U.S. House of Representatives
Committee on Science & Technology
Subcommittee on Investigations & Oversight

HEARING CHARTER

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 handheld 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 PVT's refer 1 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 1 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 PVT's 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 PVT's, 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 outpaced 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 multibillion 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:

Panel I:

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)*