO with functional requirements for the ASP and has been actively engaged in every step of testing, including performance testing at the Nevada Test Site and integration testing currently ongoing at a mock port of entry at the Pacific Northwest National Laboratory.

During CBP-led field validation and integration testing, CBP has been working closely with DNDO to assess each ASP system's performance as an integrated unit, including reach back capability and ancillary equipment such as traffic lights and automated gate arms that are essential to maintaining positive control of vehicles at our ports of entry. In addition, CBP works with DNDO to assess and categorize each system's issues to ascertain their technological impact on performance and their operational impact on front-line CBP officers—the users of the system.

CBP will continue to work with DNDO toward certification by the Secretary, which is dependent on demonstrating a "significant increase in operational effectiveness" over existing first-generation radiation detection systems. At such time, the discussion could then turn to potential acquisition and deployment of ASP systems. Any decision to purchase and deploy ASPs in the operational arena will be based on mission needs, operational requirements, and a full understanding of maintenance and operational costs, to include a comprehensive cost-benefit analysis and an analysis of alternatives.

CONCLUSION

Technology plays an enormous role in securing the supply chain. Security technology is continuously evolving, not only in terms of capability but also in terms of compatibility, standardization, and integration with information systems. It is important to note that there is no single technological solution to supply chain security. As technology matures, it must be evaluated, and adjustments to operational plans must be made. Priority should be given to effective security solutions that complement and improve the business processes already in place, and which build a foundation for secure 21st century global trade.

Mr. Chairman, Members of the Subcommittee, thank you again for this opportunity to testify about CBP's commitment to investing in new and emerging detection technology, as well as some of the steps we have taken toward enhancing cargo security. I will be happy to answer any of your questions.

BIOGRAPHY FOR TODD C. OWENS

Mr. Todd C. Owen was appointed to Executive Director of the Cargo and Conveyance Security office, Office of Field Operations (OFO), in May 2006. Mr. Owen is responsible for all cargo security programs and policies for CBP, including the Container Security Initiative, the Customs-Trade Partnership Against Terrorism Program (C–TPAT) office, all non-intrusive inspection technology and radiation portal monitor deployments, the national canine enforcement program, the National Targeting Center-Cargo, and the 100 percent scanning initiative. Mr. Owen also coordinates U.S. Customs and Border Protection's (CBP) maritime cargo enforcement policies and activities with the U.S. Coast Guard and all air cargo efforts with the Transportation Security Administration.

Mr. Owen previously served as the Director of the C–TPAT program from January 2005 until May 2006. As Director, he strengthened management control and increased hiring, allowing for a significant enhancement in the level of foreign site assessments performed worldwide under this 9,000 member partnership program.

Before arriving in Washington, D.C., Mr. Owen was the Area Port Director in New Orleans, where he was directly responsible for all CBP operations throughout Louisiana, managing 240 officers at seven port offices. Before being selected as Area Port Director, Mr. Owen spent eight years in South Florida where he held various trade related positions within OFO and the Office of Strategic Trade.

Mr. Owen began his career with U.S. Customs Service in 1990 as an Import Specialist in Cleveland, Ohio.

Mr. Owen is a career member of the Senior Executive Service and was a senior executive fellow at Harvard University's John F. Kennedy School of Government.

He is a graduate of John Carroll University in Cleveland, Ohio, and holds a Master's degree in Public Administration from St. Thomas University in Miami, Florida.

Chairman MILLER. Thank you, Mr. Owen. Dr. Hagan for five minutes.

STATEMENT OF DR. WILLIAM K. HAGAN, ACTING DEPUTY DIRECTOR, DOMESTIC NUCLEAR DETECTION OFFICE, DEPARTMENT OF HOMELAND SECURITY

Dr. HAGAN. I am sorry. I am losing my voice. Good afternoon Chairman Miller, Ranking Member Broun and the distinguished Members of the Subcommittee. As Acting Deputy Director of the Domestic Nuclear Detection Office, DNDO, at the Department of Homeland Security, I am honored to be here with the U.S. Customs and Border Protection Executive Director for Cargo and Conveyance Security, Mr. Todd Owen.

I would like to thank the Committee for the opportunity to provide this update on our Advanced Spectroscopic Portal Program, or ASP. Since our last hearing, ASP systems have undergone another round of field validation conducted by CBP. The purpose of field validation is to produce information about the operational characteristics of the system and correct any issues that must be resolved before moving onto the last test event for the system, the Operational Test and Evaluation (OT&E).

The July field validation identified several issues. We worked with CBP to classify the severity of these operational and technical issues and DNDO has since addressed all the issues initially identified. Because the systems are configuration controlled, adjustments were checked and validated through use of a replay tool and regression testing to ensure that sensitivity to threats was not decreased below guidance. Although a few issues remain to be resolved, we are optimistic that field validation can be restarted in the near future.

After CBP completes field validation, OT&E will be conducted by the DHS Science and Technology Directorate's operational testing authority. The current path to certification includes field validation and OT&E, as well as preparation of all the departmental acquisition program requirements, including presentation of the program before the DHS Acquisition Review Board, or ARB, for a production decision. We are committed to following the Department's Management Directive 102–01. As such, we cannot speculate about the outcome of the ARB decision. The Secretary's decision regarding certification will follow the ARB.

Beyond testing of the ASP systems, deployment of our current, low-rate initial production ASP units is now being considered. The fiscal year 2010 appropriations bill signed three weeks ago contains specific language encouraging incremental deployments of ASP, as did the report from the National Academy of Sciences, and we are planning discussions with CBP regarding the best way to deploy these units once OT&E is completed.

However, one new obstacle has emerged that will greatly impact the path forward. The United States is facing a severe helium-3 shortage. Helium-3 is a gas that is used for neutron detection within both current and next-generation RPMs. Because this decreased supply affects multiple agencies within the Federal Government and beyond, the White House has convened an Interagency Policy Committee, including DHS, to discuss the issue and possible solutions. This group decided in September that no more helium-3 will be allocated to RPMs for the time being. We are currently leading interagency efforts to identify alternative neutron detectors, and we are working to assess the impact this will have on our deployment strategy and path forward. For now, we plan to continue field validation and operational testing evaluation in exploring our options for the path forward beyond that.

Additionally, I have also been asked to address the status of improvements to the currently deployed RPM systems, the PVT systems. Some have asked if software or algorithm improvements including improvements to the energy windowing algorithms that are currently deployed could provide enhanced capabilities for PVT systems. We are currently funding work at Pacific Northwest National Laboratory and the Johns Hopkins University Applied Physics Laboratory to improve energy windowing and conduct related research to determine what kinds of PVT improvements may be possible. This research is still ongoing. That being said, it is important to note that any improvements to PVT detectors will only improve primary inspection capabilities or detection. Current performance limitations, and secondary inspection where CBP officers require the ability to identify radiological sources, are not addressed by improvements to PVT technology. Better energy windowing algorithms will not change this fact.

As a final note, I would like to emphasize that the ASP program is only one piece of the multi-layered solution we have termed the global nuclear detection architecture. This strategy calls for the use of multiple preventive actions at our ports as well as security measures along all potential pathways beyond, at and within the Nation's borders.

We will continue to work with our partners within DHS, other federal departments, State and local agencies and the Members of this subcommittee and the Congress to keep the Nation safe from radiological and nuclear terrorism.

This concludes my statement. I thank you for your attention, and I will do my best to answer any questions you may have.

[The prepared statement of Dr. Hagan follows:]

PREPARED STATEMENT OF WILLIAM K. HAGAN

Introduction:

Good afternoon Chairman Miller, Ranking Member Broun, and distinguished Members of the Subcommittee. As Acting Deputy Director of the Domestic Nuclear Detection Office (DNDO) at the Department of Homeland Security (DHS), I would like to thank the Committee for the opportunity to provide a status update on the Advanced Spectroscopic Portal (ASP) program. I would also like to thank the Committee for its support of DNDO's mission to reduce the risk of radiological and nuclear terrorism to the Nation.

In late June of this year, I provided testimony about our next-generation radiation portal monitors (RPMs), including where RPMs are deployed and how DHS' U.S. Customs and Border Protection (CBP) operates this technology at our ports of entry (POEs). My testimony today will include a status update and the path forward for the ASP program. I will also describe operations during field validation and improvements for poly-vinyl toluene (PVT) systems.

Energy Windowing for PVT Systems:

Before I get into an update on the ASP Program, I have been asked to address the status of improvements to PVT systems. For some time, there have been various questions about the possibility of exploring energy windowing improvements to the currently deployed PVT systems. Energy windowing is an algorithmic alarm method that can be applied to plastic scintillator-based RPM systems to improve operational sensitivity to certain threat sources while reducing the alarm rates from naturally occurring radioactive material. Some have asked if software or algorithm improvements could provide enhanced capabilities for PVT systems that would achieve performance similar to that of the ASP systems. Algorithms that provide energy windowing for PVT systems were introduced into the currently deployed systems in 2007, and DNDO is currently funding work both at the Johns Hopkins University Applied Physics Laboratory (APL) and at Pacific Northwest National Laboratory (PNNL) to determine if further gains can be made through additional energy windowing techniques. We have also asked that, wherever possible, the labs work cooperatively on these efforts. Funding for the work at PNNL is approximately $1.6 million of Fiscal Year (FY) 2008 appropriations, and investments in APL for studies related to energy windowing are approximately $90,000 of FY 2009 appropriations. Scientists are thus far uncertain whether additional gains in operational performance can be coaxed from PVT RPMs by using more energy windowing, because the limits of passive detection with plastic-based detectors are coupled with a need to keep false alarms at a minimum. As new techniques are studied and evaluated, it is important to note that the scintillation properties of PVT detectors are fundamentally different than the ASP technology and we continue to evaluate the operational effectiveness of next-generation systems concurrently.

Current Status of the ASP Program:

DNDO continues to enhance the capability to detect and report attempts to import, possess, store, develop, or transport nuclear or radiological material for use against the Nation. Part of our work involves working with DHS partners to provide the equipment and systems they need to perform their missions, including scanning cargo for possible radiological or nuclear threats. After 9/11, considerable concern was raised about the possibility that terrorists could use the enormous volume of cargo flowing into the United States as a means to bring in nuclear material or a nuclear weapon. By far, the largest mode for incoming cargo is maritime shipping containers, with approximately 11 million containers coming into the country every year. Additionally, in the *Security and Accountability for Every (SAFE) Port Act of 2006,* Congress mandated that all containers coming in through the 22 top volume ports be scanned for radiation by the end of 2007. Thus, considerable effort and resources have been devoted to this mode of transportation to provide comprehensive radiological and nuclear detection capabilities, particularly at POEs.

CBP currently scans cargo entering at our nation's POEs using PVT-based radiation portal monitors (RPMs) that can detect radiation, but cannot distinguish between threat materials and naturally occurring radioactive materials (NORM), such as kitty litter and ceramic tiles. Narrowing down alarms to just those for dangerous materials is especially important for POEs that have a high volume of containers, or those that see a high rate of NORM.

Building on previous work within CBP and the DHS Science and Technology Directorate (S&T), DNDO initiated the ASP program in 2006 to develop next-generation technology that can both detect radiological material and distinguish between threat and non-threat materials. ASP systems have shown significantly improved capability to distinguish radiological threats from non-threats over the hand-held instruments currently used in secondary screening. Thus, the introduction of ASP systems is expected to not only reduce the number of unnecessary referrals and false positives in primary scanning but increase the probability of detecting dangerous materials in secondary. I want to be clear here that ASP cannot and will not be acquired and deployed until an Acquisition Review Board (ARB) has been conducted and the Secretary of Homeland Security has certified that the technology provides a significant improvement in operational effectiveness over current systems. Although we are getting closer to these decision points, testing and evaluation still remains so that all the data required to make informed decisions has been accumulated, analyzed, and documented.

To date, two ASP vendors have developed systems that have completed the following 2008–2009 tests: System Qualification Testing, designed to demonstrate that ASP units are manufactured in accordance with processes and controls that meet the specified design requirements; and Performance Testing at the Nevada Test Site (NTS), designed to evaluate ASP, PVT, and radioisotope identification devices (RIID) detection and identification performance against controlled, realistic threat materials, shielding, and masking scenarios. One vendor has also completed Integration Testing, designed to determine whether the ASP systems are capable of operating and interfacing with the other equipment found in operational settings. This vendor has now begun field validation testing, designed to exercise ASP systems in a stream of commerce environment at POEs.

The second vendor has experienced technical and accounting issues that have caused its testing schedule to lag behind. DNDO is in the process of determining the best path forward with this vendor. The remainder of my testimony will focus solely on the first vendor.

Field Validation:

Since our last hearing, CBP conducted an additional round of field validation at operational POEs. You may recall that CBP operated the ASP systems at four field validation sites in January and February of 2009 for a period of two weeks. During this time, the systems were run in tandem with the PVT systems to scan incoming cargo conveyances, and were able to collect data in an operational port environment with real flow-of-commerce. During these operations, the ASP systems showed higher than expected alarm rates for three industrial sources.

Following this first round of field validation, the ASP thresholds were adjusted to more effectively eliminate alarms on benign sources and were retested to ensure that the sensitivity for detection of special nuclear material and threats did not fall below guidance requirements. Utilizing a computer-based replay tool, we were able to determine that the adjustments solved the problem without decreasing the probability that the system will detect and identify threats. Additionally, the systems were put through regression testing to determine if the problem had been appropriately addressed.

After the threshold adjustments were fine-tuned for the three specific isotopes that were problematic in the winter, CBP restarted field validation in July. This testing identified two additional issues. First, there was a single mission-critical fault at one field validation site in which the software database system failed to scan multiple conveyances, and did not immediately notify the CBP Officer of the problem. There was no security threat at this port because ASP systems were operating in parallel with the current generation systems. A technical representative from the vendor was summoned and the issue was rectified. The cause of the problem has since been identified and fixed. To assure that the fix did not create any unintended problems, the software has been successfully regression tested.

The second technical issue identified during July field validations was a higher than expected rate of false alarms for certain special nuclear material (SNM) threats. Since ending this second round of testing, the ASP thresholds were adjusted to eliminate this problem, and the systems were retested to ensure that the sensitivity for detection of special nuclear material and threats was not reduced below guidance requirements. Use of the replay tool and regression testing validated that the false alarm rate will be reduced below guidance requirements, and it is anticipated that another round of tandem operation field validation will verify the effectiveness of the settings. In this case, the threshold adjustments resulted in an acceptable reduction in the sensitivity of the system, while remaining more sensitive than required by the original specifications.

The fact that the SNM false alarms did not occur at the same rate in the first round of field validation as seen in the second round is a good example of the need for robust, multi-stage testing, since it may have revealed a sensitivity to seasonal changes and cargo contents that was not expected. Such oddities are typical when a new system transitions from the lab to the real world, and we will continue to learn and improve as testing progresses. At present, DNDO and CBP are in discussions to establish the ground rules for starting the next period of tandem field validation evaluations. Following the completion of tandem operations, ASP systems will undergo solo field validation evaluations.

Path Forward:

Once all the phases of field validation are completed to the satisfaction of both DNDO and CBP, ASP systems will complete independent operational testing and evaluation (OT&E) conducted by the S&T Operational Testing Authority. Test data will be analyzed and provided to inform the Secretary's certification decision. DNDO is also engaged with the National Academy of Sciences (NAS) to perform an additional review of ASP testing and inform the certification process, as required in the FY 2008, 2009, and 2010 Homeland Security Appropriations bills.

Additionally, DNDO is working to develop a cost-benefit analysis that will analyze the cost effectiveness of deploying ASP systems in several different configurations. This cost-benefit analysis methodology is still being processed with the available data and requires additional data from the remaining tests before it can undergo review within the Department and be finalized.

The current path to certification includes testing as described above, accompanied by the analysis of results, to ensure that Secretary Napolitano has sufficient information and all the Departmental acquisition program requirements are met. ASP systems have been under review and evaluation for over three years now, but we are focused on informing a decision to go forward with acquisition and deployment with the appropriate processes. Such a decision will be made only when it has been determined that ASP will increase the probability of detecting dangerous materials while minimizing operational burdens, rather than based on a pre-determined timeline.

The changes and continued diligence that DNDO exercises in conjunction with the ASP program will ensure that any eventual certification and acquisition decisions are consistent with DHS priorities and made with a documented acquisition management foundation. The ASP program will also be presented to the DHS ARB for an MD 102–01 milestone decision for purchase and deployment of ASP. This is a very well-defined milestone that was developed for all large programs within the Department of Homeland Security. Items such as mission needs, operational requirements, analysis of alternatives, etc., are part of the MD 102–01 process—no production units can be purchased and deployed without successfully navigating the process. To be clear, the Secretarial certification requirement is in addition to the MD 102–01 deployment decision. DNDO intends to present both the Secretary and the ARB with all the necessary information to make decisions about the operational effectiveness and potential optimal deployment of ASP systems.

Conclusion:

DNDO will continue to work with CBP and other partners within and beyond DHS to improve the Nation's ability to detect radiological and nuclear threats at our ports and borders. DHS is facing a challenge; we must balance facilitating the flow of commerce at our ports and borders with the need to sufficiently scan cargo for radiological or nuclear threats before it enters our Nation. As both the President and Secretary have said, the Nation needs more technology to meet its security challenges and the technologies that DNDO is pursuing, of which ASP is but one example, are a critical component in addressing that challenge.

Our efforts to develop and evaluate ASP systems are based on sound, proven testing and evaluation processes used with proven success across government and academia. Current test results are capturing the benefits of ASP systems, and the reviews to date have provided a valuable assessment of the program and identified a number of key lessons learned. As we collect more operational data for the ASP systems, we are better able to determine the optimized settings for detecting and identifying threats, while facilitating the flow of legitimate commerce.

I welcome and appreciate the Committee's active engagement with this program, and look forward to continuing our cooperation as we move forward together. Chairman Miller, Ranking Member Broun, and Members of the Subcommittee, I thank you for your attention and will be happy to answer any questions that you may have.

BIOGRAPHY FOR WILLIAM K. HAGAN

Dr. William Hagan serves as the Acting Deputy Director for the Department of Homeland Security's (DHS) Domestic Nuclear Detection Office (DNDO). Prior to January 2009, Dr. Hagan served as the Assistant Director of the Transformational Research and Development (R&D) within DNDO. Dr. Hagan was responsible for long-term R&D, seeking technologies that can make a significant or dramatic positive impact on the performance, cost, or operational burden of detection components and systems.

Before his work with DNDO, he was a Deputy Business Unit Manager at Science Applications International Corporation (SAIC). Business areas included nuclear technology (analysis, detection, and applications), telecommunications, optics, transportation, system integration, and technology assessments during his thirty years at SAIC.

Dr. Hagan earned a Bachelor of Science in Engineering Physics in 1974, Master of Science in Physics in 1975, and Master of Science in Nuclear Engineering in 1977 from the University of Illinois at Urbana. He received his Ph.D. in Physics from the University of California–San Diego in 1986. He holds three patents. Dr. Hagan was appointed to Senior Executive Service in 2006.

DISCUSSION

Chairman MILLER. Thank you, Dr. Hagan. I now recognize myself for five minutes.

CBP PROCEDURES AFTER A PRIMARY ALARM AND THE EFFECT OF FALSE POSITIVES

Mr. Owen, I hope that CBP's procedure is, if you identify nuclear materials, the kind of nuclear material that would be used in a nuclear weapon or for a dirty bomb, that your procedures would require that you act like your hair was on fire, that you act with great urgency. Without getting into anything that is classified in this setting, could you describe what your procedures are?

Mr. OWEN. Yes, sir. Whenever we have any alarm of a PVT on primary, the cargo or the passenger vehicle is then sent into secondary because again, the PVTs at this point only detect radiation, they do not identify what it is.

In the secondary, we use the hand-held Radiation Isotope Identification Device. If that determination is that we have special nuclear materials, we then implement what we call SIN procedures: secure, isolate, notify. We secure the area, we isolate the conveyance, and then we begin our notifications back to our Laboratory and Scientific Services folks at our National Targeting Center for cargo here in Northern Virginia. The CBP officers would transmit the radiation spectra to the Laboratory and Scientific Services people to make a determination as to what exactly what we have there. So as this is going on, again, we are in secondary. It is a more controlled arena. Depending on the footprint of the port, depending on the layout, the time of day, the traffic, will impact how much of a disruption it will be to some port operations. But clearly, whenever we have a higher level threat such as the special nuclear materials, we do act accordingly. There is some disruption to the port operations until we resolve that alarm.

Chairman MILLER. You said secure, secure and identify, secure the area. How big an area do you secure?

Mr. OWEN. Mostly it is just in the secondary area with what we have. We will create a perimeter of secure area if you will. It will not require an automatic shutdown of neighboring activities or anything like that. As we do the initial readings, send it back to our Laboratory and Scientific Services folks—clearly, if the issue has escalated, if it is of grave concern to us, your exclusion zone would expand and the level of activity would increase.

Chairman MILLER. Okay. Do you have any idea how many hours ports like New York, New Jersey, Los Angeles, Long Beach, would be closed or how they would be affected by false positives for special nuclear materials?

Mr. OWEN. I don't have any data as to how many times this has happened or was shut down, but those are the procedure. And really again, based on the layout of the port, if it is a large seaport, you can have just one terminal affected by an alert of special nuclear materials through one of our detection devices. If it is a smaller land border crossing, you could theoretically have a much greater impact on that type of operation. So there is an impact depending on the different variables as to how much of an impact, but clearly there is an impact whenever we have an alert of a special nuclear material.

Chairman MILLER. Okay. Well, obviously one of the most immediate problems with false positives is disruption of commerce, disruption of ports and borders. But I remember from college that the first time the fire alarm went off in the dorm, everyone rolled right out of bed and went outside, but by the time it happened three or four times because of a prank, all anyone did was just put a pillow over their head to make the noise—so they could sleep through the noise. I don't ever want it to become routine if we have an alert that there is a special nuclear material. Obviously, if there is a real fire, the fire alarm would have done no good at all.

Mr. Aloise, the July round of field validation tests, there were, you said, false positives. The machinery, the device, ASPs detected materials that were not there at all. Can you give us the details of how many false positives or was it one or two machines, was it all the machines? What happened?

Mr. ALOISE. Yes, I believe, and CBP can confirm this, there was four per thousand at the smaller ports and eight per thousand, eight false positives per thousand conveyances at the larger ports during the testing in July.

Chairman MILLER. And was that across all machines or was that just one or two machines that seemed not to be quite right?

Mr. ALOISE. I believe it was across all machines, yes.

Chairman MILLER. So it was a problem with technology generally not with a problem with a specific——

Mr. ALOISE. With any one machine.

Chairman MILLER. Okay. My time has almost expired, so I will recognize Dr. Broun for five minutes.

Mr. BROUN. Thank you, Chairman. I still am going to be very generous with time. You have been very generous with me, and I will continue to be generous with you at any point. I want to make the Chairman——

Chairman MILLER. After serving for two years with Dana Rohrabacher as a Member of the Subcommittee, it is really not a problem.

STEPS TAKEN TO REDUCE FALSE POSITIVES AND NEGATIVES

Mr. BROUN. Thank you, Mr. Chairman. Some of the field validation tests reveal high levels of false positives for the special nuclear materials. This is a serious problem because any identification of any special nuclear materials requires a robust response from CBP officers. What is DNDO doing to address this issue? And you might also—I am concerned not only about false positives but false negatives. And I really haven't heard anything about that so if you could deal with that, too?

Dr. HAGAN. Regarding what we are doing about the false positives, the field validation showed a large number or unacceptably high number of calls for SNM (Special Nuclear Material). We have adjusted the threshold levels for the ASP and run a replay tool to demonstrate that in fact the number of false alarms, if these threshold settings had been used instead of what was used in July, that almost all of those false alarms would have been eliminated. The number would have dropped from about, according to my data here, from about 49 to seven. Now, no system is flawless or perfect. And so it is not likely that we will ever build a system that will produce no false alarms in primary. But the levels that we are operating now according to the replay tool are within the acceptability range.

Regarding false negatives, in the flow of real commerce in the field validation activity, there is really no way to know if you have dismissed something that you shouldn't have. Now, we have testing at another place, the Nevada Test Site, where we tested that, and I don't recall what the false negative rate was, but it was quite low.

Mr. BROUN. As a physician, I am concerned about, and in science, as you know, talk about specificity and sensitivity. Several independent sources have already indicated that ASP only marginally increases our ability to detect lightly shielded special nuclear materials. If we manipulate those thresholds, won't this decrease that margin even more, and if this is the case, how would that affect any future cost benefit analysis?

Dr. HAGAN. The change in—when the threshold settings were changed, again using the replay tool, we were able to calculate what the difference or see what the difference was in the sensitivity. It is a reduced sensitivity as with any detector. When you make your system—when you reduce, make changes to reduce the false alarm rate, the sensitivity is usually affected. So this is true of this detector as well. But when we compare the sensitivity of the system before the threshold settings were made to that after, while it was reduced, the reduction was rather slight and the performance of the system is still within the specification and the guidance.

Mr. BROUN. In order to verify and validate the threshold changes made to ASP systems, a replay tool was developed. Has this tool been validated by an independent party?

Dr. HAGAN. Yes, it has.

Mr. BROUN. Okay. And who is that party?

Dr. HAGAN. The Johns Hopkins APL, Applied Physics Lab.

Mr. BROUN. And what was the results of that?

Dr. HAGAN. Okay. Well, maybe the best way to convey that is to comment or to give you some of the results from the replay tool validation exercise. So when we say a replay tool, we mean we want a tool that when given the same input data as the real system, it produces the same results as the real system. And so the replay tool was given the real data for 11,000 occupancies, and the results were compared to what actually came out of the system. The results were identical for all 11,000 except for eight. Those eight that were found, the reason that the differences were slightly different, the results were slightly different, is that the codes were run on two different computers, and there was a slight round-off error difference between the two computers. And because of that, there were eight occupancies that yielded slightly different results. Other than that, the results were identical.

Mr. BROUN. Thank you. Mr. Aloise or Dr. Persons, do you all have a response to that?

Mr. ALOISE. We would say this and then I will let Dr. Persons answer as well. As you recall in June when we testified, we said there was a marginal improvement in the Nevada testing over what the PVTs were, and that marginal improvement, because of this reducing of the thresholds has now gotten smaller. So when they do the cost benefit analysis, all this has to be factored into that cost benefit analysis because now the ASP seemingly does not have the performance that it initially did when we testified here earlier this year. So that is one point.

The other point is we have not looked at the replay tool. We have not talked to Johns Hopkins, so we can't really comment on the replay tool. Dr. Persons, would you like to——

Dr. PERSONS. Well, just to confirm what Mr. Aloise was saying, we have not been able to look at that, but one of our key points on this is just the idea of an independent verification or validation of such a tool to do that. And in interviews with CBP officials, for example, there was a concern about perhaps having an institution such as the American National Standards Institute, or ANSI, do something more standardized oriented body to do that. There is also of course when you are dealing with software development issues which are implied in these systems with this level of complication, then you would look at of course the software models, the software standards, how those were constructed, how they execute the algorithms and perform under test.

Mr. BROUN. Dr. Hagan, I would like for you to, if you would, submit that report for the record for us——

Dr. HAGAN. Sure, in the form of a letter.

Mr. BROUN.—and a discussion about it. Okay. Good. Thank you, sir. Mr. Chairman, I yield back.

Chairman MILLER. Thank you, Dr. Broun. The Chair joins Dr. Broun in that request.

Ms. Dahlkemper for five minutes.

MISSION CRITICAL FAILURE

Ms. DAHLKEMPER. Thank you, Mr. Chairman. Thank you to all those here testifying today. I want to go to one of the most basic problems and I guess one of the most alarming was the mission critical failure when two dozen cargo trucks were permitted to go through the ASP in order to be screened and actually were not operating at that time. And supposedly this has been rectified by the contractor with an indicator light. Is that correct?

Dr. HAGAN. No.

Ms. DAHLKEMPER. Nothing has been rectified?

Dr. HAGAN. It has been rectified but not with an indicator light. There is a message that gets shown to the operator on screen that says that the system is in mission critical failure and should not be operated.

Ms. DAHLKEMPER. So prior to this there was no way to detect if there was——

Dr. HAGAN. There was a message but it was confusing and not clear, and so that is what led to the incident. By the way, I should comment that this only happened one time in one system in all the testing in validation runs that have been going on for approximately for a year. So we don't think it is going to happen again, but we modified the software to properly notify the operator.

Ms. DAHLKEMPER. I can buy a $15 smoke detector for my house and it will tell me when it is beginning to not work, and when it doesn't work, it will beep so I have to get up in the middle of the night and take the battery out. But anyway, I just wanted to make sure that that problem is rectified at this point.

Dr. HAGAN. It has been rectified, it has been regression tested, and we are confident that the message will be properly displayed. We are struggling a bit with this one error or issue that has come up because it has only happened once. So we don't think it will happen again. But that is the point of field validation, is to shake out some of the issues and problems before you move on to the actual operational test.

Ms. DAHLKEMPER. How may of these are in operation in this field testing? How many?

Dr. HAGAN. Six.

Ms. DAHLKEMPER. Six? And how many of the PVTs do we have currently?

Mr. OWEN. Just under 1,400 deployed nationwide at the land borders and seaports and some mail facilities.

ENERGY WINDOWING TO IMPROVE PVT PERFORMANCE

Ms. DAHLKEMPER. Okay. One of the things I wanted to ask, Mr. Owen, is on the GAO's previous work on the ASPs, they found that the ASPs provide a marginal improvement of the PVTs to attack the certain types of radioactive sources under a handful of very specific scenarios. But the GAO has also recommended that DNDO invest in ways to increase performance of the existing radiation monitors known as PVTs by a software improvement process called energy windowing. Do you believe that more efforts should be made to investigate the benefits of the energy windowing?

Mr. OWEN. Yes, our position remains that we need to fully maximize what the detection capabilities of the existing technology of the PVTs is. So we believe there are gains that have already been made with energy windowing, and we would rely on our scientific partners to tell us if we have reached the edge of that envelope as to how much they can do, either with the existing algorithms or with advanced algorithms that may be there. So as the operator and end-user of the equipment, yes, we would like to etch out as much detection capabilities as we can from the PVTs, recognizing that even with energy windowing, there will still not be an identification device, just a detection device.

Ms. DAHLKEMPER. Mr. Aloise, how much has been spent on energy windowing work by DNDO or DHS in the last few years compared to how much has been spent on developing ASPs?

Mr. ALOISE. I don't have that information, but I do know that we have been told that further research has sort of been slow-balled, and we would have liked to have seen them a lot further by now in where the energy windowing is with the PVTs.

Ms. DAHLKEMPER. Could I get that information? Could that information be found, Mr. Owen, in terms of how much work has been done?

Dr. HAGAN. Yeah, I can give you the numbers right now.

Ms. DAHLKEMPER. Okay.

Dr. HAGAN. For energy windowing, we have funded a total of about $1.9 million again to Pacific Northwest National Laboratory and the Johns Hopkins University Applied Physics Laboratory.

Ms. DAHLKEMPER. And how does that compare to how much has been spent on ASPs?

Dr. HAGAN. It is a lot less. I don't know the exact ratios or anything.

Ms. DAHLKEMPER. What is the total? You don't know what the total has been spent?

Dr. HAGAN. Well, I think the number that was quoted I wouldn't argue with. I think it was $230 million over the last——

Ms. DAHLKEMPER. It is $1.9 million over the last how many years?

Dr. HAGAN. Which——

Ms. DAHLKEMPER. Last few years. When did we start? I am new to Congress so when did we start working on ASPs.

Dr. HAGAN. Oh, ASPs? 2004 or 2005. I actually don't know. I wasn't here then.

Ms. DAHLKEMPER. So we have spent $230 million in that time period on that?

Dr. HAGAN. Right.

Ms. DAHLKEMPER. And the energy windowing, you started working on that?

Dr. HAGAN. That was in fiscal year 2009. I think the actual work started in July of '09 at PNNL.

Ms. DAHLKEMPER. So since just this past July we spent $1.9 million?

Dr. HAGAN. Oh, we haven't spent it. We have obligated it.

Ms. DAHLKEMPER. Obligated it?

Dr. HAGAN. I don't think it has been actually expended yet, but the work is ongoing.

Ms. DAHLKEMPER. Okay. And that just started this year, in July?

Dr. HAGAN. Yes, in July, right.

Ms. DAHLKEMPER. My time is expired. I yield back.

Chairman MILLER. Thank you, Ms. Dahlkemper. Mr. Bilbray for five minutes.

Mr. BILBRAY. Thank you, Mr. Chairman. I apologize for being late, and so if my questions have already been answered, you can remind me my tardiness was inappropriate.

THE CBP INSPECTION SYSTEM

Mr. Owen, the issue of inspection, do we have a formal, multitier inspection system and when we talk about the inspection is there any pre-entrance inspection before they get to the port facilities?

Mr. OWEN. We do not pre-inspect cargo. What we do have is part of our layered cargo security strategy. We receive advanced information on all cargo and all modes before it arrives in the United States, different timelines, whether it is coming by air, by truck, by rail or maritime. With that advanced information, we make an initial assessment if the cargo poses a risk. In our maritime environment through our container security initiative, we have officers deployed in 32 countries at 58 seaports that can then conduct an inspection on the highest risk maritime cargo before it is put on a vessel coming to the United States. We do not have a similar program in air or in land. So even though we have that advanced information before the truck or the train or the airplane arrives in the United States, we can identify the highest risk, but then it would be looked at at the port of arrival. So we do not have preinspection overseas for cargo.

Mr. BILBRAY. Okay. So we do have it for the maritime. Do we have any structure at all that if there was the ability to basically modify the arrival system, in other words hold them offshore until we could board the craft and be able to inspect it?

Mr. OWEN. Yes, sir. Absolutely. We work very closely with the Coast Guard. If there are any threats on a vessel, we will keep the vessel out at sea to address those threats or concerns with the crew or whatever the case may be. Likewise with the air cargo, we receive the information four hours before the plane lands, so in most cases if we have a concern that aircraft can be diverted to have address that threat, yes, sir.

Mr. BILBRAY. And I am glad to hear that because, let us face it, the port facilities tend to be much more centrally located in high population areas than either the port of entries for vehicles or with the aircraft, so thats preemptive.

THE HELIUM-3 SHORTAGE AND POTENTIAL ALTERNATIVE MATERIALS

The issue of helium-3, as we are fighting to try to make what we have stretch, any discussion of the crisis and what we would need to do to crank up the breeder so we can produce more and make it available for you?

Dr. HAGAN. There has been a lot of discussion. This issue has really risen quickly to the top of a lot of people's lists, including the White House. They have formed an Interagency Policy Committee to address this that involves not only DHS but of course the White House folks, DOE, DOD and so forth. The problem is rather severe. The demand will probably outstrip the supply by a factor of ten. There is just not very much. And there are other uses for this material, for helium-3 that involve medical uses and so forth that frankly will probably end up having higher priority, although I can't say that for sure.

Mr. BILBRAY. So the fact that this is a strategic supply problem that we need to address as a nation?

Dr. HAGAN. Yes. I believe that is the case. Now, there are—so for some applications, like low-temperature physics research, helium-3 is pretty much the only—you are almost researching the material itself, so it can't be replaced.

For our applications in neutron detection, there are other potential alternatives which we are, DNDO, is taking the lead for the interagency group to explore. We have been funding research in this area for several years already. So we are looking at alternative means of detecting neutrons. But because we don't know what those means are today, there are several, as I say, potential alternatives. But it can still take a year or two probably to sort of test those, evaluate them and make sure that the designs work. So it is a real problem for us. That is why it has thrown a real glitch into our planning process.

Mr. BILBRAY. Are there any other jurisdictions or agencies around the world that are specifically looking at developing this capability?

Dr. HAGAN. To make helium-3?

Mr. BILBRAY. Yeah.

Dr. HAGAN. Well, there are places——

Mr. BILBRAY. We don't have any others domestically. Is there anybody domestically looking at it?

Dr. HAGAN. There is some thought to perhaps going into natural gas wells and separating some of the helium from that and then distilling that, pulling out the helium-3 from that. There is a possibility of a source in—well, several sources in other countries. I probably shouldn't say much more than that.

Mr. BILBRAY. Okay, Mr. Chairman, I know my time has expired but in all fairness, there are a whole lot of issues that the Federal Government gets involved with that states, counties, cities, international bodies could work on or whatever. Here is one where this really is in our lap. I just can't perceive a state or a county or a coalition of states being able to address this issue, and here is one that I would sure like to see the Federal Government make some priority decisions and say this is one that only the Federal Government can do so the Federal Government has to be more aggressive on this. And I will remind all of us as we talk about other issues that could be handled by other agencies that we keep forgetting about the ones that only we can handle. And maybe we need to focus on these items that other people can't handle. So I appreciate your testimony and yield back, Mr. Chairman.

Chairman MILLER. Thank you. Mr. Rothman was here and I think will be back shortly. I will recognize him out of turn if he returns for a first round rather than for a second round.

IN WHAT CIRCUMSTANCES SHOULD ASPS BE DEPLOYED?

The Chair of the Appropriations Subcommittee for Homeland Security is my colleague from North Carolina, David Price. His district adjoins mine. In fact, they kind of wrap around each other like a couple playing Twister. If he should ask me in what circumstances the new technology of the ASP should be deployed, what should I tell him? What are the markers for when it is reliable enough to replace the PVTs? Should it never replace the PVTs? Should it always be used unless there is some breakthrough that we haven't seen yet, some improvement in the technology? Should it always be used for secondary screening after a PVT has identified something to be concerned about? Or is this worth it at all? If the PVTs seem to be working, there is some disruption of having a truck pull over to the side and going over it by hand or cargo. But is this worth it? Mr. Aloise.

Mr. ALOISE. Well, our position has consistently been that nothing should be acquired in large scale until all the testing is complete, all the results are in, we know whether the system works or not, a cost benefit analysis has been done, and we can see whether it is worth it given all the other demands we have in our architecture, all the gaps in that architecture. After that cost benefit analysis is done, we will have a better answer to know whether it is worth to pursue with the ASPs versus the PVTs. Then the question is where? Does it make sense more in secondary? Does it make sense in other places?

So our position, again, we need to get the testing done, all of it done, we need to do the cost benefit analysis. And until then we really don't have enough information to make this decision on.

Chairman MILLER. Well, the original idea was to replace PVTs with the ASPs. Given what we know, even assuming that the testing improves, we figure out what all the problems are so that it doesn't sort of go off without—it doesn't become non-functional without us noticing it until after a lot of trucks have gone through or it doesn't produce an amount of false positives that is going to shut down major ports for a significant period of time. After we have worked out those kinks, does it still make sense at all for it to be a primary detection device instead of the PVTs?

Mr. ALOISE. We have our doubts.

Chairman MILLER. Mr. Owen.

Mr. OWEN. Well, again, from our perspective, assuming it meets all of the technical and scientific endeavors and the machines work, then we have a serious concern about the operation and maintenance costs, the tail that will come with each one of these devices. As you mentioned in your opening statement, we are looking at perhaps as much as five times or more what it costs to currently operate it. So we also are waiting anxiously to see the cost benefit analysis as well as the life cycle costs to see if we can even as an agency afford these devices should they continue to develop and mature and be proven scientifically to work.

Chairman MILLER. Dr. Hagan.

Dr. HAGAN. I agree with the GAO on this. Until we get the cost benefit analysis and a lot of other data, by the way, that goes into what we call an Acquisition Review Board, it is really not prudent to try to presuppose the result of that. We absolutely adhere to the notion that doing the testing and doing the validation, doing the cost benefit analysis, life cycle cost estimates, all that has to be done and fed into this process. We have a very rigorous process within the department to do that. I wouldn't want to speculate about whether it is going to make sense in primary or secondary, either or both. But we at DNDO at least are indifferent to that. The point is it has to be driven by, you know, real data and analysis.

Chairman MILLER. Three years ago, Vayl Oxford, who was then Director of DNDO, said the priority for the first year is to get units out immediately. That seems like not the best idea right now. Does anyone disagree with that? Does anyone agree still with what Vayl Oxford said then, three years ago? Not a priority to get this in place immediately? Okay.

When do we expect we will get the cost benefit analysis?

EXPECTATIONS OF A COST-BENEFIT ANALYSIS ON ASPs

Dr. HAGAN. The cost benefit analysis is—we are actually struggling with this right now because of the helium-3 shortage and the impact of that. The cost benefit analysis of course depends on what the cost of the system is. We will have to most likely replace to helium-3 neutron detectors with some alternative. At this point, we don't know what that alternative is. As I said before, we have several potential candidates for that. But until we know what that is, it is going to be difficult to generate a cost benefit analysis because we won't know what the cost of the systems is. It may be possible to work around that, but frankly we don't know that yet. We are still looking at all the various options. We can try to get to a CBA, cost benefit analysis, but without that information and of course without the results from the operational test, we can't do that.

Chairman MILLER. Dr. Persons, actually, most of my questions I have directed initially to Mr. Aloise and he used the first person plural, and then you nodded. So I didn't direct an additional question at you, but you have worked with many new technologies. Are there best practices? Are there lessons to be learned for how to develop new practices, how to develop and deploy new technologies and have those lessons, have those best practices been applied with respect to this technology?

Dr. PERSONS. Yes, sir. I worked with—coming out of an environment where, if you are familiar with the Defense Advance Research Projects Agency, it is the idea about rapid technology development, in the absence of requirements that is normally for a very high-risk type, high-reward research and development paradigm. And this particular case, as you mentioned earlier, there is sort of some relatively mature technologies, it was just relatively immature, the concept of operations it was going to be asked to be placed under, in other words, a port operation with high volume and so on.

And so I think some of the lessons learned from this is what you put your finger on just a moment ago, was what I would call the mistake of scheduling invention, in other words, setting artificial deadlines. We want to get these out and then we will worry about sort of the technology development later on. GAO best practices for many years on this topic have shown that that is a mistake to do that. You want to risk mitigate the way you develop your programs by investing and particularly empowering your science and technology folks to do that and do that outside a procurement operation. Even though there needs to be close ties there, it still needs to be this idea that the science and tech folks can do the technology and development, and the procurement folks can worry about how to do the procurement

And so keeping that sort of balance of power, doing that, the requirements definitions is hugely important. I think in this case, the customer ultimately was CBP and what were they going to be comfortable with in an operational paradigm? Was the con-op really going to be an ASP and primary alone in solo mode, or is there going to be a reduction in their manpower requirements and so on. or was it an SNM detection paradigm alone? Those are some issues that drive requirements through CBP out to the end of the program.

And then thirdly, of course, the independent testing and evaluation, we have had a lot of discussion on that. Again, the key thing is there is the independence of that and how that is done.

Chairman MILLER. Okay.

Dr. PERSONS. And so we have been pleased to see DNDO talking about interacting with DHS's OT&E office and so on——

Chairman MILLER. Okay.

Dr. PERSONS.—at this phase.

Chairman MILLER. One of the lessons learned is that, at some point, you look for an off-ramp that if a technology seemed like a good idea but just didn't work, that you determine is not a matter of just working out kinks, but this was not as good idea as it seemed. Are there measures for when you should look for an off-ramp?

Dr. PERSONS. Right. Well, GAO best practices recommend the use of readiness levels, technology readiness levels and so on. I think one of the things here that I think could perhaps be used is the idea of software readiness levels and so on because software an algorithms are such a critical part. I think that has manifested itself in the recent conclusion of the field validation tests and so on.

So you have these metrics for doing that, and I think organizationally as I believe DHS likely has is some idea about what is an acceptable risk of this technology or this system for deployment. And there are ways to measure that and just give your managers informed decisions so that they can determine the risk of something, whether or not it needs to move forward and—mode.

Chairman MILLER. Well that is not quite a Dana Rohrabacher five minutes, but I am over the traditional five minutes. And with that I recognize Dr. Broun for five minutes or more.

METRICS AND TIMELINES FOR MAKING DECISIONS ABOUT ASPS

Mr. BROUN. Thank you, Chairman, and I am going to dovetail back into what the Chairman was asking. I would like to know the metrics. It seems to me that we keep fooling around here and have excuses of not implementing a technology, and not only a valid technology that is not only useful but may be preferable over our current technology, but there are other things that CBP is already doing. And going back to the Chairman, you are talking about an off-ramp, it seems to me we are getting to the point of fishing or cutting bait or one of the two. I mean, we have got to do something. If you all would give us some metrics about when we can expect the decision-making process, if you can help us to understand at what point do we need to pull the plug on the ASP program or implement something else or what have you with all of you, and I would like to—because I don't have a good feeling about this, frankly. I don't know about other Members but I would appreciate it if you all would give us some metrics or if you have them, please tell me right now. Mr. Aloise?

Mr. ALOISE. Well, you know, DHS came up with their "significant increase in operational effectiveness" as their metric for going forward with this new equipment, and we from the beginning thought it was a pretty low bar. I mean, I will go back to what I said. You know, even if this ASP works, it is a marginal increase. Now, with the adjustments and thresholds, that margin has gotten more narrow. So what GAO's role is here to evaluate what DHS is doing and provide this information to the Congress, of course, and we have made recommendations all along to make improvements in the testing, in the reporting, but the bottom line, I have to go back to what I have said, once the testing is done, we need to do that cost benefit analysis and decide whether or not it is worth to go ahead with this.

Now, it has taken longer. You know, you mentioned in 2007 they were ready to deploy, but the Congress who has oversight and getting GAO involved has got us to where we are today. Now, where do we go from here? I assume a third round of field validation testing. The first round, they made adjustments. The second round, we may be seeing the results of those adjustments, and we don't know what is going to happen in the third round. The question is, is this equipment worth it? And that is a decision that DHS has to make. And I mean, we have got a lot of information right now, and somebody can make a decision or they can put this back into what we belong—where it should have been for a long while, and that is R&D, in development, and see where—what is the most you can get out of this promising piece of equipment. But when you know, we started down the path or just started down the path of acquisition, deployment and spiral development, they have called it, and it has got us to where we are today, where the equipment has a lot of problems, it doesn't work very well right now. And to take a risk and replace the equipment we have got now on the borders that we know works with equipment we don't know works, you are always going to have GAO saying, whoa, step back. We need to look at this again.

So I don't know. It is kind of a long-winded answer to your question, but we need more information before we could come to a conclusion, and that has to be the cost benefit analysis.

Mr. BROUN. Another question with cost benefit analysis, how can you do one without first knowing whether the ASP was used as a primary screening tool or as a secondary screening tool? I think that needs to be determined, too, just doing that cost benefit analysis because otherwise you are just shooting in the dark.

Frankly, I see the private sector developing screening methods without the taxpayer being on the hook for them, and we have this, we have spent a bunch of money and a lot of it is sitting in a warehouse and not being deployed and we are testing. Mr. Chairman, I think it might be time to have that offer out from everything that I can see, but I don't know.

And I would just like to ask Mr. Owen, would you possibly agree with me that it is time to maybe look at other technologies?

Mr. OWEN. Well, again, as you mentioned, the PVTs do meet our needs right now. They are effective. We can handle the level of alarms that we have got there. Hopefully, with any advances through the energy windowing, they give us a little bit greater technology detection capabilities than we have right now. Whether we can say we should pull the plug or not, I think again from the CBP standpoint, the jury is still out. We need that cost benefit analysis. We need to see how much better these in fact perform over the technology that we have before we could even make a decision as to should they just be in secondary or should they be primary and secondary.

But I would like to just close by saying again, through all of our testing, we have kept the PVTs up and running. So we have always had that safety net, that effective equipment that we know has worked so that those 27 trucks did not get through when the machine went down.

Mr. BROUN. Thank you, Mr. Chairman. I yield back.

Chairman MILLER. Thank you.

Dr. HAGAN. Could I respond to any of this?

Chairman MILLER. Yes. Dr. Hagan.

Dr. HAGAN. Thank you. First of all, I wanted to comment that the cost benefit analysis addresses both primary and secondary screening, so we are not pre-determining that outcome. Second, the ASP, what we have been talking about here primarily is about ASP and PVT in primary, and you know, the debate will rage on. As I said before, I agree that the CBA is the way to determine that, you know, whether that is effective or not and worth the money.

The ASP operating in secondary is another matter. The limitations of the current system—CBP officers are using the current equipment as well as they possibly can. There is no question about that. But there are limitations to those systems in both primary and secondary, and let me just focus on secondary. In secondary, there are limitations which improvements to PVT cannot address. Only ASP can do that. I can't talk about the limitations or the changes or improvements of ASP compared to hand-helds in an open session. But the differences are dramatic. And so I think this talk of an off-ramp would be very premature and perhaps a closed session would be the way to deal with that. But I would urge you to consider the fact that ASP has considerable application and benefit in secondary.

Chairman MILLER. It is not really my turn, but I do hold the gavel. Mr. Aloise, Dr. Persons, do you all have security clearances? Do you have that top secret security, the top? Are you familiar with all of the analyses of the comparative benefits of PVT and ASP and primary and secondary versus hand-held? Are you familiar with all of that as part of the work you have done?

Mr. ALOISE. We are familiar with everything we have been shown, yes.

Chairman MILLER. Okay. Have you asked for everything?

Mr. ALOISE. Yes, we have.

Chairman MILLER. If there is something you haven't been shown, you have asked for it and not been shown it?

Mr. ALOISE. Right, and we don't know that that is the case but——

Chairman MILLER. Okay. Right. And you do understand that GAO is part of Congress and when they ask, we are asking and we need for you to give them anything they have asked for.

Mr. ALOISE. Absolutely.

Chairman MILLER. Okay. Assuming that you have seen everything, is there anything—if you know all the tippy-top secret stuff, is it really different? Is analysis a lot different in the way that Dr. Hagan suggests?

Mr. ALOISE. I would say this. I think you pretty much know the story as I have testified and GAO has reported on.

Now, in regards to secondary, just in discussions among ourselves, the ASP is bigger in radiation detection size matters. So it is a bigger instrument than the hand-held. So just for that—you have longer dwell times in secondary. So there might be uses. There might be a possibility where it make sense to put it into secondary, but we still don't have all that information.

Chairman MILLER. Okay. What is a dwell time? I am sorry.

Mr. ALOISE. You know, the container can sit a little bit longer in a secondary inspection, so you have a better account.

Chairman MILLER. I see. You are not trying to move things through.

Mr. ALOISE. You are not driving through.

Chairman MILLER. All right. I now recognize Ms. Dahlkemper.

Ms. DAHLKEMPER. Staying on this line of questioning, if it was used in the secondary manner, how many units would we need?

Mr. OWEN. Yeah, I don't have the date available as to how many secondary locations we have in all of the ports of entry, but it is far fewer than what we have in primary obviously. But even with that, the volume through secondary is relatively low. I mean, we have about a one percent alarm rate on the land border and about 2.5, 2.6 percent in seaports. So we would have to again look at the life cycle costs, the cost benefits as to how much better does it offset what it is costing us to buy this equipment versus the time savings or the fewer officers to address the secondaries.

Ms. DAHLKEMPER. Would anyone else like to address that? I don't know if anyone else can give you a better—more answer on that?

Dr. HAGAN. I can give you sort of a range. Like Mr. Owen, I don't have the numbers in front of me, but I believe the number of secondary sites is on the order of 400 to 500. Not clear that one would put an ASP at every one of those by any means. But as Mr. Owen says, it is far fewer than the number of primary screening locations. So the——

Ms. DAHLKEMPER. I am certain there would be certain points that would be much more crucial. Maybe some of the borders—I mean, I live near the Canadian border. Some of those ports of entry are much more crucial than others.

Dr. HAGAN. Right.

Ms. DAHLKEMPER. I did want to ask, though, I did want to kind of go back to this helium-3 issue because I think this is a crucial issue even beyond this hearing today. Who is in charge of the interagency task force on this?

Dr. HAGAN. It is the White House. I can't remember the name of the organization. I can give you the name of the person. That is about all I could do.

Ms. DAHLKEMPER. Who is that?

Dr. HAGAN. Her name is Julie Bentz, B-e-n-t-z.

Ms. DAHLKEMPER. Okay. My understanding is the ASP need three times the helium-3 as the PVTs?

Dr. HAGAN. The way it was designed was to have even more sensitivity for neutrons than the PVT systems did. So we put helium-3 tubes in the ASP design. But if we wanted to maintain the same level of sensitivity as the PVT for neutrons, it would require the same amount of helium-3. There is nothing that links the neutron detection technology to whether it is an ASP or a PVT.

Ms. DAHLKEMPER. As it is currently designed?

Dr. HAGAN. It was designed to have more sensitivity to neutrons than the PVT system because more sensitivity is better.

Ms. DAHLKEMPER. So how much more helium-3 is being utilized in an ASP than a PVT?

Dr. HAGAN. About three times more.

Ms. DAHLKEMPER. About three times?

Dr. HAGAN. What I am saying though is if we want to go back to the same level of sensitivity as we currently have with the PVT, then the amount of helium-3 that would be required for an ASP unit would be the same as for a PVT unit.

Ms. DAHLKEMPER. Well, then why would we have to change the unit if the sensitivity wasn't increased?

Dr. HAGAN. Because this is for neutron detection only.

Ms. DAHLKEMPER. Okay.

Dr. HAGAN. There is another part of the system that detects gamma rays, and that is the part that is different. So maybe I should say that the difference between an ASP and a PVT is the gamma ray detection part. In one case, with the PVT, it is a big block of plastic, and in the case of an ASP it is chunks of sodium iodide. But in both cases, the neutron detection part is done with tubes of helium-3 gas. And that part is essentially the same with both systems.

Ms. DAHLKEMPER. So you could redesign it so it would use the same amount of helium-3 and not really jeopardize the security?

Dr. HAGAN. Right. You wouldn't even have to redesign it. You could just take the tubes out, cut the number of tubes down by pulling them out.

Ms. DAHLKEMPER. Okay.

Dr. HAGAN. It would be simple to do that.

Ms. DAHLKEMPER. Okay. That answers my question. Thank you. I yield back.

Chairman MILLER. Thank you. I thought there was a Steve Rothman sighting, but that was perhaps a false positive. I think we now had sufficient questions for now at least. We may have an additional hearing. On this, you know, we do have—all Members have top-secret clearance. We have in this building and in the Cannon Building we have—leaded walls and Members go in and have to drop off their Blackberries and their cell phones before they go in, and they bring down a cone of silence and we hear all the top-secret stuff. And if we need to do that, we will, but if we go through that exercise and don't hear anything, it is going to be pretty irritating. So let us not do that right away, but before we close the hearing out, Dr. Hagan, can you tell us exactly where you think we will be on April 1? Will we have completed successful field tests, will there be a cost benefit analysis, where will we be on April 1? Three years ago the then-head of your unit said let us get this stuff deployed right now. Where will we be in April?

Dr. HAGAN. Because of the helium-3 issue, I cannot give you an answer about the cost benefit analysis. We know how important it is, and we may be able to do something, but without knowing how much the helium-3, or the neutron detection part of the system will cost, it makes that difficult. But we are looking at ways to try to get around that. Going back to field validation—well, maybe I should let Mr. Owen respond about the schedule. But by April, we will be, I suspect, in some phase of field validation or operational test.

Mr. OWEN. In terms of the field validation, we have those two critical areas that we have been discussing. We feel those have been addressed by DNDO. There are a few other minor issues that we are working through. Our objective is to restart field validation in the first quarter of calendar year 2010. So within the next month, we should restart field validation for a third round and go forward from there.

Chairman MILLER. Okay. Before we bring this hearing to a close, I want to thank our witnesses for testifying, and I guess it is a little early to say I look forward to seeing you the next time. Under the rules of the Committee, the record will remain open for two weeks for additional statements from the Members and for any answers to any follow-up questions the Committee may have for the witnesses. The witnesses are excused and the hearing is now adjourned.

[Whereupon, at 2:27 p.m., the Subcommittee was adjourned.]

Appendix:

ANSWERS TO POST-HEARING QUESTIONS

Responses by William K. Hagan, Acting Deputy Director, Domestic Nuclear Detection Office, Department of Homeland Security; and Todd C. Owen, Acting Deputy Assistant Commissioner, Office of Field Operations, U.S. Customs and Border Protection, Department of Homeland Security

Questions submitted by Representative Paul C. Broun

Questions for Dr. Hagan, and Mr. Owen:

Q1. Do you believe computer modeling through replay tools, injection studies, or regression tools are enough for certification, or do you believe real-world field testing is required?

A1. Certification requires that the ASP system be both effective and suitable for the operation it is designed to perform and that it meets the significant increase in operational effectiveness (SIOE) criteria. Each of the elements listed in the question play a part.

Real-world testing is vital. During the ASP program the systems have undergone or will undergo real-world and near-real world testing during controlled performance tests at the Nevada Test Site (NTS, real-world targets of interest), Integration testing (real-world interface and interoperability testing), and both Field Validation activities and Operational Testing (real-world stream of commerce and Customs Officer involvement), as well as any initial deployments. Real-world events allow the system to be exposed to a variety of traffic, cargo and radiological conditions that cannot be duplicated in any other way. Because real-world data is so important, it is vital that the data relating to traffic, cargo and radiological conditions be collected so that the impact of certain system changes can be evaluated without having to re-experience all real-world environments. For ASP systems all of this data is collected in what is known as ICD–1 files.

Replay tools provide the developer with an opportunity to re-create the real-world sensor data from previous data collection events (ICD–1 files), and to explore how changes in systems parameters would have impacted the results from those events. Replay tools are not computer modeling. These types of tools are used extensively for many types of systems, especially when data collection/ real-world testing is expensive, dangerous, or time consuming. In this case, Replay tools can determine the performance of the detector system for a previous data collection event under various system parameter changes, such as threshold settings. In another example, Replay tools are used to determine if the system can continue to perform if one or more of its elements are faulty. Since ICD–1 data files are organized by detector type, the replay tools can be used on modified ICD–1 files that have had this data removed. These sorts of regression analysis are extremely useful and can be used to provide information toward a certification decision. Injection studies are a way of extending the types and amounts of threat sources into stream of commerce data (i.e., ICD–1 files) so that system response to a broad spectrum of sources can be estimated. Injection studies are a type of computer modeling, and should therefore be checked against real, controlled experiments to validate that the injection tools closely match the output of real systems given the same input. Injection tools are useful to point toward potential improvements in systems performance, and should be used during continuous improvement planning—For certification, the best approach to confidently understanding system performance for threat sources is to perform measurements that span the threat space as much as practicably possible.

Q2. Has other ASP equipment been developed outside of this process by the private sector?

A2. DNDO is aware of other vendors, outside the ASP program, that have continued to develop spectroscopic portals.

Q3. How much money has DNDO spent on ASP R and D to date?

A3. $181M.

Q4. What is the proper role for DNDO in this process?

Should DNDO be simply testing moderate changes to Commercial Off The Shelf Technology, or should it be focusing on next generation technology?

A4. The Congressional and Executive guidance establishing DNDO, specifically the SAFE Port Act of 2006, the National Security Presidential Directive 43, and Homeland Security Presidential Directive 14, charge DNDO with maturing "transformational technologies" as well as to "develop . . . and enhance national nuclear and radiological capabilities."

Q5. Who should be testing COTS, CBP or DNDO?

A5. Three entities within DHS cooperate in the testing of COTS (and GOTS) systems: DNDO, the end-user (in the case of ASP this would be CBP), and S&T. CBP must ensure that the testing of systems incorporates realistic operational scenario, DNDO must ensure that the testing properly addresses the detection and identification requirements of the system within the GNDA and also must ensure that any developmental testing has been completed prior to Operational Testing. S&T is the DHS Operational Testing Authority and as such must assess the suitability and effectiveness of the final system configuration in real operational environments.

Q6. In addressing previous problems indentified in Field Validation Testing, has the agency changed the underlying algorithms that were tested at the Nevada Test Site (NTS)?

A6. No.

Q7. Will simply changing isotope thresholds be enough to fix these problems, or will algorithms need to be changed?

A7. As demonstrated by replay and regression testing, we are convinced that threshold adjustments, while reducing sensitivity, will reduce the false alarm rate while maintaining adherence to the ASP specification.

Q8. If algorithms are changed, will the equipment have to go back to the NTS?

A8. If the Department determines that changes, if they are to occur, warrant a return, to NTS, then such testing will be conducted.

Q9. If so, how much will this cost and how long will it take?

Is the Department only changing threshold levels (and not changing algorithms) simply because it does not want to go back to NTS?

A9. The cost and schedule of such tests, if needed, would be dictated by the type of testing required. ASP thresholds were changed because the algorithm is performing well, and because no reasons to make changes to the algorithm have been identified. The thresholds were changed because real-world field validation showed that they were not previously set in the best configuration. The Department has not intentionally avoided making any necessary changes to the algorithm to avoid returning to NTS.

Q10. At our previous hearing, we discussed the possibility of deploying the Low Rate Production (LRP) ASPs that are currently in storage in tandem with PVTs in order to get more data.

Does the Department currently have the authority to do this?

A10. The FY 2010 Appropriations Bill, and accompanying Conference Report, addresses low rate initial production ASP systems. Specifically, H.Rept. 111–298 states that, "the conferees encourage DNDO to undertake deployment of low rate initial production ASP systems, as appropriate, and use data from such deployments to inform future portal monitor decisions."

Q11. Has the Department made any progress on this front?

A11. The Department is working through the logistics of completing operational testing to get to Secretarial certification before making an LRIP deployment decision.

Q12. How much would this cost and how long would it take?

A12. There are eight (8) LRIP systems available for deployment. Approximately $3 million would be needed for installing and maintaining the systems for 1 year. Installation of the 8 systems would take place over a six (6) month window. Data collection and data analysis would take approximately 6–12 months and would cost $100K–$200K per system. Total for all activities would be less than $5 million.

Q13. CBP issued a RFI for ASPs several years ago only to have it rescinded by UNDO after the office was formed.

In retrospect, do you believe the Request For Information (RFI) should have gone forward, with an eventual Request for Proposal (RFP) after that?

A13. Given the urgency to address perceived limitations in fielded systems at the time, DHS still believes that those decisions were appropriate. It is difficult to gauge what may have come from an RFI/RFP process from 2003. CBP believes that the success of any research and development program, leading to possible deployments of next generation equipment, must begin with requirements defined by the end user/operator, and robust field evaluations/development.

Q14. Do you believe the requirements developed by DNDO will create a system that can stand up to a cost-benefit analysis?

A14. An initial cost-benefit analysis, based on performance assumptions and systems requirements developed by DHS, warranted a decision to proceed with the program. Performance testing has shown potential benefits for ASP systems over current systems, particularly in secondary screening. However, the Department will not make any predictions as to the results of a final cost-benefit analysis, based on performance data, until such all testing and analysis is complete

Q15. Should the cost-benefit analysis consider upgrades in current Radioisotope Identification Device (RIID) technology and Polyvinyl Toluene (PVT) "energy windowing" as options?

A15. No. The CBA will assess the cost and benefits of the ASP vs. the current system (which currently utilizes energy windowing). Should the "current system" change before the CBA is complete, the CBA would be adjusted accordingly.

Q16. How is the Department responding to the recommendations of GAO and the National Academy of Sciences?

A16. DNDO has appropriately incorporated or responded to the recommendations of both organizations as follows.

a. Responding to the GAO

Recommendation regarding significant improvement to operational effectiveness (SIOE): The GAO Recommended DNDO assess whether ASPs meet SIOE criteria based on valid comparison with PVT's full performance potential, including use of energy windowing to increase sensitivity to threats. DNDO has structured ASP testing to validate that ASP meets SIOE criteria. The SIOE criteria require that the comparison be made against the "current system." DNDO will and should follow this path. We stress that the current PVT based system contains energy windowing algorithms that were updated in 2007. DNDO has also funded additional research at both Pacific Northwest National Laboratory and Johns Hopkins University Applied Physics Laboratory to further investigate the potential to improve performance of PVT systems based upon algorithm enhancements, including new approaches to energy windowing. On a side note, energy windowing techniques may also be applied to spectroscopic systems like the ASP, which may enhance performance there as well.

Recommendation to revise ASP testing and Certification schedules: The GAO recommended altering schedules to allow sufficient time for review and analysis of results from final testing including injection studies. The ASP program schedule incorporates time following completion of Field Validation and Operational Testing of

ASP, before presenting ASP to the DHS Acquisition Review Board for approval and then to the DHS Secretary for certification. This time interval prior to a decision allows all stake holders to thoroughly review test results and for proper consideration of the ASP cost-benefit analysis.

b. Responding to the NAS

Recommended approach for testing and evaluation: The NAS recommended an "iterative approach with modeling and physical testing complimenting each other." In this approach, "theory and models of threat objects, radiation transport, and detector response" should be used to "simulate performance and predict outcome," using "physical experiments to validate the predictions and allow critique of the models." We believe that the ASP program, through development activities carried out by vendors, to test programs executed by the government, to replay tools and injection tools used for analysis, has followed the spirit of this recommendation. The performance of the ASP systems in controlled performance tests has mirrored predictions extremely well. The issue that remains for ASP is one of threshold settings against real-world cargo which must be determined through empirical evidence.

Recommended Approach of the Procurement Process: The NAS recommended that DNDO employ an "iterative" approach for the procurement process. Rather than a "onetime certification decision in the near future," the NAS recommended a continuous process of improvement and adaptation of the system, beginning with the deployment of LRIP systems. We agree with the NAS in principle and are evaluating this approach. This approach is consistent with the ASP Acquisition Plan and will be reflected in actual deployments when they begin.

Recommended Approach for Cost-Benefit Analysis: The NAS Committee recommended that DHS not proceed with further procurement until "ASP is shown to be a favored option in the cost-benefit analysis." This recommendation is incorporated into the governance structure of the ASP program. Additionally the NAS made recommendations about the nature of the CBA itself, stating that it "needs to include three key elements: (1) a clear statement of the objectives of the screening program: (2) an assessment of meaningful alternatives to deploying ASPs; and (3) a comprehensive, credible and transparent analysis of in-scope benefits and costs." We continue to agree with the NAS that a complete CBA is necessary before any decisions are made and the elements suggested by NAS are factored into the CBA.

Q17. Setting aside the increased costs of ASPs over the current PVT/RIDD combination, how much more money will ASP Operations and Maintenance (0 and M) cost CBP?

A17. Current PVT RPM units cost approximately $12,000 per year to operate and maintain. While CBP has not seen the final ASP maintenance cost estimate, this figure is expected to range from $65–100k each year per unit.

Q18. Given dwindling budget estimates, how will these increased O&M costs affect overall security?

A18. If no increase in O&M funds accompanies the deployment of ASPs, CBP would have to secure funding from other programs or staff positions.

Q19. Will CBP even be able to operate ASPs in the current budget environment if they are certified?

A19. CBP anticipates that the appropriate O&M funding would be included should the ASPs be deployed.

Q20. If the ASP systems are certified and deployed, will the Department be able to find cost savings?

A20. The deployment of ASPs will result in an overall increase in life cycle costs.

Q21. Does the ASP system require less CBP personnel to operate?

A21. There is no appreciable savings in required personnel over the entire deployed architecture. In primary scanning operations, for example, land border crossings would not see a staff reduction. In secondary, the ASPs may require less physical labor and less time to operate; however, a CBP Officer will still be required to operate the ASPs. It should be noted that the ASP will not eliminate the need for RIIDs which will be used for more detailed inspections and alarm adjudication.

Only very limited reductions likewise would be seen in seaport deployments.

Q22. Does the ASP system allow for greater flow of commerce, or would other factors at ports and border crossings still impede commerce?

A22. No appreciable gains to the flow of commerce would be realized over the entire deployed architecture. At land border crossings, impediments to the flow of commerce are due to non-radiation scanning processes (i.e.—passport control and anti-smuggling inspections). At seaports, the flow of commerce is mostly determined by individual terminal procedures.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Gene Aloise, Director, Natural Resources and Environment, U.S. Government Accountability Office (GAO); Todd C. Owen, Acting Deputy Assistant Commissioner, Office of Field Operations, U.S. Customs and Border Protection, Department of Homeland Security; and William K. Hagan, Acting Deputy Director, Domestic Nuclear Detection Office, Department of Homeland Security

Questions submitted by Representative Paul C. Broun

Questions for Mr. Aloise, Dr. Hagan, and Mr. Owen:

Q1. Do you believe computer modeling through replay tools, injection studies, or regression tools is enough for certification, or do you believe real world field testing is required?

A1. The current campaign of ASP testing, which started in early 2008, involved several different types of testing each for its own purpose. The August 2008 testing at the Nevada Test Site (NTS) was designed to test sensitivity of the ASPs (and PVTs) against actual physical sources of special nuclear materials (e.g., uranium and plutonium). For the current campaign of testing, the NTS phase of testing was particularly important given that the ASPs were expected to have an improved capability of detecting special nuclear materials, and, for security reasons, NTS was the only place where DNDO could fully physically test the ASPs capability of detecting these very dangerous materials.

To this point, the field validation tests have shown an unacceptable level of false alarms for the presence of certain nuclear materials. To resolve this, DNDO officials told us that they have made changes to the thresholds of the ASP, but not to the underlying algorithms (or software) that allows these machines to detect radiation. As we testified, this change makes the ASP less capable of detecting certain nuclear materials, raising questions about whether the ASPs represent a significant improvement in operational effectiveness over the PVTs in detecting certain nuclear materials.

While DNDO officials told us that they were not making changes to the ASP algorithms, the report of the Field Validation Advisory Panel stated that "correcting algorithm issues will change ASP referral rate" suggesting that there will be future changes to the ASP algorithms. So, there is some confusion about exactly what changes will need to be made in order to successfully complete field validation testing. This represents a subtle, but important distinction—we regard "algorithm corrections" as algorithm changes and not simple threshold adjustment.

In our view, prior to any certification decision to move forward with procurement of ASPs, there should be additional testing at NTS against actual physical sources of special nuclear materials in order to (1) understand exactly how the modified ASPs performance compares against the performance of PVTs in detecting certain nuclear materials, and (2) assure that there are not any unintended consequences in detection capabilities resulting from the modifications made to the ASPs since the August 2008 testing at NTS.[1] This is to say, at this stage in the development of the ASP, major systems acquisition best practices require performance testing with actual special nuclear material because of the expected corrections to the software (beyond simple threshold adjustment).

Q2a. Has other ASP equipment been developed outside of this process by the private sector?

A2a. Based on the number of proposals submitted to DNDO's initial RFP for the ASP, it is quite possible that spectroscopic radiation detection systems have been developed outside of DNDO sponsorship. The issue here is determining the extent to which those COTS vendors have focused development on spectroscopic radiation detection systems that could operate in a high-impact port environment (large format and high traffic throughput) in support of CBP's mission. Moreover, only DNDO's two developers have been afforded the ability to test their systems with actual special nuclear material at the NTS.

Q2b. How much money has DNDO spent on ASP R&D to date?

A2b. DNDO would be the best source for this information.

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[1] Without tests at NTS we will not have True Positive or False Negative data with the new software.

Q2c. What is the proper role for DNDO in this process? Should DNDO be simply testing moderate changes to Commercial off the Shelf Technology or should it be focusing on next generation technology?

A2c. We believe the Secretary of DHS should determine whether DNDO should be a technology development or a major systems acquisition organization. If she chooses to keep both functions within the organization, then the Secretary should establish a strong separation and independent operational construct between the technology development and major systems acquisition missions. Ultimately, DNDO's goal should be toward addressing the mission needs of the end-user (CBP in the case of the ASP program). Organizational best practices hold that DNDO should regularly assess the extent to which these needs may be met with existing commercial-off-the-shelf technologies, as well as the nature and extent of development necessary for emerging or next-generation technologies. In the case of ASPs, the mission need has become less clear based upon the lessening of the criteria for a "significant increase in operational effectiveness." This is to say, the primary mission need DNDO put forward was to better detect certain special nuclear materials, and the expectation was established that ASPs would vastly outperform PVTs in this area as manifested by a dramatic reduction of referrals to secondary screening due to NORM. However, recent testing has raised questions about both the ASPs capabilities to reliably and efficiently detect these materials as well as the exact significance of the increase in operational effectiveness of these next generation systems that are 2.5 times more expensive per unit than the current generation of technology. Moreover, it is not clear that the PVT technology has reached its limit of performance based upon energy windowing algorithms or other advances in materials science for nuclear detection.

Q2d. Who should be testing COTS, DNDO, or CBP?

A2d. GAO sees three parts of a testing regime for these systems: (1) software development testing, (2) physical performance testing at NTS (supported by follow-up modeling and simulation work), and (3) field validation testing. In our view, the first is managed by DNDO and its contractors with independent testing and evaluation done by a federally funded research and development center (FFRDC), university affiliated research center (UARC), or the National Institute of Standards and Technology (NIST). The second is also managed by DNDO in partnership with the National Nuclear Security Administration's staff at NTS as well as the OT&E group of DHS and/or NIST (simulation work can be supported by national labs or UARCs). The third should be managed by CBP with support from DHS OT&E as the end-user since they are responsible for screening operations at a working port of entry.

Questions for Mr. Aloise and Dr. Hagan:

Q3a. In addressing previous problems identified in Field Validation Testing, has the agency changed underlying algorithms that were tested at the Nevada Test Site (NTS)?

A3a. As discussed above, while DNDO officials told us that they were not making changes to the ASP algorithms, the report of the Field Validation Advisory Panel stated that "correcting algorithm issues will change ASP referral rate" suggesting that there will be future changes to the ASP algorithms. So, there is some confusion about exactly what changes will need to be made in order to successfully complete field validation testing.

Q3b. Will simply changing isotope thresholds be enough to fix these problems, or will algorithms need to be changed?

A3b. Only additional testing can answer this. However, once the problem with false alarms is fixed, the ability of the ASPs to detect certain nuclear materials will be diminished. Understanding whether the ASP can detected certain nuclear materials better than the PVTs will be an important part of deciding whether to move forward with procurement of the ASPs.

Q3c. If algorithms are changed, will the equipment have to go back to the NTS?

A3c. In our view, prior to any decision to move forward with procurement of ASPs, there should be additional testing at NTS against actual physical sources of special nuclear materials in order to (1) understand exactly how the modified ASPs performance compares against the performance of PVTs in detecting certain nuclear materials, and (2) assure that there are not any unintended consequences in detection capabilities resulting from the modifications made to the ASPs since the August 2008 testing at NTS.

Q3d. If so, how much will this cost and how long will it take?

A3d. DNDO would be the best source for this information. However, we were previously told by DNDO that NTS testing costs about $500,000 per week. In our view, this testing, while expensive, would be worthwhile prior to DNDO committing billions of dollars toward procurement of the ASPs.

Q3e. Is the Department only changing threshold levels (and not changing the algorithms) simply because it does not want to go back to NTS?

A3e. DHS would be the best source for this information.