



Statement for the Record  
To the Committee on Homeland Security  
and Governmental Affairs,  
U.S. Senate

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**COMBATING NUCLEAR  
SMUGGLING**

**Inadequate Communication  
and Oversight Hampered  
DHS Efforts to Develop an  
Advanced Radiography  
System to Detect Nuclear  
Materials**

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## COMBATING NUCLEAR SMUGGLING

**Inadequate Communication and Oversight Hampered DHS Efforts to Develop an Advanced Radiography System to Detect Nuclear Materials**

Highlights of [GAO-10-1041T](#), a statement for the record to the Committee on Homeland Security and Governmental Affairs, U.S. Senate.

**Why GAO Did This Study**

The Department of Homeland Security's (DHS) Domestic Nuclear Detection Office (DNDO) is charged with developing and acquiring equipment to detect nuclear and radiological materials to support federal efforts to combat nuclear smuggling. Also within DHS, Customs and Border Protection (CBP) has the lead for operating systems to detect nuclear and radiological materials entering the country at U.S. ports of entry. In 2005, DNDO began working on the cargo advanced automated radiography system (CAARS) intending that it be used by CBP to detect certain nuclear materials in vehicles and containers at U.S. ports of entry. However, in 2007 DNDO decided to cancel the acquisition phase of the program and convert it to a research and development program. GAO was asked to examine events that led to DNDO's decision to cancel the acquisition phase of the program and provide lessons learned from DNDO's experience. This statement is based on prior GAO reports from March 2006 through July 2010 and ongoing work reviewing DHS efforts to develop radiography technology. For ongoing work, GAO reviewed CAARS planning documents and interviewed DHS, DNDO, and CBP officials.

GAO provided a draft of the information in this testimony to DHS and component agencies, which provided technical comments and which were incorporated as appropriate.

View [GAO-10-1041T](#) or [key components](#). For more information, contact Gene Aloise at 202-512-3841 or [aloisee@gao.gov](mailto:aloisee@gao.gov).

**What GAO Found**

From the start of the CAARS program in 2005 until DNDO cancelled the acquisition phase of the program in December 2007, DNDO pursued the acquisition and deployment of CAARS machines without fully understanding that they would not fit within existing primary inspection lanes at CBP ports of entry. This occurred because during the first year or more of the program DNDO and CBP had few discussions about operating requirements at ports of entry. When CBP and DNDO officials met, shortly before DNDO's decision to cancel the acquisition phase of the program, CBP officials said they made it clear to DNDO that they did not want the CAARS machines because they would not fit in primary inspections lanes and would slow down the flow of commerce through these lanes and cause significant delays. Also, the CAARS program was among numerous DHS acquisition programs about which GAO reported in 2008 that appropriate oversight was lacking. Further, the development of the CAARS algorithms (software)—a key part of the machine needed to identify shielded nuclear materials automatically—did not mature at a rapid enough pace to warrant acquisition and deployment. Also, the description of the progress of the CAARS program used to support funding requests in DNDO's budget justifications was misleading because it did not reflect the actual status of the program. For example, the fiscal years 2010 and 2011 DHS budget justifications both cited that an ongoing CAARS testing campaign would lead to a cost-benefit analysis. However, DNDO officials told GAO that when they cancelled the acquisition part of the program in 2007, they also decided not to conduct any associated cost benefit analysis. During recent discussions with DNDO officials, they agreed that the language in the budget justifications lacked clarity, and they have no plans to prepare a cost benefit analysis.

Based on GAO's review of the CAARS program and its prior reports on DHS development and acquisition efforts, GAO identified lessons learned for DHS to consider in its continuing efforts to develop the next generation of radiography imaging technology. For example, GAO previously reported that agencies can enhance coordination by agreeing on roles and responsibilities. In this regard, a draft memorandum of agreement among DHS agencies that intends to clarify roles and responsibilities in developing technologies and help ensure effective coordination has not been finalized. Completing this memorandum could give DHS reasonable assurance that problems associated with the CAARS program do not recur. In discussions with senior officials from DHS, DNDO, CBP and S&T, they all agreed with the need for the memorandum and said that they intend to work toward finalizing the draft memorandum of agreement. Other lessons GAO identified include (1) engage in a robust departmental oversight review process (2) separate the research and development functions from acquisition functions (3) determine the technology readiness levels before moving forward to acquisition, and (4) rigorously test devices using actual agency operational tactics before making decisions on acquisition.

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Mr. Chairman and Members of the Committee:

We appreciate the opportunity to provide a statement for the record on efforts of the Department of Homeland Security's (DHS) Domestic Nuclear Detection Office (DNDO) to develop the cargo advanced automated radiography system (CAARS) to strengthen DHS's ability to prevent the smuggling of nuclear materials into the United States. Preventing terrorists from using radiological or nuclear materials to carry out an attack in the United States is a top national priority. As we reported in January 2009, a terrorist could try to smuggle nuclear materials into the United States in a variety of ways, including hiding them in a car, train, private aircraft or small vessel; sending them through the mail; carrying them in personal luggage through an airport; walking them across the border; or concealing them in maritime cargo containers in the global supply chain.<sup>1</sup> Maritime cargo containers are of particular concern because they can be filled overseas at many different locations and are transported through complex logistics networks before reaching U.S. ports. As a result, terrorists could try to take advantage of such vulnerabilities by placing nuclear materials into a container for shipment to the United States. U.S. government officials believe that the likelihood of terrorists smuggling nuclear materials into the United States in cargo containers is relatively low, but criminals have long exploited containers for other illegal purposes, such as smuggling weapons, people and illicit substances.

As we testified before this committee in June, DHS has made significant progress over the past several years in both deploying radiation detection equipment and developing procedures to scan cargo and conveyances entering the United States through fixed land and sea ports of entry for nuclear and radiological materials.<sup>2</sup> Moreover, DHS reports that while it scans nearly 100 percent of the cargo and conveyances entering the United States through land borders and major seaports, it has made less progress scanning for radiation in other pathways into the United States such as general aviation and small maritime craft.

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<sup>1</sup>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).

<sup>2</sup>GAO, *Combating Nuclear Smuggling: DHS Has Made Some Progress but Not Yet Completed a Strategic Plan for Its Global Nuclear Detection Efforts or Closed Identified Gaps*, [GAO-10-883T](#) (Washington, D.C.: Jun. 30, 2010).

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DNDO is charged with developing, acquiring, and deploying equipment to detect nuclear and radiological materials in order to support the efforts of DHS and other federal agencies, such as the departments of Energy and State, in combating nuclear smuggling. DNDO is also charged with enhancing and coordinating federal, state, and local efforts to prevent radiological and nuclear attacks. In doing this, DNDO is required to work with other federal agencies to develop a global nuclear detection architecture.<sup>3</sup> To date, DHS has spent nearly \$4 billion on various aspects of the architecture but has not developed a strategic plan to guide its efforts to develop and implement this architecture as we recommended in 2008.<sup>4</sup> DNDO agreed with this recommendation but has not developed such a plan.

Also within DHS, Customs and Border Protection (CBP) has the lead for deploying, operating, and maintaining systems to detect nuclear and radiological materials entering the country through land borders, seaports, and other ports of entry. CBP also has a broad mission to detect more traditional contraband, such as drugs and guns; to prevent the inflow of inadmissible aliens; and to conduct its operations in a way that does not impede the flow of commerce. To detect nuclear materials, CBP, in coordination with DNDO, has deployed over 1,400 radiation portal monitors (RPM) at U.S. ports of entry. Most of the RPMs are installed in primary inspection lanes through which nearly all traffic and shipping containers must pass. These monitors alarm when they detect radiation coming from a package, vehicle, or shipping container. CBP then conducts further inspections at its secondary inspection locations to identify the cause of the alarm and whether it is a reason for concern.

While these RPMs are sensitive and have been effective at detecting radiation, they also have limitations. In particular, in May 2009 we reported that RPMs are capable of detecting certain nuclear materials only when these materials are unshielded or lightly shielded.<sup>5</sup> In contrast,

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<sup>3</sup>National Security Presidential Directive-43 (also known as Homeland Security Presidential Directive-14), sec. 2(d).

<sup>4</sup>GAO, *Nuclear Detection: Preliminary Observations on the Domestic Nuclear Detection Office's Efforts to Develop a Global Nuclear Detection Architecture*, [GAO-08-999T](#) (Washington, D.C.: July 16, 2008).

<sup>5</sup>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).

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advanced radiography can be used to detect dense material that may be consistent with the presence of certain nuclear materials in vehicles and cargo containers, and CBP already uses radiography to more closely investigate the contents of a vehicle or cargo container that has been selected for secondary inspection at a U.S. port of entry. However, according to CBP officials, only a small percentage of vehicles or cargo containers are subjected to secondary inspections.

DNDO began working on the CAARS program in 2005 with the intention that through advanced radiography and improved algorithms (software), CAARS would be used by CBP to automatically detect and identify highly shielded nuclear material in vehicles and cargo containers in both primary and secondary inspection lanes at U.S. ports of entry. Thus, through CAARS, DNDO expected that CBP would be able to detect more heavily shielded nuclear material in nearly all vehicles and cargo containers going through primary inspection lanes, and therefore, close a gap in the nuclear detection architecture. In September 2006, DNDO awarded a contract for the CAARS program to research, develop, acquire, and deploy advanced radiography imaging technology designed to detect highly shielded nuclear material being smuggled through U.S. ports of entry. At that time, DNDO expected the program could cost as much as \$1.5 billion. However, in December 2007, DNDO made what it called a “course correction,” by canceling the program’s acquisition and deployment plans and significantly reducing its scope. The CAARS program then became a research and development program designed to demonstrate the potential capability of the technology. As a result of this change, DNDO no longer expected to deploy CAARS machines but instead opted to demonstrate the maturity and promise of CAARS technology. As part of the CAARS demonstration project, DNDO, with the assistance of scientists from the Department of Energy’s Lawrence Livermore National Laboratory (LLNL), began testing the capabilities of CAARS’ prototypes in the fall of 2009 and completed testing in March 2010. According to DNDO officials, DNDO plans to report on the results of the tests and lay out a way forward regarding the future application of CAARS radiography imaging by the end of September 2010. Overall, from the inception of the program in 2005 until today, DNDO officials reported that the agency has spent about \$113 million on the CAARS program.

Since the capabilities of radiography systems are an important part of cargo security, you asked us to examine the history of the CAARS program. Accordingly, this statement discusses events that led to the course correction in the CAARS program, and provides potential lessons learned from DNDO’s experience with the CAARS program. This

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statement is based on prior reports and testimonies we issued from March 2006 through July 2010.<sup>6</sup> Detailed information on our scope and methodology for our prior work can be found in these reports. This statement is also based on results from our ongoing work in response to your request to review radiography systems within DHS.

As part of our ongoing review of radiography systems, specifically CAARS, from March 2010 to September 2010 we analyzed key CAARS planning documents developed in the early stages of program development, such as the acquisition plan, program baseline, performance specifications, and requests for proposals and reviewed subsequent CAARS documents that reflect DNDO's decision to scale back the program and removal of the acquisition phase from CAARS contracts. We conducted interviews with former and current CAARS program managers and other key officials within DNDO, CBP, the DHS Science & Technology Directorate (S&T), and the DHS Office of Policy. We also met with representatives from contractors that were developing CAARS and consulted with subject matter experts from LLNL involved in testing those contractors' CAARS prototypes. We provided a draft of the information in this testimony to DHS and component agencies, which provided technical comments and which we incorporated as appropriate. We conducted this work 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.

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<sup>6</sup> See Appendix I for a list of related GAO products.

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## **DNDO Planned for the Acquisition and Deployment of CAARS without Fully Understanding that It Could Not Feasibly Operate in a U.S. Port Environment**

From the start of the CAARS program in 2005 until the course correction in December 2007, DNDO planned the acquisition and deployment of CAARS machines without understanding that they would not fit within existing primary inspection lanes at CBP ports of entry. This occurred because during the first year or more of the program DNDO and CBP had few discussions about operating requirements for primary inspection lanes at ports of entry. In addition, the CAARS program was among numerous acquisition programs about which we previously reported that appropriate DHS oversight was lacking. Furthermore, the development of the CAARS algorithms—a key part of the machine needed to identify shielded nuclear materials automatically—did not mature at a rapid enough pace to warrant acquisition and deployment. Moreover, the description of the progress of the CAARS program used to support funding requests in DNDO’s budget justifications for fiscal years 2009 through 2011 was misleading because it did not reflect the actual status of the program.

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## **Inadequate Communication**

From the inception of the CAARS program until the decision in December 2007 to cancel acquisition of the program, DNDO and CBP had few, if any, in-depth discussions about CBP’s requirements to be able to use radiography in primary inspection lanes. According to DNDO officials, they requested information from CBP on its user requirements for the CAARS system, but CBP was slow to respond to these requests. DNDO continued with its plans to develop CAARS machines because, according to DNDO officials, at the time it was thought that a solution was urgently needed to be able to detect shielded nuclear materials in primary inspection lanes. In discussing this with senior CBP officials, they said that DNDO officials did not attempt to meet with them during the beginning of the CAARS program. When CBP and DNDO officials met, shortly before the course correction, CBP officials said they made it clear to DNDO that they did not want the CAARS machines because they would not fit in primary inspections lanes and would slow down the flow of commerce through these lanes and cause significant delays.<sup>7</sup>

In our view, had CBP and DNDO officials met early in the development of the program to discuss CBP’s needs and operational requirements, as stated in DHS’s acquisition policy at the time, it is unlikely that DNDO

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<sup>7</sup>DNDO officials later acknowledged that they proceeded in developing CAARS with the CBP specifications for using radiography in secondary inspection areas—not knowing that these same specifications were not suitable for primary inspection lanes.

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would have found reason to move forward with its plan to develop and acquire CAARS technology. Nonetheless, in September 2006, DNDO awarded contracts to three CAARS vendors. In December 2007, DNDO decided to cancel the acquisition of CAARS and limit any further work to a research and development effort. In recent joint discussions with CBP and DNDO officials, they acknowledged that communication between the two agencies could have been improved during the early part of the CAARS program. They said they communicate much more routinely now and that, in their view, it would be unlikely that the communication problems associated with the CAARS program would reoccur.

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## Inadequate Oversight

DNDO did not follow DHS acquisition protocols for the CAARS program. Specifically, in 2008, we reported that CAARS was among numerous major DHS acquisition programs that did not have a mission needs statement—a required DHS acquisition document that formally acknowledges that the need for an acquisition is justified and supported.<sup>8</sup> DHS policy also called for programmatic reviews at key decision points and required certain analytical documents. However, CAARS did not undergo annual department level reviews as called for nor did DNDO program officials obtain or prepare basic analytical documents. For example, one of these documents, a concept of operations (CONOPS), was intended to demonstrate how CBP would use CAARS machines in primary inspection areas at the ports. However, as a result of inadequate communication and collaboration between CBP and DNDO discussed earlier, no CONOPS was developed during the early phase of the CAARS program. Ultimately, according to DNDO officials, once DNDO made the decision to cancel the acquisition portion of CAARS in December 2007, a CONOPS was no longer required.

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## Immature Technology

According to DNDO officials, at the time of the inception of the CAARS program, there was a widespread view within DNDO that something had to be done to provide CBP with the capability to detect highly shielded nuclear material in primary inspection lanes. DNDO officials acknowledged that the agency decided to move forward with the CAARS program despite the fact that automatic detection, a key feature of CAARS, depended on the rapid development of algorithms that were

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<sup>8</sup>GAO, *Department of Homeland Security: Billions Invested in Major Programs Lack Appropriate Oversight*, [GAO-09-29](#) (Washington, D.C.: Nov. 18, 2008).

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technologically immature. The algorithms are critical because they provide the capability for CAARS to automatically detect highly shielded nuclear material in primary inspection areas without the need for extensive operator review and interpretation of an image—two factors that could adversely affect CBP’s ability to avoid delays to the flow of commerce along with its overall effectiveness in detecting highly shielded nuclear material. Although algorithms supporting the CAARS technology were technologically immature, DNDO created an aggressive production and deployment schedule that was to begin in August 2008, the end of DNDO’s planned 2-year development period for the CAARS program. At the time it decided on this production milestone, DNDO officials said it was likely that the algorithms would be developed in time to meet the start of planned production. However, the technology did not develop as expected and contributed to DNDO’s decision to cancel the acquisition phase of CAARS.

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## Basis of CAARS Funding Requests

For fiscal year 2009 through fiscal year 2011, DHS justified annual budget requests to Congress by citing significant plans and accomplishments of the CAARS program, including that CAARS technology development and deployment was feasible, even though DNDO had made the decision in December 2007 to cancel the acquisition of CAARS. For example, in its fiscal year 2009 budget justification, DHS stated that a preliminary DNDO/CBP CAARS production and deployment program had been successfully developed and that CAARS machines would be developed that would detect both contraband and shielded nuclear material with little or no impact on CBP operations. The fiscal years 2010 and 2011 DHS budget justifications both cited that an ongoing testing campaign would lead to a cost benefit analysis, followed by rapid development of a prototype that would lead to a pilot deployment at a CBP point of entry. Furthermore, the fiscal year 2010 budget justification stated that while the CAARS technology was less mature than originally estimated, successful development was still feasible. However, DHS’s description and assessment of the CAARS program in its budget justification did not reflect the actual progress of the program. Specifically, DNDO officials told us that when they made their course correction and cancelled the acquisition part of the program in 2007, they also decided not to conduct a cost benefit analysis because such analyses are generally needed to justify going forward with acquisitions. In addition, DNDO completed CAARS testing in March 2010; however, as of today, the final test results for two of the three CAARS machines are not yet available. Currently, no CAARS machines have been deployed. CAARS machines from various vendors have either been disassembled or sit idle without being tested in a port

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environment, and CBP is considering whether to allow DNDO to collect operational data in a port environment. During recent discussions with DNDO officials, they agreed that the language in the budget justifications lacked clarity and stated that they are not planning to complete a cost benefit analysis since such analyses are generally associated with acquisition programs.

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## CAARS Offers Lessons Learned Regarding the Importance of Developing Requirements, Coordinating with Users, and Managing Acquisitions

Based on our review of the CAARS program and our reports on DNDO efforts to develop an advanced RPM called the advanced spectroscopic portal (ASP),<sup>9</sup> we have identified lessons learned for DHS to consider in its continuing efforts to develop the next generation of radiography imaging technology.

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## Enhance Interagency Collaboration and Coordination

Despite the importance of coordinating crosscutting program efforts, we have reported that weak coordination of those efforts has been a long-standing problem in the federal government and has proven to be difficult to resolve.<sup>10</sup> We have also reported that agencies can enhance and sustain their collaborative efforts. One way we reported that agencies can enhance coordination is to agree on roles and responsibilities and establish mutually reinforcing or joint strategies.<sup>11</sup> As discussed, DNDO did not coordinate and collaborate with CBP early in the development of the CAARS program to identify CBP's needs and requirements. According

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<sup>9</sup>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), and *Combating Nuclear Smuggling: Lessons Learned from DHS Testing of Advanced Radiation Detection Portal Monitors*, [GAO-09-804T](#) (Washington, D.C.: June 25, 2009)

<sup>10</sup>GAO, *Managing for Results: Barriers to Interagency Coordination*, [GAO/GGD-00-106](#) (Washington, D.C.: Mar. 29, 2000).

<sup>11</sup>GAO, *Results-Oriented Government: Practices that Can Help Enhance and Sustain Collaboration among Federal Agencies*, [GAO-06-15](#) (Washington, D.C.: Oct. 21, 2005).

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to DHS budget documents, in fiscal year 2011, the responsibility for research and development of advanced radiography will shift from DNDO to S&T. Leading up to this transition, there is confusion related to roles and responsibilities among DNDO, S&T, and CBP. For example, DNDO officials said they have requested permission from CBP to collect operational data in a port environment on an enhanced radiography machine. However, CBP officials stated that they had already purchased, operationally tested, and deployed 11 of these machines in secondary inspection areas. We recently discussed this issue at a joint meeting with DNDO and CBP officials. CBP and DNDO officials agreed that there was confusion over this issue, and both agencies agreed with the need to collect operational data on this enhanced radiography machine, and CBP has begun making arrangements to do so.

Also, S&T officials said that they are about to contract out for radiography imaging technology for CBP that will improve imaging capabilities. DNDO officials told us that S&T's efforts will include development of radiography capabilities to detect shielded nuclear material, while S&T officials told us that this is not an area of their focus. As DHS transitions its research and development of radiography, DHS officials said that a draft memorandum of agreement intended to clarify roles and responsibilities for cooperation and coordination among DNDO, CBP, and S&T has not been finalized. Completing the memorandum of agreement to clarify roles and responsibilities before proceeding with the research, development, and deployment of radiography technology could give DHS reasonable assurance that problems resulting from a lack of clearly defined roles and responsibilities in the CAARS program do not recur. In discussions with senior officials from DHS, DNDO, CBP and S&T, they all agreed with the need for the memorandum and said that they intend to work toward finalizing the draft memorandum of agreement.

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## Engage in a Robust Oversight Review Process

DNDO officials said that they were aware of the DHS draft management directive in 2006 that was intended to guide management and oversight of acquisition programs like CAARS but did not follow it. DHS policy officials acknowledged that at the time CAARS was in its early stages, DHS was continuing the process of organizing and unifying its many disparate components and there was not strong oversight over its major programs, including CAARS. Policy officials told us the oversight review process is more robust today. However, we reported in June 2010 that DHS

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acquisitions need further improvement and sustained management attention.<sup>12</sup> For example, while DHS' current management directive includes more detailed guidance than the previous 2006 management directive for programs to use in preparing key documentation to support component and departmental decision making, it is not applied consistently and most major programs have not been reviewed.

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### Separate Research and Development from Acquisition Functions

DNDO was simultaneously engaged in a research and development phase while planning for an acquisition phase of the CAARS program. In this regard, we have previously reported that separating technology development from product development and acquisition is a best practice that can help reduce costs and deliver a product on time and within budget because separation of the technology development phase from production in particular helps to ensure that (1) a sound business case is made for the product, (2) product design is stable, and (3) production processes are mature and the design is reliable.<sup>13</sup>

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### Determine the Technology Readiness Levels Before Acquisition

At the time that the CAARS program was in its early stages, DHS and DNDO did not have clearly defined ways to define and communicate the maturity of technology leading to acquisition. We have previously reported on the need for a disciplined and knowledge-based approach of assessing technology maturity, such as using technology readiness levels.<sup>14</sup> In that report, we recommended that technologies need to reach a high readiness level before an agency should make a commitment to production. DNDO officials acknowledged that CAARS algorithm's readiness level was not high enough to warrant entering into the acquisition phase.

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<sup>12</sup>GAO, *Department of Homeland Security: Assessments of Selected Complex Acquisitions*, [GAO-10-588SP](#) (Washington, D.C.: June 30, 2010).

<sup>13</sup>See GAO, *Defense Acquisitions: Assessments of Selected Weapon Programs*, [GAO-07-406SP](#) (Washington, D.C.: Mar. 30, 2007) and *Best Practices: Better Management of Technology Development Can Improve Weapon System Outcomes*, [GAO/NSIAD-99-162](#) (Washington, D.C.: July 30, 1999).

<sup>14</sup> [GAO/NSIAD-99-162](#).

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## Rigorously Test Devices Using Actual Agency Operational Tactics

As we testified in June 2009 on DNDO's testing of ASPs, a primary lesson to be learned regarding testing is that the push to replace existing equipment with the new portal monitors led to an ASP testing program that lacked the necessary rigor.<sup>15</sup> We reported 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 and if properly implemented, would provide rigor to DHS's testing of other advanced technologies.

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## GAO Contacts and Staff Acknowledgements

For further information about this statement, please contact Gene Aloise at (202) 512-3841 or aloisee@gao.gov; or Stephen L. Caldwell at 202-512-9610 or caldwells@gao.gov. Dr. Timothy Persons (Chief Scientist), Ned Woodward (Assistant Director), Mike Harmond, Jonathan Kucskar, Linda Miller, Ron Salo, Kiki Theodoropoulos, and Franklyn Yao also made key contributions to this testimony.

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<sup>15</sup>GAO, *Combating Nuclear Smuggling: Lessons Learned from DHS Testing of Advanced Radiation Detection Portal Monitors*, [GAO-09-804T](#) (Washington, D.C.: June 25, 2009).

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# Appendix I: Related GAO Products

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*Maritime Security: DHS Progress and Challenges in Key Areas of Port Security.* [GAO-10-940T](#). Washington, D.C.: July 21, 2010.

*Combating Nuclear Smuggling: DHS Has Made Some Progress but Not Yet Completed a Strategic Plan for Its Global Nuclear Detection Efforts or Closed Identified Gaps,* [GAO-10-883T](#), Washington D.C.: June 30, 2010.

*Supply Chain Security: Feasibility and Cost-Benefit Analysis Would Assist DHS and Congress in Assessing and Implementing the Requirement to Scan 100 Percent of U.S.-Bound Containers.* [GAO-10-12](#). Washington, D.C.: Oct. 30, 2009.

*Combating Nuclear Smuggling: Lessons Learned from DHS Testing of Advanced Radiation Detection Portal Monitors,* [GAO-09-804T](#), Washington, D.C.: June 25, 2009.

*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.

*Nuclear Detection: Domestic Nuclear Detection Office Should Improve Planning to Better Address Gaps and Vulnerabilities.* [GAO-09-257](#). Washington, D.C.: Jan. 29, 2009,

*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.

*Supply Chain Security: CBP Works with International Entities to Promote Global Customs Security Standards and Initiatives, but Challenges Remain.* [GAO-08-538](#). Washington, D.C.: Aug. 15, 2008

*Maritime Security: National Strategy and Supporting Plans Were Generally Well-Developed and Are Being Implemented.* [GAO-08-672](#). Washington, D.C.: June 20, 2008.

*Supply Chain Security: Challenges to Scanning 100 Percent of U.S.-Bound Cargo Containers.* [GAO-08-533T](#). Washington, D.C.: June 12, 2008.

*Supply Chain Security: U.S. Customs and Border Protection Has Enhanced Its Partnership with Import Trade Sectors, but Challenges*

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*Remain in Verifying Security Practices.* [GAO-08-240](#). Washington, D.C.: Apr. 25, 2008.

*Supply Chain Security: Examination of High-Risk Cargo at Foreign Seaports Have Increased, but Improved Data Collection and Performance Measures Are Needed.* [GAO-08-187](#). Washington, D.C.: Jan. 25, 2008.

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

*Maritime Security: The SAFE Port Act: Status and Implementation One Year Later.* [GAO-08-126T](#). Washington, D.C.: Oct. 30, 2007.

*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.

*Department of Homeland Security: Progress Report on Implementation of Mission and Management Functions.* [GAO-07-454](#). Washington, D.C.: Aug. 17, 2007.

*International Trade: Persistent Weaknesses in the In-Bond Cargo System Impede Customs and Border Protection's Ability to Address Revenue, Trade, and Security Concerns.* [GAO-07-561](#). Washington, D.C.: Apr. 17, 2007.

*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.: Mar. 14, 2007.

*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.: Mar. 9, 2007.

*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.

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*Cargo Container Inspections: Preliminary Observations on the Status of Efforts to Improve the Automated Targeting System.* [GAO-06-591T](#). Washington, D.C.: Mar. 30, 2006.

*Combating Nuclear Smuggling: Challenges Facing U.S. Efforts to Deploy Radiation Detection Equipment in Other Countries and in the United States.* [GAO-06-558T](#). Washington, D.C.: Mar. 28, 2006.

*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.: Mar. 22, 2006.

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