United States Government Accountability Office

GAO

Report to Congressional Requesters

September 2004

TRANSPORTATION SECURITY R&D

TSA and DHS Are Researching and Developing Technologies, but Need to Improve R&D Management

GAO-04-890

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Highlights

Highlights of GAO-04-890, a report to congressional requesters.

Why GAO Did This Study

Conducting research and development (R&D) on technologies for detecting, preventing, and mitigating terrorist threats is vital to enhancing the security of the nation's transportation system. Following the September 11, 2001, terrorist attacks, Congress enacted legislation to strengthen homeland security, in part by enhancing R&D. The Transportation Security Administration (TSA) and the Department of Homeland Security (DHS) are the two federal agencies with primary responsibility for transportation security.

GAO was asked to assess the transportation security R&D projects that TSA, DHS, and other agencies have funded and assess how TSA and DHS are managing their transportation security R&D programs according to applicable laws and best practices.

What GAO Recommends

GAO is recommending that TSA and DHS improve their transportation security R&D management by conducting some basic research, completing their strategic planning and risk assessment efforts, developing a management information system, and better coordinating with other federal agencies and reaching out to the transportation industry. DHS, TSA, and DOT generally agreed with the report's findings and recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-04-890.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Kate Siggerud at (202) 512-2834 or siggerudk@gao.gov.

What GAO Found

For fiscal years 2003 and 2004, TSA and DHS funded over 200 R&D projects designed to develop technologies for enhancing security in most modes of transportation. In fiscal year 2003, TSA spent 81 percent of its $21 million transportation security R&D budget for aviation projects, and DHS spent about half of its $26 million for projects related to more than one mode of transportation. In fiscal year 2004, TSA continued to budget most of its $159 million for aviation, and DHS also budgeted most of its $88 million for aviation, as shown in the table below. According to the National Research Council, federal R&D programs should include some basic research, but TSA and DHS do not appear to be funding any basic research for transportation security. TSA and DHS have not estimated deployment dates for the vast majority of their R&D projects. Other federal agencies, such as the Department of Transportation (DOT) and the National Aeronautics and Space Administration, also funded some transportation security R&D projects. Several members of an expert panel on transportation security and technology that GAO convened believed the distribution of R&D projects by transportation mode was reasonable, while others believed that aviation has been overemphasized at the expense of maritime and land modes.

TSA's and DHS's Transportation Security R&D Funding by Mode, Fiscal Years 2003 and 2004

Dollars in thousands

Transportation mode	TSA		DHS	
	Fiscal year 2003 (obligated)/(%)	Fiscal year 2004 (budgeted)/(%)	Fiscal year 2003 (obligated)/(%)	Fiscal year 2004 (budgeted)/(%)
Aviation	$17,101 (81.1)	$126,487 (79.5)	$3,709 (14.3)	$63,240 (71.9)
Highway	0 (0.0)	0 (0.0)	1,052 (4.1)	3,000 (3.4)
Maritime	0 (0.0)	9,350 (5.9)	3,474 (13.4)	1,626 (1.8)
Multimodal	3,819 (18.1)	22,242 (14.0)	12,630 (48.8)	20,117 (22.9)
Pipeline	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Rail	169 (0.8)	1,096 (0.7)	0 (0.0)	0 (0.0)
Transit	0 (0.0)	0 (0.0)	5,000 (19.3)	0 (0.0)
Total	**$21,089 (100.0)**	**$159,175 (100.0)**	**$25,865 (100.0)**	**$87,983 (100.0)**

Source: GAO analysis of TSA and DHS data.

TSA and DHS have made some progress in managing their transportation security R&D programs according to applicable laws and R&D best practices, but neither agency has fully complied with the laws or implemented the best practices. For example, neither agency has prepared a strategic plan for R&D that contains measurable objectives. In addition, although TSA has completed threat assessments for all modes, it has not completed vulnerability and criticality assessments. DHS also has not completed risk assessments of the infrastructure sectors. Furthermore, both TSA and DHS lack complete, consolidated data for managing their R&D projects. Finally, although TSA and DHS have made some efforts to coordinate R&D with other federal agencies, their outreach to consider the concerns of the transportation industry has been limited.

Contents

Abbreviations

CAPPS II	Computer Assisted Passenger Prescreening System II
DHS	Department of Homeland Security
DOE	Department of Energy
DOT	Department of Transportation
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
HSARPA	Homeland Security Advanced Research Projects Agency
MANPADS	man-portable air defense systems
NASA	National Aeronautics and Space Administration
R&D	research and development
TRIP	Transit and Rail Inspection Pilot
TSA	Transportation Security Administration
TSWG	Technical Support Working Group

GAO
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United States Government Accountability Office
Washington, D.C. 20548

September 30, 2004

Congressional Requesters:

Researching and developing technologies to detect, prevent, and mitigate terrorist threats is vital to enhancing the security of the nation's transportation system. Following the September 11, 2001, terrorist attacks, Congress enacted legislation to strengthen homeland security, in part by enhancing research and development (R&D) for transportation security—especially for aviation. The recent bombings of the rail system in Madrid, Spain, have heightened concern about the security of all modes of transportation in the United States, and concern is growing in Congress about whether the Transportation Security Administration's (TSA) and the Department of Homeland Security's (DHS) efforts to counter terrorist threats to the nation's transportation systems are proceeding fast enough and are focused on the appropriate technologies.

To enhance the nation's transportation security, including its R&D capabilities, in November 2001, Congress enacted the Aviation and Transportation Security Act, which created TSA within the Department of Transportation (DOT) and made TSA responsible for security in all modes of transportation (aviation, highway, maritime, pipeline, rail, and transit). The Homeland Security Act of 2002, passed a year later, established DHS; transferred TSA and many other federal agencies to DHS; and made DHS responsible for homeland security, including transportation security. The act specified, however, that TSA would remain a distinct entity within DHS until November 25, 2004. Both laws authorized funding for homeland and transportation security R&D and established requirements for its management, including requirements for planning and coordination, but neither law includes deadlines for implementing these requirements. As you requested, we are reporting on

- the transportation security R&D projects that TSA, DHS, and other agencies funded in fiscal year 2003 and have budgeted for in fiscal year 2004; the status of these projects; and experts' views on the reasonableness of the distribution of these projects by mode and

- the extent to which TSA and DHS are managing their transportation security R&D programs according to applicable laws and best practices recommended by the National Academy of Sciences and the National Research Council.

In addition, we are reporting on some new and emerging technologies for screening passengers, baggage, and cargo (see app. II). For this review, we considered transportation security R&D to encompass the research, development, testing, and evaluation of technologies to protect the nation's transportation system from terrorist attacks or major crimes. The transportation system consists largely of (1) infrastructure, such as airports, seaports, border crossings, rail stations, transit stations, highways, bridges, tunnels, and pipelines, and (2) vehicles, such as aircraft, ships, ferry boats, trucks, buses, automobiles, and trains. We refer to the key modes of transportation as aviation, highways, maritime, pipeline, rail (passenger and freight), and transit (buses and subways). Because TSA and DHS each has its own R&D portfolio, we discuss the two agencies' transportation security-related R&D programs separately in this report. When we discuss TSA's R&D portfolio, we include projects funded by TSA's Office of Security Technologies, Office of Maritime and Land Security, and Office of Aviation Operations. Our discussion of DHS's transportation security R&D portfolio includes projects funded by DHS's Science and Technology Directorate, U.S. Coast Guard, U.S. Customs and Border Protection, and U.S. Secret Service.

To describe the types of transportation security R&D projects that TSA and DHS are funding in fiscal year 2003 and plan to fund in fiscal year 2004, we analyzed detailed information on their transportation security R&D projects. Detailed information on the transportation security R&D projects that TSA and DHS plan to fund in fiscal year 2005 was not yet available. Although TSA and DHS are the primary federal agencies responsible for conducting transportation security R&D, DOT and the National Aeronautics and Space Administration (NASA) also fund some transportation security R&D projects, and we included information on those agencies' projects in this report. We discussed the reliability of project and budgetary information with TSA and DHS officials and determined that the data they provided were sufficiently reliable for us to complete our review. To determine the extent to which TSA and DHS are managing their transportation security R&D programs according to applicable laws and best practices, we analyzed applicable legal requirements for TSA and DHS and best practices for managing R&D identified by the National Academy of Sciences and the National Research Council; analyzed documentation relating to both agencies' programs; and interviewed TSA and DHS officials about their strategic planning and risk management. We also interviewed TSA and DHS officials, as well as other stakeholders, about the agencies' coordination with other federal agencies and outreach to technology providers and the transportation industry. To

help evaluate the reasonableness of the distribution of transportation security R&D funding by mode and the challenges that TSA and DHS are facing in managing their programs, we convened a panel of transportation security and technology experts on March 2, 2004. At our request, the National Research Council selected the experts, who were affiliated with state transportation departments, universities, national laboratories, private industry, and other organizations and were knowledgeable about transportation security technologies.

We conducted our review at TSA, DHS, and DOT in Washington, D.C.; at TSA's Transportation Security Laboratory in Atlantic City, New Jersey; and at the Department of Energy's (DOE) National Laboratories in Los Alamos, New Mexico, and Oak Ridge, Tennessee. Appendix I contains detailed information about our scope and methodology, and appendix III lists the transportation security and technology experts who assisted us in our review. We conducted our review from July 2003 through September 2004 in accordance with generally accepted government auditing standards.

Results in Brief

TSA and DHS are funding transportation security R&D projects that are aimed at developing technologies to enhance security in most modes of transportation. For fiscal years 2003 and 2004, TSA funded 146 transportation security R&D projects, and DHS funded 56 projects. As shown in table 1, in fiscal year 2003, TSA spent about $21 million on transportation security R&D projects and budgeted about $159 million for fiscal year 2004. In both years, TSA spent or budgeted most of its R&D funding for aviation security. TSA's funding for aviation security R&D increased from about $17 million in fiscal year 2003 to about $126 million for fiscal year 2004, partly because of an appropriation of $55 million for air cargo security R&D. Also as shown in table 1, in fiscal year 2003, DHS spent about $26 million on transportation security R&D projects and budgeted about $88 million for fiscal year 2004. In contrast to TSA, in fiscal year 2003, DHS spent almost $13 million, or about 49 percent, of its R&D funding on projects related to more than one mode. However, similar to TSA, for fiscal year 2004, DHS budgeted the majority of its R&D funding for aviation security, increasing the amount from about $4 million in fiscal year 2003 to about $63 million. The majority of this increase is for a program to develop technical countermeasures to minimize the threat posed to commercial aircraft by shoulder-fired missiles, also known as man-portable air defense systems.

Table 1: TSA's and DHS's Transportation Security R&D Funding by Mode, Fiscal Years 2003 and 2004

Dollars in thousands

	TSA		DHS	
Mode	**Fiscal year 2003 (obligated) /(%)**	**Fiscal year 2004 (budgeted)/(%)**	**Fiscal year 2003 (obligated)/(%)**	**Fiscal year 2004 (budgeted)/(%)**
Aviation	$17,101 (81.1)	$126,487 (79.5)	$3,709 (14.3)	$63,240 (71.9)
Highway	0 (0.0)	0 (0.0)	1,052 (4.1)	3,000 (3.4)
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Multimodal	3,819 (18.1)	22,242 (14.0)	12,630 (48.8)	20,117 (22.9)
Pipeline	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Rail	169 (0.8)	1,096 (0.7)	0 (0.0)	0 (0.0)
Transit	0 (0.0)	0 (0.0)	5,000 (19.3)	0 (0.0)
Total	**$21,089 (100.0)**	**$159,175 (100.0)**	**$25,865 (100.0)**	**$87,983 (100.0)**

Source: GAO analysis of TSA and DHS data.

Note: The figures in this table represent transportation security R&D projects funded by TSA's Office of Security Technologies. Other TSA offices also funded several transportation security R&D projects in fiscal years 2003 and 2004, such as Operation Safe Commerce, the Computer Assisted Passenger Prescreening System II, and the Transportation Worker Identification Credential program. However, TSA was not able to provide us with funding information for these projects.

Although TSA and DHS have not decided what additional projects they will fund in fiscal year 2005 and beyond, the President's fiscal year 2005 budget requests $154 million for TSA's R&D program and about $1 billion for DHS's Science and Technology Directorate, which includes some transportation security R&D.[1] DOT spent $8 million in fiscal year 2003 and has budgeted about $31 million for transportation security R&D projects during fiscal year 2004. For example, in 2003, DOT spent about $2 million to develop and field-test a system to track trailers containing hazardous materials when they are not attached to a tractor; for fiscal year 2004, it budgeted $20 million to develop a secure information network to share air traffic control information with DHS and others. NASA did not fund any transportation security R&D projects in fiscal year 2003, but it has budgeted about $18 million for aviation security R&D projects during fiscal year 2004. Although the National Research Council has stated that federal R&D programs should include some basic research, project information provided by TSA and DHS did not show that any of the transportation security R&D projects

[1]The President's fiscal year 2005 budget request for TSA's R&D program is for R&D in TSA's Office of Security Technologies only and does not include R&D in other TSA offices, such as the Office of Maritime and Land Security and the Office of Aviation Operations.

funded in fiscal year 2003 and budgeted for in fiscal year 2004 were in the basic research phase. TSA and DHS also have not estimated deployment dates for the vast majority of the projects that they funded in fiscal years 2003 and 2004. Of the 24 projects for which the two agencies were able to estimate deployment dates, 8 are scheduled for deployment as early as this fiscal year, and the remaining 16 are scheduled for deployment during fiscal years 2005 to 2014. According to a TSA official, deployment dates are not always predictable because deployment is dependent on other factors, such as funding for purchasing and installing equipment. Several members of our panel of transportation security and technology experts believed that the distribution of R&D projects by transportation mode was reasonable, while others believed that aviation has been overemphasized at the expense of maritime and land modes. Finally, some panelists also questioned whether some projects should be funded.

TSA and DHS have made some progress in managing their transportation security R&D programs according to applicable laws and R&D best practices, but they have not fully complied with these laws or implemented best practices. For example:

- The Homeland Security Act requires DHS to prepare a strategic plan that identifies goals and includes annual measurable objectives for coordinating the federal government's civilian efforts in developing countermeasures to terrorist threats. Similarly, the National Research Council has indicated that research programs should be described in strategic and performance plans and evaluated in performance reports. TSA and DHS have prepared strategic plans for their agencies, and TSA has prepared a strategic plan for its R&D program, but these plans do not contain measurable objectives for tracking the progress of projects. According to DHS officials, the department is preparing a separate strategic plan for its R&D program that will include more specific goals and measurable objectives.

- The Aviation and Transportation Security Act requires TSA to use risk management principles in making its R&D funding decisions. Furthermore, under the Homeland Security Act, DHS is required to prepare comprehensive assessments of the vulnerabilities of the nation's key resources and critical infrastructure sectors, which include transportation. Although both TSA and DHS have established processes to select and prioritize R&D projects that include risk management principles, they have not yet completed vulnerability and criticality assessments, which we have identified as key elements of a risk

management approach, for all modes of transportation.[2] In the absence of completed risk assessments, for example, TSA and DHS officials are using available threat intelligence, expert judgment, and information about past terrorist incidents to select and prioritize their R&D projects.

- The National Research Council has emphasized the need for R&D programs to have adequate databases that will provide managers with key project management information. TSA's and DHS's R&D managers were not able to provide us with complete information on all projects in their R&D portfolios. For example, for the 146 projects that it funded in 2003 and 2004, TSA was not able to provide information on anticipated deployment dates for 91 percent of these projects, the current phase of development for 49 percent, and the amounts obligated and/or budgeted for 8 percent. DHS was not able to provide information on anticipated deployment dates for 68 percent of its projects, the current phase of development for 14 percent, and the amounts obligated and budgeted for 9 percent. Although the National Research Council has stated that federal R&D programs should include some basic research, project information provided by TSA and DHS did not show that any of the transportation security R&D projects that they funded in fiscal year 2003 and budgeted for in fiscal year 2004 were in the basic research phase.

- The Aviation and Transportation Security Act and the Homeland Security Act require TSA and DHS to coordinate their R&D efforts with those of other government agencies. Similarly, the Transportation Research Board, a division of the National Research Council, indicates that while TSA should have its own analysis and research capability, it should also coordinate with the transportation sector, the federal government, and the science and technology community. Although TSA and DHS have made some efforts to coordinate R&D with each other and with other federal agencies, their coordination with DOT has been limited. Specifically, officials from the modal administrations of DOT, which continue to conduct some transportation security R&D, said that they had not provided any input into TSA's and DHS's transportation security R&D project selections, nor had TSA or DHS provided any input into DOT's transportation security R&D project selections. In addition, TSA's and DHS's outreach to the transportation industry has been limited. An air cargo association official said that TSA contacted his

[2]GAO, *Homeland Security: Key Elements of a Risk Management Approach*, GAO-02-150T (Washington, D.C.: Oct. 12, 2001).

association about the air cargo industry's security R&D needs. However, most transportation officials we interviewed said that TSA and DHS had not contacted them about their security R&D needs. Consequently, the transportation industry's security R&D needs may not be adequately reflected in TSA's and DHS's R&D portfolios.

We recognize that TSA and DHS are relatively new agencies that are operating in a changing environment. However, until TSA and DHS prepare R&D strategic plans with measurable objectives and complete all of their risk assessments, Congress and other stakeholders will not have a reliable means of assessing TSA's and DHS's progress toward achieving their R&D goals or determining whether the millions of dollars that are being invested in transportation security R&D projects are being spent cost-effectively and address the highest transportation security risks. We are recommending that TSA and DHS (1) conduct some basic research, (2) complete their strategic planning and risk assessment efforts, (3) develop a management information system, and (4) better coordinate with other federal agencies and reach out to the transportation industry. We provided TSA, DHS, and DOT with draft copies of this report for their review and comment. DHS and TSA generally concurred with the draft report's findings and recommendations, agreed that the recommendations are key to a successful R&D program, and commented that they would continue to evaluate their R&D processes in light of the report's findings and recommendations. However, DHS believed that the report did not sufficiently recognize recent changes that have taken place, particularly at TSA. In particular, DHS said that TSA has made great strides in defining R&D projects and linking them to mission needs and identified gaps. In response to these and other technical comments that DHS provided, we have made changes to the report as appropriate. DOT agreed with our findings and a recommendation that to improve R&D coordination, a memorandum of agreement that defines roles and responsibilities be developed between it and DHS. DOT also provided some technical comments, which we incorporated where appropriate. See appendix IV for DHS's comments and our responses.

Background

The nation's transportation system is vast and complex, consisting of about 3.9 million miles of roads, over 100,000 miles of rail, almost 600,000 bridges, over 300 ports, over 2 million miles of pipeline, about 500 train stations, and over 5,000 public-use airports. The size of the transportation system, which moves millions of passengers and tons of freight every day, makes it both an attractive target for terrorists and difficult to secure. Moreover,

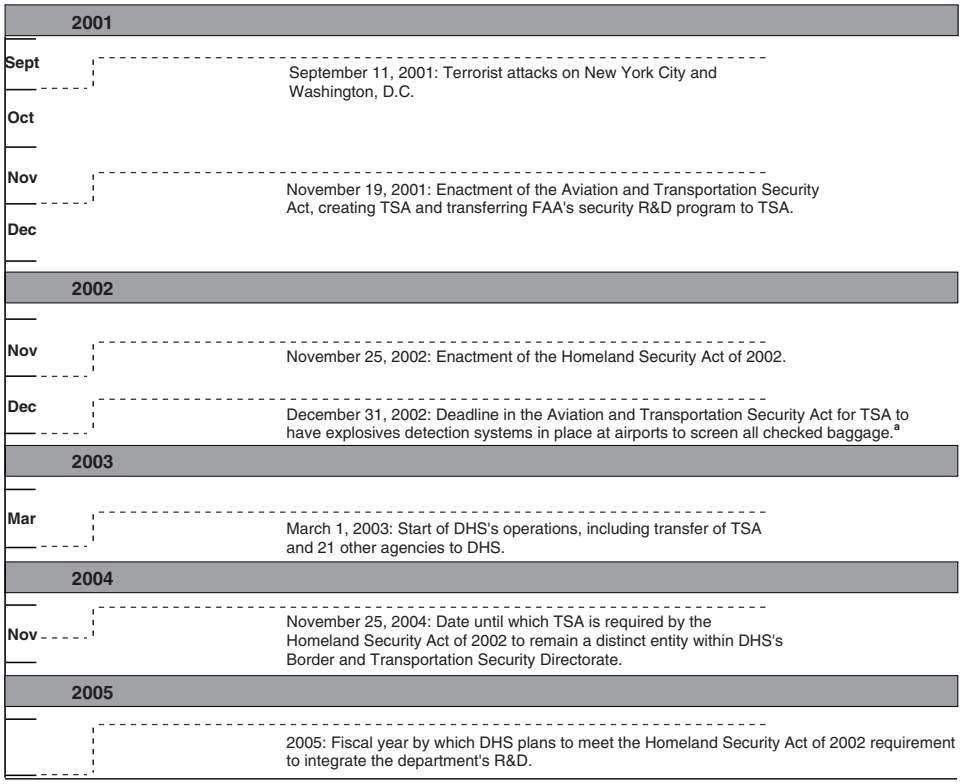
transportation systems can be used as weapons themselves as was done on September 11, 2001.

As we indicated in our June 2003 report on transportation security challenges,[3] transportation experts, state and local governments, and industry representatives generally believe that investing in transportation security R&D is the federal government's responsibility. After the September 11, 2001, terrorist attacks, Congress enacted legislation that resulted in changes in the federal organization and funding for transportation security R&D. In November 2001, the Aviation and Transportation Security Act created TSA within DOT and transferred the Federal Aviation Administration's (FAA) aviation security R&D program to TSA. The act also required TSA to meet a December 31, 2002, deadline for deploying explosives detection systems to screen all checked baggage. One year later, the Homeland Security Act created DHS and transferred TSA from DOT to DHS. This legislation also transferred to DHS several other agencies that conducted transportation security R&D, including the U.S. Customs Service (now part of U.S. Customs and Border Protection) and the U.S. Secret Service from the Department of the Treasury and the U.S. Coast Guard from DOT.[4] In addition, the Homeland Security Act extended the deadline for deploying new checked baggage screening equipment for certain airports to December 31, 2003, and transferred certain chemical and biological research programs that have potential transportation security applications from the Department of Defense and DOE to DHS. Although TSA and DHS have their own research facilities, most of their transportation security R&D is conducted by contractors. Figure 1 identifies major events in the establishment of TSA and DHS.

[3]GAO, *Transportation Security: Federal Action Needed to Help Address Security Challenges*, GAO-03-843 (Washington, D.C.: June 30, 2003).

[4]Under the Homeland Security Act, the Secret Service and Coast Guard remained distinct entities within DHS. The Secret Service and Coast Guard portfolio managers said that DHS's Science and Technology Directorate does not direct the types of transportation security R&D projects that they conduct.

Figure 1: Major Events in the Establishment of TSA and DHS



Sources: Aviation and Transportation Security Act, Homeland Security Act of 2002, and DHS.

[a]This deadline was extended to December 31, 2003, by the Homeland Security Act.

Under the Aviation and Transportation Security Act, TSA is required to

- secure all modes of transportation;
- coordinate transportation security countermeasures with other federal government agencies; and
- accelerate the research, development, testing, and evaluation of explosives detection technology for checked baggage and of new technology to screen for threats in carry-on items and other items being loaded onto aircraft, including cargo, and on persons.

TSA's Office of Security Technologies is responsible for the research, development, testing, and deployment of security technology countermeasures employed to protect the transportation system against criminal and terrorist threats. It organizes its R&D projects according to the different approaches through which threats can reach a target, such as on a person; in carry-on items, vehicles, checked baggage, or cargo; or through access points at airports or at marine ports. The Office of Security Technologies operates the Transportation Security Laboratory, located in Atlantic City, New Jersey, which conducts transportation security R&D and tests products submitted by potential vendors for compliance with TSA standards.

Although FAA's aviation security R&D program was moved to TSA and TSA has since initiated R&D related to other modes of transportation, several DOT administrations[5] conducted transportation security R&D before TSA was created and continue to do so. However, security is not the primary focus of DOT's R&D programs.

The Homeland Security Act brought 22 separate federal agencies under DHS's umbrella and provided a framework for organizing DHS into five directorates, giving the Science and Technology Directorate responsibility for DHS's research, development, testing, and evaluation activities and the Border and Transportation Security Directorate responsibility for security along the nation's borders and in all modes of transportation. The act also requires TSA to remain a distinct entity within the Border and Transportation Security Directorate until November 25, 2004. Consequently, TSA's R&D program office—the Office of Security Technologies—currently operates outside of DHS's Science and Technology Directorate.

Under the Homeland Security Act, DHS's Information Analysis and Infrastructure Protection Directorate is required to prepare risk assessments of the nation's key resources and critical infrastructure,[6]

[5]These include the Federal Aviation Administration, the Federal Highway Administration, the Federal Motor Carriers' Safety Administration, the Federal Railroad Administration, the Federal Transit Administration, and the Research and Special Programs Administration.

[6]The Homeland Security Act refers to the USA Patriot Act for a definition of critical infrastructure, which defines it as systems and assets that are so vital to the United States that their incapacity or destruction would have a debilitating impact on security, national economic security, or national public health or safety. See Pub.L. No. 107-56, § 1016(e) (2001).

which includes transportation. In addition, the Homeland Security Act requires the Science and Technology Directorate to

- coordinate with the appropriate executive branch agencies in developing and carrying out the science and technology agenda of the department to reduce duplication and identify unmet needs;

- accelerate the prototyping and development of technologies to address homeland security vulnerabilities; and

- coordinate and integrate all research, development, demonstration, testing, and evaluation activities of the department.

The Science and Technology Directorate's programs are organized by the type of threat (e.g., chemical, biological, radiological, nuclear, cyber, and high explosives) or by the end-users of the technologies within and outside of DHS (e.g., borders and transportation, critical infrastructure protection, and emergency preparedness and response). The directorate's four offices, as discussed below, are involved in conducting, coordinating, or soliciting some transportation-security-related R&D projects.

- The *Office of Programs, Plans, and Budgets* establishes overall priorities, oversees R&D activities across the Science and Technology Directorate, and provides policy guidance for the directorate's interactions with other DHS components. The office is organized into R&D portfolios that are focused on various types of terrorist threats or DHS components. The portfolios involving transportation-security related R&D include Border and Transportation Security, High Explosives Countermeasures, Biological and Chemical Countermeasures, Radiological and Nuclear Countermeasures, the Coast Guard, and the Secret Service.

- The *Office of Research and Development* executes research, development, testing, and evaluation of technologies at DOE and other federal laboratories; supports university and fellowship programs; and provides an R&D capability dedicated to homeland security.

- The *Homeland Security Advanced Research Projects Agency (HSARPA)* serves as the department's R&D external funding arm by

engaging industry, academia, government, and other sectors in R&D, rapid prototyping,[7] and technology transfer.

- The *Office of Systems Engineering and Development* takes technologies developed by the Office of Research and Development or HSARPA and prepares deployment strategies to transfer technologies to federal, state, and/or local government users.

TSA, DHS, and Others Are Funding Transportation Security R&D Projects and Experts Had Mixed Views about Some Projects

As the primary federal agencies responsible for enhancing the security of all modes of transportation, in fiscal year 2003, TSA spent about $21 million and DHS spent about $26 million on transportation security R&D projects; for fiscal year 2004, TSA and DHS have budgeted about $159 million and $88 million, respectively. In addition, DOT spent about $8 million on transportation security R&D projects in fiscal year 2003 and has budgeted about $31 million for fiscal year 2004. NASA did not fund any transportation security R&D projects in fiscal year 2003 but has budgeted about $18 million for aviation security R&D projects during fiscal year 2004. TSA and DHS were not able to estimate deployment dates for the vast majority of projects that they funded in fiscal years 2003 and 2004. Although TSA and DHS have not decided what additional projects they will fund in fiscal year 2005 and beyond, the President's fiscal year 2005 budget requests $154 million for TSA's R&D program and about $1 billion for the Science and Technology Directorate, which includes some transportation security R&D.[8] Overall, members of our panel of transportation security and technology experts had mixed views about the reasonableness of the distribution of transportation security R&D projects by mode and raised questions about the types of projects that were funded and not funded by TSA and DHS.

TSA Has Used a Majority of Its R&D Funding for Aviation Security

Overall, TSA increased its funding for transportation security R&D from $21 million in fiscal year 2003 to $159 million in fiscal year 2004, as shown in table 2. Although TSA is responsible for addressing the security needs of

[7]Rapid prototyping is a process that uses computer-aided design and fabrication to create and build a prototype more quickly than through traditional means.

[8]The President's fiscal year 2005 budget request for TSA's R&D program is for R&D in TSA's Office of Security Technologies only and does not include R&D in other TSA offices, such as the Office of Maritime and Land Security and the Office of Aviation Operations.

all modes of transportation, in fiscal year 2003, TSA spent about $17 million, or about 81 percent, of its R&D funding for projects related to aviation security. For fiscal year 2004, TSA has budgeted about $126 million on aviation security, or about 79 percent of its R&D budget. This increase reflects, in part, a $55 million appropriation for R&D related to air cargo screening. According to TSA, it has spent the majority of its R&D funding on aviation security because aviation was the greatest concern following the September 11, 2001, terrorist attacks and because Congress directed TSA to use R&D funding to enhance aviation security. In fiscal year 2004, TSA increased its budget for multimodal R&D projects from about $4 million in fiscal year 2003 to about $22 million. This increase is due, in part, to a $5.6 million increase for the Manhattan II project[9] and about $6.4 million for development of a walk-through trace portal for detecting explosives on aviation, maritime, and rail passengers. In fiscal year 2004, TSA also increased its budget for rail security R&D projects from $169,000 in fiscal year 2003 to about $1.1 million. This increase reflects the $1.1 million that was budgeted for the Transit and Rail Inspection Pilot (TRIP).[10] TSA also increased maritime security R&D funding from zero in fiscal year 2003 to about $9 million in fiscal year 2004; this increase is due, in part, to $3.6 million for a project to develop equipment to screen vehicles on ferries. Finally, TSA did not spend any money for highway, pipeline, or transit R&D projects. Several members of our panel of transportation security and technology experts commented that R&D for rail and transit security warrants additional funding. Congress is considering legislation to increase funding for these as well as other modes of transportation in fiscal year 2005. For example, the Rail Security Act, S. 2273, which has been passed by the Senate Committee on Commerce, Science, and Transportation, would authorize $50 million in each of fiscal years 2005 and 2006 for an R&D program for improving freight and intercity passenger rail security.

[9]Manhattan II is TSA's long-term approach for improving checked baggage screening systems for aviation as well as maritime and land modes. This program seeks to achieve revolutionary improvements in detection capability and operational efficiency in 5 to 10 years using new screening technologies. TSA plans to award this project's first "proof of concept" grants in the fourth quarter of fiscal year 2004.

[10]TRIP is intended to assess the feasibility of the screening of people and their carry-on baggage traveling on U.S. trains.

Table 2: TSA's Transportation Security R&D Funding by Mode, Fiscal Years 2003 and 2004

Dollars in thousands				
	Fiscal year 2003		Fiscal year 2004	
Mode	**Obligated**	**Percent**	**Budgeted**	**Percent**
Aviation	$17,101	81.1	$126,487	79.5
Highway	0	0.0	0	0.0
Maritime	0	0.0	9,350	5.9
Multimodal	3,819	18.1	22,242	14.0
Pipeline	0	0.0	0	0.0
Rail	169	0.8	1,096	0.7
Transit	0	0.0	0	0.0
Total	**$21,089**	**100.0**	**$159,175**	**100.0**

Source: GAO analysis of TSA data.

Note: The figures in this table represent transportation security R&D projects funded by TSA's Office of Security Technologies. Other TSA offices also funded several transportation security R&D projects in fiscal years 2003 and 2004, such as Operation Safe Commerce, the Computer Assisted Passenger Prescreening System II, and the Transportation Worker Identification Credential program. However, TSA was not able to provide us with funding information for these projects.

Aviation Security R&D Projects Funded by TSA

In fiscal years 2003 and 2004, TSA spent or budgeted R&D funds for projects in several aviation security program areas, including the following:

- *Aviation Checked Baggage:* To improve the detection capability and operational efficiency of its current checked baggage-screening program, TSA has both near-term (1 to 3 years) and long-term R&D programs. To date, TSA has spent most of its checked baggage screening R&D funds on the near-term programs. In fiscal year 2003, it obligated about $12 million, and, for fiscal year 2004, it budgeted about $27 million for near-term activities; whereas for long-term activities under the Manhattan II project, it obligated $75,000 in fiscal year 2003 and has budgeted $5.6 million for fiscal year 2004. Most of the near-term activities are to develop next-generation checked baggage screening equipment through the Phoenix project, which is funded jointly by government and industry. As part of the Phoenix project, in September 2003, TSA awarded $9.4 million to enter into five cooperative agreements with private sector firms to enhance existing systems and develop new screening technologies. For example, in fiscal year 2003, TSA spent almost $2.4 million to have a contractor develop a new

computed tomography explosives detection system[11] that is smaller and lighter than systems currently deployed in airport lobbies. The new system is intended to replace the systems currently placed in airport lobbies, including both larger, heavier explosives detection systems and explosives trace detection equipment. The smaller size of the system creates opportunities for TSA to transfer screening operations to other locations, such as airport check-in counters. TSA expects to certify this equipment later this year. TSA is also working with a contractor to integrate technologies, such as quadrupole resonance,[12] with its existing explosives detection systems to improve processing speed and detection capability and to reduce false alarm rates and human resource requirements.

- *Aviation Checkpoint:* To address the limitations of its current metal detectors for screening passengers and of X-ray machines for screening carry-on baggage, TSA, in fiscal year 2003, obligated about $1 million and has budgeted $18 million for fiscal year 2004. For example, during the summer of 2004, TSA installed and began testing explosives trace detection portals at four airports and had scheduled to test the portal at a fifth airport in the near future. Passengers who enter a checkpoint lane with a trace portal machine will proceed through the metal detector while their carry-on baggage is being screened by X-ray. Each passenger will then be asked to step into the trace portal and to stand still for a few seconds while several quick puffs of air are released, as shown in figure 2. The portal will analyze the air for traces of explosives as the passenger walks through, and a computerized voice will tell the passenger when to exit the portal.

[11]A computed tomography explosives detection system uses an X-ray source that rotates around a bag, obtaining a large number of cross-sectional images that are integrated by a computer, which displays the densities of objects in the bag. The system automatically triggers an alarm when objects with high densities, which are characteristic of explosives, are detected.

[12]Quadrupole resonance uses radio frequency pulses to probe bags by eliciting unique responses from explosives based on their chemical characteristics.

Figure 2: A Walk-through Explosives Trace Detection Portal

Source: Smiths Detection.

To help focus its screening resources on the highest risk passengers, in fiscal years 2003 and 2004, TSA worked to develop the Computer Assisted Passenger Prescreening System II (CAPPS II).[13] CAPPS II is intended to identify terrorists and other high-risk individuals before they board commercial airplanes. Originally, TSA intended to conduct a risk assessment of each passenger using national security information, commercial databases, and information provided by the passenger during the reservation process—specifically, the passenger's name,

[13]TSA was not able to tell us how much it had obligated and budgeted for CAPPS II in fiscal years 2003 and 2004, respectively.

date of birth, home address, and home telephone number. In our February 2004 report on CAPPS II, we found that TSA was behind schedule in testing and developing initial increments of CAPPS II and had not yet completely addressed other issues, including concerns about privacy and the accuracy of the data used for CAPPS II.[14] In August 2004, a DHS official said that DHS was revising the program with an emphasis on fully protecting passengers' privacy and civil liberties.

- *Aviation Cargo*: To enhance the security of the nation's air cargo system, TSA obligated about $700,000 in fiscal year 2003 for cargo security R&D and has budgeted about $53 million for fiscal year 2004. For example, as part of its Air Cargo Strategic Plan, TSA plans to develop a prescreening system to identify high-risk cargo and to work with the appropriate stakeholders to ensure that all such cargo is inspected. To complete its inspection of high-risk cargo, TSA has a number of R&D projects, one of which is a project budgeted at $19.5 million for fiscal year 2004 to research and develop equipment for the detection of threats in containerized air cargo and mail. Under this project, TSA is considering funding several technologies, including high-power computed tomography and X-ray combined with pulsed fast neutron analysis.[15]

In its July 2004 report, the National Commission on Terrorist Attacks Upon the United States expressed concerns about checked baggage, checkpoint, and cargo security.[16] The commission recommended that TSA and Congress give priority attention to improving the ability of screening checkpoints to detect explosives on passengers. The commission also stated that TSA should (1) expedite the installation of advanced in-line baggage screening equipment; (2) require that every passenger aircraft carrying cargo deploy at least one hardened container to carry any suspect cargo; and (3) intensify its efforts to identify, track, and appropriately screen potentially dangerous cargo in both aviation and maritime modes.

[14]GAO, *Aviation Security: Computer-Assisted Passenger Prescreening System Faces Significant Implementation Challenges*, GAO-04-385 (Washington, D.C.: Feb. 12, 2004).

[15]Pulsed fast neutron analysis probes targets, using high-energy neutrons, for the presence of explosives.

[16]National Commission on Terrorist Attacks Upon the United States, *The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks Upon the United States* (Washington, D.C.: 2004).

Maritime and Land Security R&D Projects Funded by TSA

In addition to its R&D projects to enhance aviation security, in fiscal years 2003 and 2004, TSA spent or budgeted R&D funds for projects to improve security for maritime and land transportation, including the following:

- *The Transit and Rail Inspection Pilot* will assess the feasibility of using emerging technologies to screen passengers and their checked baggage and carry-on items for explosives at rail stations and aboard trains. In May 2004, TSA completed a 30-day test to screen Amtrak and commuter rail passengers for explosives at a Maryland train station by having them walk through a trace detection portal that TSA is also considering for use at airports. According to TSA officials, the test provided useful information about customer-screening wait times, the effectiveness of screening equipment in a non-climate-controlled environment, and the cost and impact of using the technology for Amtrak and commuter rail operations. In addition, in June and July 2004, TSA tested the screening of Amtrak passengers' checked baggage for explosives at a Washington, D.C., train station, and in July 2004, TSA tested the screening of passengers and their carry-on items for explosives on a Connecticut commuter rail train while the train was in motion.

- *The Transportation Worker Identification Credential* is intended to establish a uniform, nationwide standard for the secure identification of as many as 12 million public- and private-sector workers who require unescorted physical or cyber access to secure areas at airports and other transportation facilities, such as seaports and railroad terminals. TSA was not able to provide funding information for the program for fiscal years 2003 and 2004. As we have previously reported, airport and seaport officials have expressed concern about how much the program would cost and who would pay to implement it.[17] We have recently completed a separate review that looked at pilot tests of the program at maritime ports and expect to issue a report to the House Transportation and Infrastructure Committee by September 30, 2004.

- *The Conveyance Tracking Program* is investigating the capability of technologies that are or are nearly available for the secure tracking of hazardous materials shipments by rail and truck. TSA budgeted about $1 million for this program for fiscal year 2004.

[17]GAO, *Posthearing Questions Related to Aviation and Port Security*, GAO-04-315R (Washington, D.C.: Dec. 12, 2003), and *Aviation Security: Progress Since September 11, 2001, and the Challenges Ahead*, GAO-03-1150T (Washington, D.C.: Sept. 9, 2003).

- *Operation Safe Commerce* is designed to improve container supply chain security by testing practices and commercially available technologies in an operational environment, including technologies for tracking and tracing containers, nonintrustive detection of threats, and sealing containers. In June 2003, TSA awarded grants to the ports of Los Angeles and Long Beach, California; Seattle and Tacoma, Washington; and the Port Authority of New York and New Jersey. TSA was not able to provide funding information for the program for fiscal years 2003 and 2004.

TSA Spent or Budgeted Most of Its R&D Funding for Projects That Are Beyond the Basic Research Phase

For our review, we classified R&D projects according to the following four phases:

- *Basic research* includes all scientific efforts and experimentation directed toward increasing knowledge and understanding in those fields of physical, engineering, environmental, social, and life sciences related to long-term national needs.

- *Applied research* includes all efforts directed toward the solution of specific problems with a view toward developing and evaluating the feasibility of proposed solutions.

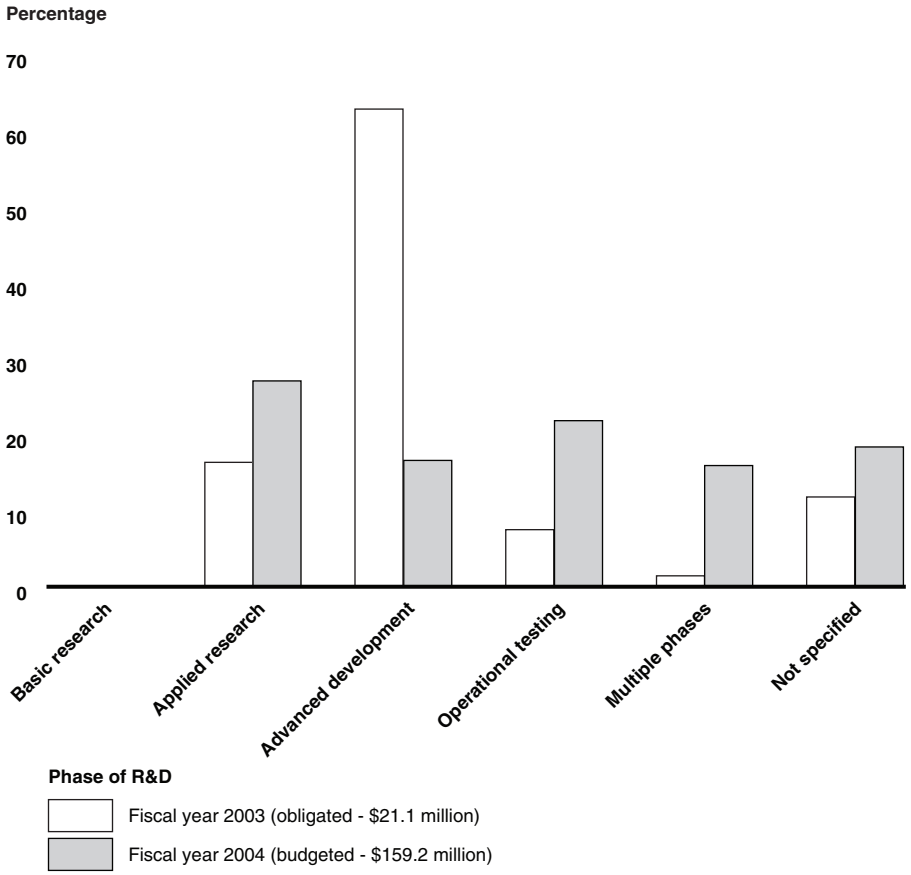
- *Advanced development* includes all efforts directed toward projects that have moved into the development of hardware for field experiments and tests.

- *Operational testing* includes the evaluation of integrated technologies in a realistic operating environment to assess the performance or cost reduction potential of advanced technology.

In fiscal years 2003 and 2004, TSA spent or budgeted the majority of its transportation security R&D funding for projects in the last three phases of R&D, but the agency agrees that it needs to spend more for basic research. Figure 3 shows TSA's allocation of R&D funding by phase of R&D. In fiscal year 2003, TSA spent about 88 percent of its $21 million budget on applied research, advanced development, and operational testing. For fiscal year 2004, TSA budgeted about 82 percent of its $159 million budget for projects in those three phases. In contrast, according to project information provided by TSA, none of the transportation security R&D projects that it funded in fiscal year 2003 and budgeted in fiscal year 2004 were in the basic research phase. According to the National Research Council, R&D organizations should consistently fund some basic research because

although it typically entails higher risks, it also offers higher payoffs than R&D in later phases. Thus far, TSA has focused its R&D efforts on making improvements to deployed technologies and testing and evaluating near-term technologies, and a senior TSA official acknowledged that the agency needs to do more basic research.

Figure 3: Distribution of TSA's R&D Funding by Phase, Fiscal Years 2003 and 2004



Source: GAO analysis of TSA data.

Note: TSA provided the R&D phase for 74 of the 146 projects that it funded in fiscal years 2003 and 2004. TSA officials did not explain why the information was not available on the R&D phase for the remaining 72 projects.

TSA Has Not Estimated Deployment Dates for Most of Its R&D Projects

Although many of TSA's projects are in later phases of development, the agency has not estimated deployment dates for 133 of the 146 projects that it funded in fiscal years 2003 and 2004. According to TSA officials, deployment dates are not always predictable because deployment is dependent on factors such as the manufacturing capacity of the private sector or the availability of funds for purchasing and installing equipment. However, we generally believe that R&D program managers should estimate deployment dates for projects that are beyond the basic research phase because deployment dates can serve as goals that the managers can use to plan, budget, and track the progress of projects. For the 13 projects for which TSA had estimated deployment dates, deployment is scheduled for fiscal years 2004 through 2014. Nine of the 13 projects are scheduled for deployment in fiscal years 2005 or 2006, including the Phoenix project, which is intended to enhance existing checked baggage screening systems and develop new screening technologies. One of the remaining 4 projects, the Manhattan II project, is scheduled for deployment from fiscal years 2009 through 2014.

Transferring R&D Funds to Other Programs Delayed TSA's Progress on Some R&D Projects

Progress on some R&D projects was delayed in fiscal year 2003 when TSA transferred about $61 million, more than half of its $110 million R&D appropriation, to operational needs, such as personnel cost for screeners. As a result, TSA delayed several key R&D projects related to checked baggage screening, checkpoint screening, and air cargo security. For example, TSA delayed the development of a device to detect weapons, liquid explosives, and flammables in containers found in carry-on baggage or passengers' effects, as well as the development and testing of a walk-through portal for detecting traces of explosives on passengers. According to a TSA official, the agency does not plan to transfer R&D funds to other programs in fiscal year 2004.

DHS Spent the Majority of Its Fiscal Year 2003 and Budgeted the Majority of Its Fiscal Year 2004 Transportation Security R&D Funding for Multimodal and Aviation Projects

Overall, DHS increased its funding for transportation security R&D from about $26 million in fiscal year 2003 to about $88 million in fiscal year 2004, as shown in table 3.[18] The President's fiscal year 2005 budget request includes about $1 billion for the Science and Technology Directorate, which includes some transportation security R&D.

Table 3: DHS's Transportation Security R&D Funding by Mode, Fiscal Years 2003 and 2004

Dollars in thousands

	Fiscal year 2003		Fiscal year 2004	
Mode	**Obligated**	**Percent**	**Budgeted**	**Percent**
Aviation	$3,709	14.3	$63,240	71.9
Highway	1,052	4.1	3,000	3.4
Maritime	3,474	13.4	1,626	1.8
Multimodal	12,630	48.8	20,117	22.9
Pipeline	0	0.0	0	0.0
Rail	0	0.0	0	0.0
Transit	5,000	19.3	0	0.0
Total	**$25,865**	**100.0**	**$87,983**	**100.0**

Source: GAO analysis of DHS data.

In fiscal year 2003, DHS spent $12.6 million, or almost half, of its $26 million transportation security R&D budget for projects related to multiple modes of transportation. For fiscal year 2004, DHS increased its budget for multimodal projects to $20 million; this increase reflects the costs of funding pilot programs with the Port Authority of New York and New Jersey to test radiation and nuclear detection devices. For fiscal year 2004, DHS budgeted almost $63 million, or 72 percent of its $88 million, on aviation projects, compared with almost $4 million spent in fiscal year 2003. This increase provides about $60 million in fiscal year 2004 funds to develop technical countermeasures to minimize the threat posed to commercial aircraft by shoulder-fired missiles, also known as man-portable

[18]Some of DHS's transportation security R&D projects are funded and managed by DHS's Science and Technology Directorate, while others are funded and managed by other DHS agencies, namely the Coast Guard, Customs and Border Protection, and the Secret Service.

air defense systems (MANPADS).[19] Figure 4 shows a MANPADS that could be used to attack a commercial aircraft.

Figure 4: Photograph of a MANPADS

Source: U.S. Department of the Army.

[19]In our January 2004 report on DHS's effort, we found that DHS faces significant challenges in adapting a military counter-MANPADS system to commercial aircraft, including establishing system requirements, developing the technology and design to a mature level, and developing reliable cost estimates. (GAO, *The Department of Homeland Security Needs to Fully Adopt a Knowledge-based Approach to Its Counter-MANPADS Development Program*, GAO-04-341R (Washington, D.C.: Jan. 30, 2004).)

DHS decreased its budget for transit security R&D projects from $5 million in fiscal year 2004 to $0 in fiscal year 2004; this decrease reflects the completion of a project to test chemical detectors in subway stations. DHS also increased its budget for highway security R&D projects from $1 million in fiscal year 2003 to $3 million in fiscal year 2004. This increase funds a project to research and develop technology for detecting truck bombs. Figure 5 shows an example of a truck bomb detection system.

Figure 5: A Mobile Search X-ray Inspection System for Detecting Truck Bombs

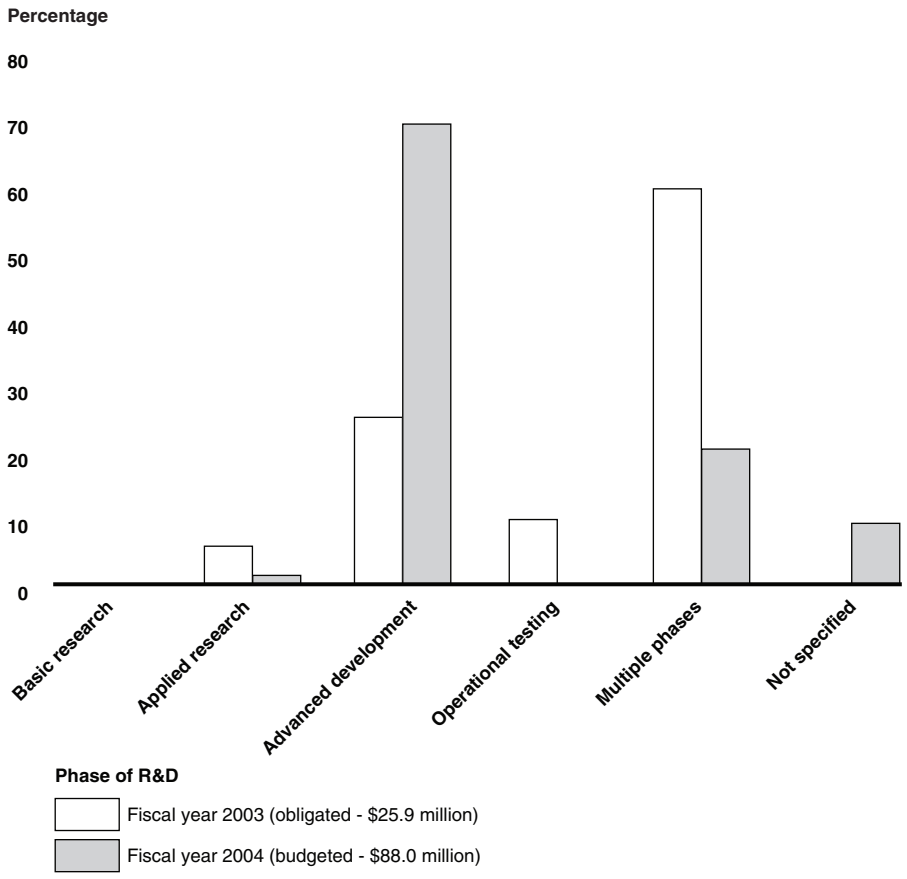
Source: American Science and Engineering.

DHS Spent or Budgeted Most of Its R&D Funding for Projects That Are in Advanced Development

In fiscal year 2003, DHS spent 25 percent and 60 percent of its $26 million transportation security R&D budget for projects in advanced development and multiple phases, respectively, as shown in figure 6. For fiscal year 2004, DHS budgeted $61 million, or 69 percent, of its $88 million budget for advanced development, including $60 million for the counter-MANPADS program. According to project information provided by DHS, none of the transportation security R&D projects it funded in fiscal year 2003 and budgeted for in fiscal year 2004 were in the basic research phase. Although DHS has focused its initial R&D efforts on the near-term development and deployment of technologies, it recognizes the importance of basic research

and, according to a senior DHS official, intends to do more basic research in fiscal year 2006 and beyond.

Figure 6: Distribution of DHS's R&D Funding by Phase, Fiscal Years 2003 and 2004



Source: GAO analysis DHS data.

Of the 56 projects that DHS funded in fiscal years 2003 and 2004, DHS has deployed technologies related to 7, has estimated deployment dates for 11, and has not estimated deployment dates for the remaining 38. Estimated deployment dates for the 11 projects range from fiscal years 2004 to 2007.

DOT and NASA Funded Some Transportation Security R&D Projects

In addition to the transportation security R&D projects funded by TSA and DHS, DOT and NASA funded some such projects. In fiscal year 2003, DOT spent about $8 million and has budgeted about $31 million for fiscal year 2004 on transportation security R&D, as shown in table 4. For example, in fiscal year 2003, DOT spent about $2 million to develop and field-test a system to track trailers containing hazardous materials when they are not attached to a tractor; for fiscal year 2004, it budgeted $20 million to develop a secure information network to share air traffic control information with DHS and others.

Table 4: DOT's Transportation Security R&D Funding by Mode, Fiscal Years 2003 and 2004

Dollars in thousands

	Fiscal year 2003		Fiscal year 2004	
Mode	**Obligated**	**Percent**	**Budgeted**	**Percent**
Aviation	$0	0.0	$20,000	65.0
Highway	3,531	43.8	400	1.3
Maritime	0	0.0	0	0.0
Multimodal	906	11.2	7,858	25.5
Pipeline	900	11.2	412	1.3
Rail	400	5.0	400	1.3
Transit	2,325	28.8	1,694	5.5
Total	**$8,062**	**100.0**	**$30,764**	**100.0**

Source: GAO analysis of DOT data.

Although NASA did not fund any transportation security R&D in fiscal year 2003, it has budgeted about $18 million for fiscal year 2004 for aviation security R&D projects. For example, NASA budgeted about $5 million for technologies and methods to provide accurate information so that pilots can avoid protected airspace, continually verify identity, and prevent unauthorized persons from gaining access to flight controls.

Experts Had Mixed Views on the Reasonableness of Distribution of Transportation Security R&D Projects, and Some Experts Questioned Decisions to Fund Some Projects

Members of our panel of transportation security and technology experts had mixed views on whether the distribution of transportation security R&D projects by mode was reasonable and raised questions about whether some projects should be funded. According to several panelists, the distribution of transportation security R&D projects by mode and program area was reasonable. However, several other panelists said that aviation has been overemphasized at the expense of maritime and land modes; two panelists felt that R&D is focused too heavily on threats that were prominent in the 1970s and 1980s, such as airplane hijackings and bombings; and one panelist said that the selection of projects seemed to be inappropriately based on the most recent terrorist event or perceived threat. While the panelists had different and sometimes conflicting views about the reasonableness of the distribution of projects, many of them said that project selections should be based on current risk assessments. As explained in the next section of this report, TSA and DHS plan to select their R&D projects on the basis of risk assessments, which have not yet been completed for all modes of transportation.

When asked whether they thought there were any transportation security R&D projects in the agencies' portfolios that did not merit funding, the panelists identified several funded by TSA that they believed did not qualify as R&D projects. For example, one panelist did not agree with funding projects that were designed to enhance existing technologies, such as a $30,000 project to test a prototype of a new, handheld ion mobility spectrometry explosives trace detector. According to this panelist, at least two very good ion mobility spectrometry handheld units can be purchased off the shelf. In commenting on a draft of this report, DHS said that TSA funded this project because the vendor demonstrated a promising technology.

When asked if there were any important areas of transportation security R&D that TSA and DHS were not addressing, individual panelists suggested that the following projects be considered for future funding:

- A project for combining neutron inspection technology with traditional transmission X-ray and backscatter X-ray technologies could enhance air cargo security by providing a thorough look at places where

explosives might be concealed in containers.[20] A ground-based system to scan trucks carrying cargo bound for passenger aircraft, ships, and highways could also be tested.

- A multifunctional portal that tests for metals, explosives, narcotics, and chemicals in near real time could help to address the limitations of current checkpoint screening equipment.

- A standard piece of luggage for testing deployed explosives detection systems could be developed to ensure that the systems maintain acceptable performance capabilities.

In commenting on a draft of this report, DHS addressed several technologies and projects, including neutron inspection technology, a multifunctional portal project, and a project to develop a standard piece of luggage for testing explosives detection systems. Specifically, DHS said that TSA is looking at pulsed fast neutron analysis, a technology that uses X-ray images in conjunction with neutron interrogation and substance identification. According to DHS, TSA considers the development of a multifunctional portal critical because it creates opportunities for fusing or integrating technologies—a long-standing transportation goal. Finally, DHS said that a standard piece of luggage had been developed to validate the performance of two different explosives detection systems to ensure that the systems are performing to their certification levels. Moreover, DHS noted in its comments that TSA has two advisory committees—the National Academy of Sciences and the Security Advisory Panel—whose members have expertise in various modes of transportation.

[20]Neutron inspection techniques use neutron beams that penetrate an object and react with concealed explosives. Traditional transmission X-ray images create a "shadowgram" image, similar to the result of a medical X-ray, when X-rays pass through an object and are absorbed, rather than scattered. While transmission technology can reveal fine details such as wires and other bomb components, the more objects or clutter in the path of the beam, the less object differentiation is achieved. Backscatter X-ray detects reflected X-ray energy, providing an image that highlights organic materials such as explosives—materials that traditional transmission-only systems can miss.

TSA and DHS Have Made Some Progress in Managing Their R&D Programs but Have Not Yet Fully Completed Their Efforts

TSA and DHS have made some progress in managing their transportation security R&D programs according to applicable laws and R&D best practices,[21] but their efforts are incomplete in the following areas:

- preparing strategic plans that contain goals and measurable objectives,
- preparing and using risk assessments to select and prioritize their R&D projects,
- maintaining a comprehensive database of R&D projects,
- coordinating their R&D programs with those of other government agencies,
- reaching out to transportation stakeholders to help identify R&D needs, and
- accelerating R&D.

The Homeland Security Act also authorizes DHS to solicit R&D proposals for security technologies from outside entities and requires DHS to integrate the department's R&D programs. Although the laws do not contain deadlines for TSA and DHS to complete these requirements, it is difficult to determine, until the agencies do, whether they are making R&D investments cost-effectively and addressing the highest transportation risks. In commenting on their progress in managing TSA's R&D program, TSA officials said that the agency was focusing initially on hiring new airport screeners and meeting statutory requirements to install new screening equipment. They further noted that a substantial transfer of R&D funds in fiscal year 2003 delayed certain projects. DHS officials said that the department is a start-up organization. Table 5 shows the progress TSA and DHS have made in complying with statutory requirements and best practices for managing their R&D programs.

[21]National Academy of Sciences, *Evaluating Federal Research Programs: Research and the Government Performance and Results Act* (Washington, D.C.: National Academy Press, 1999), and National Research Council, *World-Class Research and Development: Characteristics for an Army Research, Development, and Engineering Organization* (Washington, D.C.: National Academy Press, 1996).

Table 5: TSA's and DHS's Implementation of Statutory Requirements and Best Practices for Managing Their R&D Programs

Requirement/Best practice	TSA's implementation	DHS's implementation
The Homeland Security Act requires DHS to prepare a strategic plan that identifies goals and includes annual measurable objectives for coordinating the federal government's civilian efforts in developing countermeasures to terrorist threats. In addition, the National Academy of Sciences indicates that research programs should be described in strategic and performance plans.	Partial—TSA prepared strategic plans for the agency and its R&D program, but the plans did not contain goals or measurable objectives.	Partial—DHS prepared a strategic plan for the department, but the plan does not contain measurable objectives. DHS is in the process of preparing a strategic plan for its R&D program.
The Aviation and Transportation Security Act requires TSA to use risk management principles to make R&D decisions. The Homeland Security Act requires DHS to prepare comprehensive risk assessments for the nation's key resources and critical infrastructure sectors. In addition, GAO has advocated the use of a risk management approach in responding to national security and terrorism challenges.	Partial—According to TSA officials, threat assessments were completed for all modes of transportation, but vulnerability and criticality assessments have not been completed.	Partial—DHS is working in a pilot phase toward preparing national comparative risk assessments for infrastructure sectors with critical vulnerabilities.
The National Research Council indicates that R&D organizations should maintain a complete database of projects to help prioritize and justify expenditures.	Partial—TSA's database of projects does not provide key information on all projects.	Partial—DHS's database of projects does not provide key information on all projects.
The Aviation and Transportation Security Act and the Homeland Security Act require TSA and DHS to coordinate their R&D efforts with those of other government agencies.	Partial—TSA's efforts to coordinate with other federal agencies have been limited.	Partial—DHS's efforts to coordinate with other federal agencies have been limited.
The Transportation Research Board indicates that R&D organizations should reach out to stakeholders to obtain input on their R&D decisions.	Partial—TSA's efforts to reach out to the transportation industry have been limited.	Partial—DHS's efforts to reach out to the transportation industry have been limited.
The Aviation and Transportation Security Act requires TSA to accelerate R&D on aviation security technologies, and the Homeland Security Act requires DHS to accelerate R&D on homeland security technologies.	Unable to assess because of the absence of measurable objectives.	Unable to assess because of the absence of measurable objectives.
The Homeland Security Act requires DHS to integrate the department's various R&D activities.	Not applicable.	DHS is drafting an integration plan and has been directed by the Secretary of Homeland Security to integrate the department's R&D activities by 2005.

Source: GAO analysis of applicable laws, best practices, and information provided by TSA and DHS.

Note: Analysis of implementation status is based on agency officials' comments and our review of applicable documents and databases.

Strategic Plans for TSA's and DHS's R&D Programs Do Not Yet Contain Measurable Objectives

The Homeland Security Act requires DHS to prepare a strategic plan that identifies goals and includes annual measurable objectives for coordinating the federal government's civilian efforts in developing countermeasures to terrorist threats. Similarly, R&D best practices identified by the National Academy of Sciences indicate that research programs should be described in strategic and performance plans and evaluated in performance reports. TSA has prepared strategic plans for both the agency[22] and its R&D program that contain performance goals, such as deterring foreign and domestic terrorists and other individuals from causing harm or disrupting the nation's transportation system. Although we reported in January 2003[23] that TSA had established an initial set of 32 performance measures, none of them are contained in TSA's strategic plans or directly pertain to R&D.

DHS has prepared a strategic plan for the department, but the plan's broad objective—to develop technology and capabilities to detect and prevent terrorist attacks—is not supported by more specific R&D performance goals and measures in any program area, including transportation. A DHS official said that the department is preparing a separate strategic plan for its R&D program that will include more specific goals and measurable objectives. Another DHS official said that the plan will include input from the leaders of the Science and Technology Directorate's functional areas, one of which is transportation. DHS has indicated that the Science and Technology Directorate's strategic planning process includes (1) determining strategic goals for the next 5 years, threats, and vulnerabilities and (2) developing a list of prioritized projects for fiscal years 2005 through 2010. In a May 2004 report on DHS's use of the DOE national laboratories for research on technologies for detecting and responding to nuclear, biological, and chemical threats, we recommended that DHS complete a strategic plan for R&D.[24] Until TSA and DHS prepare R&D strategic plans with goals and measurable objectives, Congress and other stakeholders do not have a reliable means of assessing TSA's and DHS's progress toward achieving their R&D goals.

[22]As of August 2004, TSA's September 2003 strategic plan was still in draft form.

[23]GAO, *Transportation Security Administration: Actions and Plans to Build a Results-Oriented Culture*, GAO-03-190 (Washington, D.C.: Jan. 17, 2003).

[24]GAO, *Homeland Security: DHS Needs a Strategy to Use DOE's Laboratories for Research on Nuclear, Biological, and Chemical Detection and Response Technologies*, GAO-04-653 (Washington, D.C.: May 24, 2004).

TSA and DHS Plan to Use Risk Assessments to Prioritize and Select Their R&D Programs, but Many Assessments Have Not Been Completed

The Aviation and Transportation Security Act requires TSA to use risk management principles in making R&D funding decisions.[25] The Homeland Security Act requires DHS to establish R&D priorities for detecting, preventing, protecting against, and responding to terrorist attacks[26] and to prepare comprehensive assessments of the vulnerabilities of the nation's key resources and critical infrastructure sectors, one of which is transportation.[27] In addition, under the Homeland Security Act, DHS's Information Analysis and Infrastructure Protection Directorate is responsible for receiving and analyzing information from multiple sources, including local, state, and federal government agencies and private sector entities, and integrating the information, analyses, and vulnerability assessments to identify protective priorities.[28]

We have consistently advocated using a risk management approach in responding to national security and terrorism challenges. In the context of homeland security, risk management is a systematic and analytical process of (1) considering the likelihood that a terrorist threat will endanger an asset, individual, or function and (2) reducing the risk and mitigating the consequences of an attack. In our work on homeland security issues, we have identified threat, vulnerability, and criticality assessments as key elements of a risk management approach.[29] These elements are defined as follows:

- A *threat assessment* identifies and evaluates potential threats on the basis of factors such as capabilities, intentions, and past activities. This assessment represents a systematic approach to identifying potential threats before they materialize and is based on threat information

[25]Pub.L. No. 107-71, § 112(b)(1)(B) (2001).

[26]Pub.L. No. 107-296, § 302(5)(B) (2002).

[27]Pub.L. No. 107-296, § 201(d)(2) (2002).

[28]Pub.L. No. 107-296, § 201(d)(2)-(d)(3) (2002).

[29]GAO-02-150T.

gathered from both the intelligence and the law enforcement communities.[30]

- A *vulnerability assessment* identifies weaknesses that may be exploited by identified threats and suggests options to address those weaknesses.

- A *criticality assessment* evaluates and prioritizes assets and functions in terms of specific criteria, such as their importance to public safety and the economy. The assessment provides a basis for identifying which structures or processes are relatively more important to protect from attack.

To select and prioritize their R&D projects, TSA and DHS have established processes that include risk management principles. According to TSA officials, TSA has completed threat assessments for all modes of transportation but has yet to complete vulnerability and criticality assessments. A DHS official told us that the department has started to conduct risk assessments of critical infrastructure sectors but does not plan to start its assessment of the transportation sector until 2005. Without complete risk assessments, Congress and other stakeholders are limited in their ability to assess whether the millions of dollars that are being invested in transportation security R&D projects are being spent cost-effectively and to address the highest transportation security risks.

In the absence of completed risk assessments, TSA and DHS officials are using available threat intelligence, expert judgment, congressional mandates, mission needs, and information about past terrorist incidents to select and prioritize their R&D projects. TSA and DHS officials said that they obtain threat intelligence from the government's intelligence community to help make R&D decisions. TSA officials said that TSA's Chief Technology Officer receives daily intelligence briefings, and that the agency is using threat information to select R&D projects but is not yet using formal threat assessments to make those R&D decisions. In addition, DHS's

[30]As we noted in our October 2001 report on risk management, while threat assessments are a key decision support tool, it should be recognized that, even if updated often, threat assessments might not adequately capture emerging threats posed by some terrorist groups. No matter how much we know about potential threats, we will never know whether we have identified every threat or whether we have complete information even about the threats of which we are aware. Consequently, we believe that a risk management approach to preparing for terrorism that supplements threat assessments with vulnerability and criticality assessments can provide better assurance of preparedness for a terrorist attack.

Inspector General reported in March 2004 that although many Science and Technology officials agreed on the importance of maintaining a relationship with the Information Analysis and Infrastructure Protection Directorate, staff below them were not actively involved in obtaining terrorist threat information from this directorate and using the information to help select new homeland security technologies.[31]

In May 2004, TSA prepared terrorist threat assessments for all modes of transportation. In addition, in June 2004, a TSA official said that TSA is in the process of preparing vulnerability and criticality assessments for all modes of transportation. For example, in 2003, TSA supported the government's strategy to reduce the threat that shoulder-fired missiles pose to commercial aircraft by conducting vulnerability assessments at all major airports to identify major launch sites around the airports using information from local agencies and FAA. In addition to these assessments, officials in DHS's Information Analysis and Infrastructure Protection Directorate said they were working in a pilot phase toward preparing national comparative risk assessments with critical vulnerabilities that would allow comparisons to be made across different infrastructure sectors, such as transportation. The officials said the pilot program would focus on other infrastructure sectors, such as chemical and nuclear plants, before addressing the transportation sector, which they expected to work on in fiscal year 2005. However, they did not know when risk assessments would be completed for all modes of transportation.

TSA has agreed with a recommendation in our past work that it should apply a risk management approach to strengthen security in aviation and in other modes of transportation.[32] TSA indicated that it is developing four tools, including software, that will help assess threats, criticalities, and vulnerabilities, and that it plans to create risk assessment models for all modes of transportation during fiscal year 2004.[33]

[31]Department of Homeland Security, Office of Inspector General, *Survey of the Science and Technology Directorate*, OIG-04-24 (Washington, D.C.: March 2004).

[32]GAO, *Aviation Security: Vulnerabilities and Potential Improvements for the Air Cargo System*, GAO-03-344 (Washington, D.C.: Dec. 20, 2002).

[33]For an explanation of TSA's four assessment tools, see GAO, *Aviation Security: Efforts to Measure Effectiveness and Address Challenges*, GAO-04-232T (Washington, D.C.: Nov. 5, 2003).

In its July 2004 report, the National Commission on Terrorist Attacks Upon the United States also pointed out the importance of risk management and recommended that the government identify and evaluate the transportation assets that need to be protected; set risk-based priorities for defending them; select the most practical and cost-effective ways of doing so; and then develop a plan, a budget, and funding to implement the effort. The plan should assign roles and missions to the relevant federal, state, and local authorities and to private stakeholders. We agree with the commission's recommendations and are making similar recommendations.

TSA and DHS Do Not Have Adequate Databases to Effectively Manage Their R&D Portfolios

R&D best practices identified by the National Research Council indicate that a research program should maintain a complete database of projects to help prioritize and justify program expenditures. Similarly, we have stated that an R&D program should use a management information system that readily provides information to track the performance of projects. TSA's and DHS's R&D managers were not able to provide us with complete information on all projects in their R&D portfolios. For example, for the 146 projects that it funded in 2003 and 2004, TSA was not able to provide information on anticipated deployment dates for 91 percent, the current phase of development for 49 percent, and the amounts obligated and budgeted for 8 percent—including 3 TSA projects, CAPPS II, the Transportation Worker Identification Credential, and Operation Safe Commerce, that were appropriated tens of millions of dollars in both fiscal years 2003 and 2004. For the 56 projects that it funded in 2003 and 2004, DHS was not able to provide information on anticipated deployment dates for 68 percent, the current phase of development for 14 percent, and the amounts obligated and budgeted for 9 percent. Although TSA's and DHS's databases contain some information, it is scattered among several computer files and paper documents and cannot be easily retrieved or analyzed. Consequently, additional staff time is needed to prepare documents from different reports, and compiling the information could result in errors and omissions. Without accurate, complete, and timely information, TSA and DHS managers are limited in their ability to effectively monitor their R&D programs and ensure that R&D funds are being used to address the highest priority transportation security risks. In commenting on a draft of this report, DHS said that TSA had recently developed a database that will allow it to track milestones, funding, and deployment information for individual projects.

Coordination with Other Federal Agencies and Outreach to Transportation Industry Associations Has Been Limited

The Aviation and Transportation Security Act and the Homeland Security Act require DHS to coordinate its R&D efforts with those of other government agencies. Similarly, R&D best practices indicate that R&D organizations should coordinate to help fill research gaps and leverage resources. In addition, R&D best practices indicate that TSA and DHS should reach out to stakeholders, such as the transportation industry, to identify their security R&D needs. However, TSA's and DHS's efforts to coordinate with other federal agencies on transportation security R&D and reach out to transportation industry associations on the industry's security R&D needs have been limited.

The Homeland Security Act requires DHS to coordinate with other executive agencies in developing and carrying out the Science and Technology Directorate's agenda to reduce duplication and identify unmet needs.[34] In addition, the Aviation and Transportation Security Act gives TSA responsibility for coordinating terrorism countermeasures with "departments, agencies, and instrumentalities of the United States Government."[35] For TSA and DHS to select the best technologies to enhance transportation security, it is important that they have a clear understanding of the R&D projects currently being conducted, both internally and externally. TSA and DHS have coordinated with each other on some of their transportation security R&D programs, such as efforts to counter the threat posed to commercial aircraft by MANPADS; develop technologies for detecting chemical, biological, radiological, and nuclear programs; and develop explosives detection systems. However, TSA and DHS did not coordinate their R&D portfolios in fiscal year 2003. A DHS official said that the department reviewed TSA's fiscal year 2004 R&D portfolio. The official said that it was not DHS's intention to change TSA's R&D portfolio but to learn what TSA was doing and to leverage resources.

R&D best practices also emphasize the importance of coordinating R&D in the transportation security field. A 2002 Transportation Research Board

[34]Pub.L. No. 107-296, § 302(13) (2002).

[35]Pub.L. No. 107-71, § 101 (2001).

study[36] on the role of science and technology in transportation concluded that while TSA should have its own analysis and research capability, it should also have the ability to draw on the "rich and varied R&D capabilities within the transportation sector, as well as those of the federal government and the science and technology community at large." Furthermore, the report said that if TSA views the R&D activities of DOT's modal agencies from a broader systems perspective, it can help fill research gaps, monitor the progress of these activities, and observe where additional investments might yield large benefits. A member of our transportation security and technology panel suggested that TSA and DHS could be more effective if they systematized and formalized their R&D coordination efforts at the highest levels and included other organizations, such as DOT and the Transportation Research Board of the National Research Council.

Coordinating with DOT

Coordination is limited between TSA and DOT and between DHS and DOT, which continues to conduct some transportation security R&D. Although DOT modal administration officials said that limited communication was occurring between DOT and TSA and between DOT and DHS about ongoing DOT R&D projects, none of these officials said that TSA or DHS had provided any input about which R&D projects they should conduct or had asked the modal administrations for input on which transportation security R&D projects TSA and DHS should conduct. An official from one modal administration said that TSA should consult DOT agencies about their R&D plans because, in some cases, they have expertise about the various transportation modes and are more aware than TSA of the R&D needs and concerns of the transportation industry. For example, a Federal Highway Administration (FHWA) R&D official told us that FHWA has conducted extensive research on tracking freight movement and has mapped out the movement of freight across transportation modes. This official said these efforts could help improve freight security. Other DOT R&D officials expressed similar views about their R&D programs and said they need to coordinate their security R&D programs with TSA and DHS to leverage resources and knowledge and to avoid duplication. An official from one DOT modal administration (the Federal Railroad Administration)

[36]Transportation Research Board, *Deterrence, Protection, and Preparation: The New Transportation Security Imperative*, Special Report 270 (Washington, D.C.: 2002). The Transportation Research Board is a division of the National Research Council, which serves as an independent adviser to the federal government and others on scientific and technical issues.

said that although TSA and DHS had no formal input into the agency's R&D plans, all of the security-related R&D projects it had conducted since 2001 were at the request of TSA or DHS. DOT R&D officials also said that the DOT modal administrations should continue to conduct some security R&D because they have research personnel who are experts in various transportation modes and could help TSA and DHS with their security R&D efforts.

Coordinating with NASA and Other Federal Agencies

Because we found during the course of our review that NASA was also conducting some transportation security R&D, we asked NASA officials about the extent of coordination between NASA and TSA and between NASA and DHS. NASA officials said that they have effective coordination with TSA on the transportation security R&D they conduct.[37] They said that TSA and NASA coordinated on identifying the types of R&D projects that NASA should undertake to best help meet TSA's needs. NASA officials also said that at DHS's request, NASA provided input to the Science and Technology Directorate during the directorate's strategic planning process. In addition, NASA officials said that they are working with TSA on a memorandum of agreement for their R&D programs.

TSA and DHS officials said that coordination with other agencies and R&D organizations is occurring at the project level and that some coordination is based on personal relationships. In discussing DHS's coordination with other agencies in July 2004, a DHS official said that DHS relies heavily on the Office of Science and Technology Policy, a component of the Executive Office of the President, to coordinate R&D. He also noted that the department was only a year old, and that as it matured, DHS would know more about the R&D activities of other agencies.

Coordinating with the DOE National Laboratories

In creating DHS, Congress intended that DHS draw on the scientific expertise of the DOE national laboratories, which make up the world's largest system of laboratories for advanced research in support of national energy and defense needs. The Homeland Security Act requires DHS to establish an Office of National Laboratories to coordinate its R&D with that

[37]NASA's transportation security R&D focuses on aviation security, such as technologies and methods to provide accurate information so that pilots can avoid protected airspace, continually verify identity, and prevent unauthorized persons from gaining access to flight controls.

of DOE's national laboratories.[38] DHS has established this office, and in February 2003, DHS and DOE entered into an agreement allowing DOE to accept and perform work for DHS on an equal basis with other laboratory work. DHS and TSA are sponsoring transportation security-related R&D at several national laboratories, including Lawrence Livermore, Los Alamos, Oak Ridge, Pacific Northwest, and the Idaho National Engineering and Environmental Laboratory. Overall, laboratory officials told us they have an adequate level of communication and coordination with TSA and DHS about their ongoing R&D projects, but some officials believe TSA and DHS could use the laboratories more as resources for transportation security R&D and would like more information about TSA's research needs.

Reaching Out to the Transportation Industry

In a 2001 report, the Transportation Research Board recommended that research be closely connected to its stakeholders, such as transportation providers, to help ensure relevance and program support.[39] According to the report, stakeholders are more likely to use the research results if they are involved in the process from the beginning. However, most transportation industry association officials we interviewed said that TSA and DHS have not reached out to them to obtain information on their security R&D needs. Consequently, the transportation industry's security R&D needs may not be adequately reflected in TSA's and DHS's R&D portfolios.

An air cargo association official said that TSA contacted them to participate in an air cargo security working group of the Aviation Security Advisory Committee, a TSA-sponsored advisory group, where they were able to discuss the air cargo industry's security R&D needs. Some transportation association officials said that TSA and DHS should contact them to obtain input on their research priorities to determine whether the proposed technologies would be useful, avoid duplication of research that they are sponsoring, and leverage resources. Officials from another aviation association commented that, in contrast to their relationship with TSA, they had an effective relationship with FAA. The official noted that information-sharing and communication occurred more frequently with FAA, partly because FAA management recognized the importance of obtaining input from the users of FAA's services, whereas TSA and DHS

[38]Pub.L. No. 107-296, § 309(g) (2002).

[39]Transportation Research Board, *The Federal Role in Highway Research and Technology*, Special Report 261 (Washington, D.C.: National Academy Press, 2001).

have not. An official from a state highway association said that although TSA and DHS officials have participated in transportation research projects that the Transportation Research Board is conducting for the association, TSA and DHS have not directly contacted the association about its security R&D needs. A TSA official said that TSA reaches out to aviation associations and other organizations on R&D but has not formalized this process.

TSA and DHS Have Made Efforts to Reach Out to Technology Providers, but Some Potential Providers Have Expressed Concern about the Process

The Homeland Security Act authorizes DHS to solicit proposals to address vulnerabilities and award grants, cooperative agreements, and contracts with public or private entities, including businesses, federally funded R&D centers, and universities.[40] TSA and DHS have taken some actions to use this authority, but some potential technology providers believe that more information and communication are needed.

One way that TSA and DHS have reached out to the private sector is through their membership in the Technical Support Working Group (TSWG), a joint program of the Departments of State and Defense that identifies, prioritizes, and coordinates interagency R&D requirements to combat terrorism. TSA and DHS have used TSWG to issue broad agency announcements, which request proposals from private and/or public entities for projects that address specific R&D needs.[41] These solicitations have generated substantial numbers of responses. For example, TSWG received more than 3,340 responses to a broad agency announcement that it issued for DHS in May 2003 soliciting proposals for multiple homeland security R&D projects, including a system for screening rail passengers and baggage. A DHS official said that as DHS matures, it intends to rely less on TSWG and more on the Homeland Security Advanced Research Projects Agency (HSARPA), DHS's external funding arm.

TSA and DHS have also reached out to the private sector by linking their Web sites to the Federal Business Opportunities Web site, which informs potential technology providers about opportunities for conducting

[40]Pub.L. No. 107-296, § 307(b)(3)-(b)(4) (2002).

[41]A broad agency announcement is a competitive R&D contracting approach described in the Federal Acquisition Regulation in 48 C.F.R. 35.016. Broad agency announcements are used for the acquisition of basic and applied research and development that fulfill requirements for scientific study, experimentation, and demonstration and that direct advancement of state-of-the-art technology.

homeland security R&D projects. In addition, TSA's Web site invites potential technology providers and others to submit their ideas about innovative security technologies that could contribute to TSA's work on aircraft hardening, baggage and cargo screening, credentialing, physical security, and electronic surveillance. According to TSA, it has evaluated over 1,000 proposals submitted in response to this invitation. However, representatives of several private companies told us of difficulties they had experienced in trying to communicate with TSA, navigate its Web site, obtain information about its R&D program, and understand its current transportation security R&D priorities. For example, a company official told us that his company was forced into guessing about TSA's long-term R&D strategy, and that manufacturers do not want to make a large investment in developing new technologies without knowing whether TSA will embrace those technologies. This company official suggested that TSA should communicate its R&D goals promptly to vendors. Similarly, some private company representatives told us that they did not have sufficient information about DHS's transportation security R&D priorities and requirements to adequately respond to solicitations. In commenting on a draft of this report, DHS noted that TSA recently established a working group to update and improve the current Web site's discussion of technology ideas, products, and services to make it more user-friendly and plans to implement the improvements early next year.

HSARPA has also conducted various forms of outreach with potential technology providers. In September 2003, for example, it conducted a bidders' conference to discuss the release of a solicitation on detection systems for biological and chemical countermeasures. In addition, in November 2003, HSARPA conducted a best practices workshop that allowed potential technology providers to comment on how DHS could best keep industry informed about its priorities, make industry aware of agency solicitations, and manage the relationship between industry and the agency. The industry participants also stressed the importance of communication between them and DHS. In addition, some participants suggested that DHS issue early drafts of solicitations to allow industry to gain a better understanding of DHS's needs.[42] Following the workshop, in January 2004, DHS issued a draft solicitation, for technologies to detect radiological and nuclear materials, for industry comment before issuing the final version.

[42]We are conducting a separate review of DHS's use of its R&D procurement authorities.

TSA and DHS have used universities to conduct some of their R&D. For example, in June 2004, TSA indicated that it had 24 grants with colleges and universities. In addition, the Homeland Security Act requires DHS to establish university-based centers for homeland security.[43] According to DHS, the centers will conduct multidisciplinary research on homeland security. In November 2003, DHS announced that it had selected the University of Southern California as its first Homeland Security Center of Excellence.[44] DHS will provide $12 million over 3 years for the university to conduct a risk analysis on the economic consequences of terrorist threats and events. The study will address both the targets and means of terrorism, with an emphasis on protecting the nation's critical infrastructure, such as transportation systems.

TSA and DHS Have Taken Steps to Accelerate Congressionally Mandated Transportation Security Technologies

Under the Aviation and Transportation Security Act, TSA is required to accelerate the research, development, testing, and evaluation of, among other things, explosives detection technology for checked baggage and new screening technology for carry-on items and other items being loaded onto aircraft, including cargo, and for threats carried on persons.[45] The Homeland Security Act requires DHS's HSARPA to accelerate the prototyping and development of technologies that "would address homeland security vulnerabilities."[46] Although the Homeland Security Act authorized a $500 million acceleration fund in fiscal year 2003,[47] a DHS official said that no funds were specifically appropriated for that purpose.

Both TSA and DHS have taken steps to address congressionally mandated requirements to accelerate security technologies, but they are operating without goals and measurable objectives. As a result, it is difficult to determine what progress the agencies have made toward accelerating R&D projects. Although TSA does not yet have goals and objectives for measuring acceleration, the agency has funded the Phoenix project, among others, to accelerate baggage screening technologies in the near term. For

[43]Pub.L. No. 107-296, § 308(b)(2)(A) (2002).

[44]In April 2004, DHS announced that it had selected two other universities as Homeland Security Centers of Excellence, which will focus on the security of agricultural products.

[45]Pub.L. No. 107-296, § 137(a) (2002).

[46]Pub.L. No. 107-296, § 307(b)(3)(C) (2002).

[47]Pub.L. No. 107-296, § 307(c)(2) (2002).

fiscal year 2004, DHS budgeted $75 million for accelerating technologies through its Rapid Prototyping Program. For example, DHS, in coordination with TSWG, issued a broad agency announcement in May 2003 to support the development of technologies that can be rapidly prototyped and deployed to the field. Furthermore, in January 2004, DHS issued a broad agency announcement to rapidly develop detection systems for radiological and nuclear countermeasures.

DHS Plans to Integrate the Department's R&D Programs

Although the Homeland Security Act requires TSA to remain a distinct entity until at least November 2004,[48] another provision of the Homeland Security Act requires DHS to integrate all of the department's R&D activities.[49] Until that integration occurs, TSA and other DHS components that conduct transportation security R&D are operating separately. However, DHS has made some efforts to promote R&D coordination within the department, such as holding meetings with the different components to discuss R&D activities and preparing inventories of the DHS components' R&D capabilities and ongoing projects. DHS officials said they are preparing a plan to meet a directive from the Secretary of Homeland Security to integrate the department's R&D activities by 2005.

Conclusions

The nation's transportation systems, many of which are open and accessible, are highly vulnerable to terrorist attack. Whether new technologies can be researched, developed, and deployed to reduce the vulnerability of these systems depends largely on how effectively DHS and TSA manage their transportation security R&D programs. The National Research Council has stated that effectively managing federal R&D programs should include consistently funding basic research because it offers opportunities for significant improvements in capabilities. However, project information provided by TSA and DHS did not show that any of the transportation security R&D projects that they funded in fiscal year 2003 and budgeted for in fiscal year 2004 were in the basic research phase. While TSA and DHS recognize the importance of basic research, they are focusing their efforts on the near-term development and deployment of technologies.

[48]Pub.L. No. 107-296, § 424(a) (2002).

[49]Pub.L. No. 107-296, § 302(12) (2002).

Although DHS is working toward complying with legal requirements and implementing best practices for managing its R&D program, it is operating without a strategic plan for its R&D program. Furthermore, although TSA and DHS officials have said that they plan to use risk assessments to select and prioritize R&D projects, TSA has not completed vulnerability and criticality assessments, which are key components of risk assessments, for all modes of transportation. In addition, DHS has not yet completed risk assessments of the infrastructure sectors, such as transportation. As a result, Congress does not have reasonable assurance that the hundreds of millions of dollars that are being invested in transportation security R&D are being spent cost-effectively to address the highest priority transportation security risks. In addition, the National Commission on Terrorist Attacks Upon the United States recommended that the government identify and evaluate the transportation assets that need to be protected; set risk-based priorities for defending them; select the most practical and cost-effective ways of doing so; and then develop a plan, a budget, and funding to implement the effort.

TSA and DHS also do not have adequate databases to monitor and manage their spending of the hundreds of millions of dollars that Congress has appropriated for R&D. As DHS integrates its R&D programs, including TSA's, it will be important for the department to have accurate, complete, current, and readily accessible project information that it can use to effectively monitor and manage its R&D portfolios.

The limited evidence of coordination between TSA and DHS that we found, as well as between each of these agencies and other agencies such as DOT, does not provide assurance that R&D resources are being leveraged, research gaps are being identified and addressed, and duplication is being avoided. In our June 2003 report on transportation security challenges, we recommended that DHS and DOT use a mechanism such as a memorandum of agreement to clearly delineate their respective roles and responsibilities. DHS and DOT disagreed with this recommendation because they believed that their roles and responsibilities were already clear. However, we continue to believe that DHS's and DOT's roles and responsibilities for transportation security, including their respective security R&D programs, should be clarified because the Aviation and Transportation Security Act gives TSA responsibility for securing all modes of transportation but does not eliminate the DOT modal administrations' existing statutory responsibilities for the security of different modes of transportation.

Finally, because most transportation industry associations told us that TSA and DHS have not contacted them about their security R&D needs, the security R&D needs of transportation providers may not have been adequately considered.

Recommendations for Executive Action

To support efforts by TSA and DHS to maximize the advantages offered by basic research, help select and prioritize R&D projects, better monitor and manage their R&D portfolios, enhance coordination with one another and with other organizations that conduct transportation security R&D, and improve their outreach to transportation, we are making five recommendations. Specifically, we recommend that the Secretary of Homeland Security and the Assistant Secretary of Homeland Security for the Transportation Security Administration

- ensure that their transportation security R&D portfolios contain projects in all phases of R&D, including basic research;
- complete (1) strategic plans containing measurable objectives for TSA's and DHS's transportation security R&D programs and (2) risk assessments—threat, vulnerability, and criticality—for all modes of transportation, and use the results of the risk assessments to help select and prioritize R&D projects;
- develop a database that will provide accurate, complete, current, and readily accessible project information for monitoring and managing their R&D portfolios;
- develop a process with DOT to coordinate transportation security R&D, such as a memorandum of agreement identifying roles and responsibilities and designating agency liaisons, and share information on the agreed-upon roles and responsibilities with transportation stakeholders; and
- develop a vehicle to communicate with the transportation industry to ensure that its R&D security needs have been identified and considered.

Agency Comments and Our Evaluation

We provided TSA, DHS, and DOT with drafts of this report for their review and comment. DHS's written comments, which incorporated comments from TSA, are provided in appendix IV, along with our responses to specific

points. DOT also provided comments on the draft report, which we have incorporated into the report as appropriate.

DHS generally concurred with the report's findings and commented that the recommendations are key to a successful R&D program and that the department would continue to evaluate its R&D processes in light of the report's findings and recommendations. However, DHS believed that the report did not sufficiently recognize recent changes that have taken place, particularly at TSA. According to DHS, TSA has made great strides in defining R&D projects and linking them to mission needs and identified gaps. In response to these and other technical comments that DHS provided, we revised the report as appropriate.

DHS also provided additional perspectives on our recommendations:

- *Recommendation: TSA and DHS should ensure that their transportation security R&D portfolios contain projects in all phases of R&D, including basic research.* DHS said that TSA's Transportation Security Laboratory currently conducts basic research and that TSA's human factors program, Manhattan II project, and air cargo security projects include basic research. However, information provided by TSA in July 2004 in response to our request for data on projects, including their current phase of research, identified no projects in the basic research phase. This information from TSA covered the agency's R&D work on human factors, Manhattan II, and air cargo security. In addition, a senior TSA official said that the agency needed to do more basic research. In light of this information from TSA, we did not change our recommendation.

- *Recommendation: TSA and DHS should (1) complete strategic plans containing measurable objectives for TSA's and DHS's transportation security R&D programs and (2) complete risk assessments for all modes of transportation, and use the results of the risk assessments to help select and prioritize R&D projects.* DHS said that in 2004, it finalized its strategic plan, which defined missions and goals for all of the agencies under it, including TSA. DHS also said that the strategic plan being developed by TSA's Office of Security Technology would include measurable goals and milestones for R&D projects. However, DHS's strategic plan does not specifically address transportation security R&D and neither TSA nor DHS has completed an R&D strategic plan containing measurable objectives. Therefore, we did not revise this recommendation.

- *Recommendation: TSA and DHS should develop a database that will provide accurate, complete, current, and readily accessible project information for monitoring and managing their R&D portfolios.* DHS said that TSA had developed a system to track R&D projects' goals and milestones, acquisition, funding, testing, and deployment information. While such a project tracking system could address our recommendation, TSA struggled as recently as of August 2004 to provide us with basic information on many of its R&D projects and, in the end, was unable to do so for a significant number. Therefore, we retained this recommendation.

- *Recommendation: TSA should develop a process with DOT to coordinate transportation security R&D, such as a memorandum of agreement identifying roles and responsibilities, and share this information with transportation stakeholders.* DHS said that TSA is already working with DOT to avoid duplicative R&D efforts. In addition, DHS said that TSA would assess the benefits associated with a memorandum of agreement with DOT to determine whether one should be initiated. We continue to believe that a memorandum of agreement between TSA and DHS is the proper vehicle for coordinating R&D—not only to avoid duplication, but also to leverage resources and identify unmet needs. Furthermore, DOT concurred with our finding that there is room for significant improvement in coordination between DOT and TSA and between DOT and DHS. DOT also agreed with our recommendation that a memorandum of agreement with DHS is the appropriate vehicle for improving the coordination of transportation security R&D.

- *Recommendation: TSA and DHS should develop a vehicle to communicate with the transportation industry to ensure that their R&D needs have been identified and considered.* DHS said that TSA does and will continue to communicate with the transportation industry. Although DHS noted some actions that TSA is taking to reach out to the transportation industry, as we reported, most transportation industry officials we interviewed said that TSA and DHS had not reached out to them to obtain information about their transportation security R&D needs. Therefore, we did not change this recommendation.

Finally, DHS commented on the draft report's conclusion that Congress has no reasonable assurance that the hundreds of millions of dollars that are being invested in transportation security R&D are being invested cost-effectively to address the highest priority transportation risks. According to

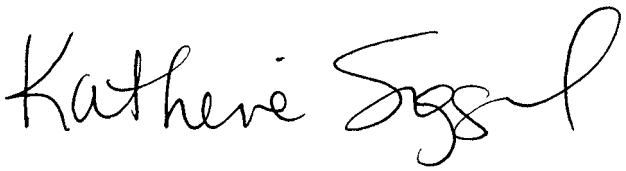
DHS, this conclusion is contradicted by evidence contained in our report, namely, that the report underscores the difficulties of integrating multiple new agencies missions, resources, and approaches. However, we believe that the report's evidence of incomplete strategic planning and risk assessment, inadequate information management, and insufficient coordination supports the conclusion. Given that DHS generally concurred with all of the recommendations, which address these issues, and said they were key to a successful R&D program, we believe that implementing them will strengthen TSA's and DHS's ability to provide Congress with reasonable assurance that the hundreds of millions of dollars that are being invested in transportation security R&D are being invested cost-effectively to address the highest priority transportation security risks.

In its comments on the draft report, DOT said that its efforts to coordinate research planning with DHS and TSA support our finding that there is room for significant improvement. According to DOT, it offers substantial transportation expertise that could provide critical input for identifying and prioritizing the transportation security R&D agenda. DOT also said that it is anxious to work with DHS and TSA to create a mutually beneficial working environment that taps its transportation experience and expertise while the department benefits from DHS's security expertise. DOT believes that through effective interagency coordination, it could work with DHS and TSA to ensure that important research needs are met in areas such as critical transportation infrastructure protection, as well as in responding to, and recovering from, a terrorist attack on the transportation system. Finally, DOT said that coordinating R&D activities represents an area that could benefit by being included in an annex to an overall memorandum of agreement between DOT and DHS such as we recommended. DOT said it fully supports the completion of a comprehensive memorandum of agreement with DHS and is working to bring one to fruition.

As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 20 days after the date of this letter. At that time, we will send copies of this report to interested congressional committees and to the Secretary of Homeland Security, the Secretary of Transportation, the Secretary of Energy, the Secretary of Defense, the Assistant Secretary of Homeland Security for the Transportation Security Administration, and the Administrator of the National Aeronautics and Space Administration. We will make copies

available to others upon request. In addition, this report will be available at no charge on our Web site at http://www.gao.gov.

Key contributors to this report are listed in appendix V. If you have any questions about this report, please contact me on (202) 512-2834 or at siggerudk@gao.gov.



Katherine Siggerud
Director, Physical Infrastructure Issues

List of Congressional Addressees

The Honorable John L. Mica
Chairman, Subcommittee on Aviation
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Sherwood L. Boehlert
Chairman, Committee on Science
House of Representatives

The Honorable Harold Rogers
Chairman, Subcommittee on Homeland Security
Committee on Appropriations
House of Representatives

The Honorable Joseph I. Lieberman
Ranking Minority Member, Committee on Governmental Affairs
United States Senate

The Honorable Ernest F. Hollings
Ranking Minority Member, Committee on Commerce,
Science, and Transportation
United States Senate

Objectives, Scope, and Methodology

The objectives of this report were to review (1) the transportation security research and development (R&D) projects that the Transportation Security Administration (TSA), the Department of Homeland Security (DHS), and other agencies funded in fiscal year 2003 and have budgeted for in fiscal year 2004; the status of these projects; and the reasonableness of the distribution of these projects by mode and (2) the extent to which TSA and DHS are managing their transportation security R&D programs according to applicable laws and best practices recommended by the National Academy of Sciences and the National Research Council.

To complete our first objective, we obtained and analyzed information from TSA, DHS, and the Department of Transportation (DOT) on the transportation security R&D projects that they were funding and are planning to fund. Within DHS, in addition to TSA and the Science and Technology Directorate, we collected this information from the U.S. Coast Guard, the U.S. Customs and Border Protection agency, and the U.S. Secret Service, which DHS officials identified as also conducting transportation security R&D. Information on the transportation security R&D projects that TSA and DHS plan to fund in fiscal year 2005 was not yet available. Because we found during our review that DOT was continuing to conduct some transportation security R&D, we obtained and analyzed information on the transportation security R&D projects that it was funding in fiscal years 2003 and 2004. At DOT, we obtained this information from the Federal Railroad Administration, the Federal Transit Administration, the Federal Highway Administration, the Federal Motor Carriers Safety Administration, the Office of Pipeline Safety, and the Research and Special Projects Administration. Regarding their transportation security R&D projects, we asked these agencies to provide project descriptions and information on who was performing the research (such as private contractors or national laboratories); their phase of research; anticipated dates of completion, initial deployment, and deployment; and funding data for fiscal years 2003 and 2004. We then aggregated these data to determine the focus of TSA's and DHS's transportation security projects in terms of the modes of transportation and program areas. On the basis of interviews with TSA, DHS, DOT, and National Aeronautics and Space Administration (NASA) officials regarding how their agencies ensure that these data are complete and accurate, we determined that these data were sufficiently reliable for purposes of this report. To gain a better understanding of the types of technologies involved in transportation security, we reviewed reports prepared by GAO, the DOT Inspector General, the Homeland Security Research Corporation (a private research organization), and others and attended conferences where transportation security R&D-

related technologies were discussed. To help evaluate the reasonableness of the R&D projects that TSA, DHS, and DOT have funded in terms of the modes of transportation and program areas addressed, we convened a meeting of transportation security and technology experts. At our request, the National Research Council selected the experts, who were affiliated with state transportation departments, universities, national laboratories, private industry, and other organizations and were knowledgeable about transportation security technologies.

To complete our second objective, we first identified and reviewed the laws relevant to the management of TSA's and DHS's R&D programs, including the Aviation and Transportation Security Act, the Homeland Security Act, and the Government Performance and Results Act. We also identified and reviewed best practices applicable to R&D programs identified by leading research organizations, such as the National Research Council and the National Academy of Sciences. In addition, we interviewed TSA and DHS officials about their strategic planning, coordination, and R&D acceleration efforts. We also reviewed GAO reports on TSA's strategic planning, on DHS's interaction with the Department of Energy (DOE) National Laboratories, on risk management principles, on implementing the Government Performance and Results Act, and on transportation security challenges and a DHS Inspector General report on the Science and Technology Directorate's operations. We then compared these laws and best practices with TSA's and DHS's management of their R&D programs. To determine the extent to which TSA and DHS were coordinating with each other and other federal agencies, we interviewed officials at TSA, DHS, DOT, NASA, the Technical Support Working Group, five DOE national laboratories that were conducting transportation security R&D for TSA or DHS, and three universities that were conducting R&D for TSA. We visited the national laboratories in Oak Ridge, Tennessee, and Los Alamos, New Mexico, because the Oak Ridge National Laboratory was conducting more transportation security R&D projects for TSA, and the Los Alamos National Laboratory was conducting more transportation security projects for DHS, compared with the other national laboratories. To determine the extent to which TSA and DHS had outreached to the transportation industry and potential technology providers, we interviewed officials from transportation industry associations and attended DHS industry workshops. In addition, we interviewed a number of members of the Homeland Security Industries Association, an organization of homeland security technology vendors, to obtain their views on TSA's and DHS's technology solicitation processes and outreach efforts. The association identified the members who chose to discuss their views with us. At our

request, the transportation security and technology experts also provided comments on TSA's and DHS's management of their R&D programs.

We conducted our review in Washington, D.C.; Arlington, Virginia; Atlantic City, New Jersey; Oak Ridge, Tennessee; and Los Alamos, New Mexico, from July 2003 through September 2004 in accordance with generally accepted government auditing standards.

Industry Is Independently Developing New and Emerging Transportation Security Technologies

According to a TSA official, private industry and universities are researching and developing several new and emerging technologies that are applicable to transportation security, in some cases without any funding from TSA or DHS. The official said that TSA has focused most of its R&D on making improvements to deployed technologies and testing and evaluating near-term technologies. However, the official stated that TSA needs to start devoting more funding to researching and developing long-term, high-risk, but potentially high-payoff technologies. Examples of new and emerging technologies include the following:

- Terahertz imaging uses terahertz radiation[1] to create images of concealed objects or to reveal their chemical composition. The rays can be directed at a person or an object from a source, with reflected rays captured by a detection device. The Homeland Security Research Corporation (a private research organization) reports that terahertz imaging will be an excellent tool for screening baggage. Terahertz imaging has been used in the laboratory to detect explosives on people through several layers of clothing. TSA is considering funding the development of this technology for detecting explosives in containerized air cargo.

- Nuclear resonance fluorescence imaging uses a high-intensity light source to identify the atomic composition of a target object. Nuclear resonance fluorescence imaging has the potential to detect explosives and nuclear materials in baggage, trucks, and cargo containers. According to a TSA official, TSA may fund R&D on this technology in the future.

- Microsensors are miniature devices that convert information about the environment into an electrical form that can be read by instruments. There are many types of microsensors, some of which have the potential to detect explosives. In fiscal year 2003, TSA funded R&D at two national laboratories and NASA on several different types of microsensors. A TSA official said that several universities are currently doing work on other types of microsensors that have potential to meet TSA's needs, but that TSA did not fund any of this work in 2004.

[1]Terahertz radiation is the part of the electromagnetic spectrum between microwave radiation and infrared radiation. With wavelengths of between 30 micrometers and 1 millimeter, it is non-ionizing and harmless to living tissue.

- Automated detection algorithms are computer software that processes data obtained by detection systems and automatically indicates the presence of an explosive or weapon. Although TSA has funded the development of such software for its currently deployed computed tomography explosives detection systems, it has not yet funded the development of such software to process images produced by emerging detection technologies, such as X-ray backscatter and millimeter wave.[2] A TSA official believes that incorporating automated detection algorithms could substantially reduce the operational cost of future detection systems by reducing the need for screeners. According to this official, TSA may fund the development of these algorithms in the future.

- Raman spectroscopy uses laser light to determine the chemical composition of an object and can be used to screen passengers, carry-on and checked baggage, cargo, and boarding passes for explosives.

- Nuclear magnetic resonance directs radio waves at an object that has been placed in a magnetic field to determine the presence of explosives. Nuclear magnetic resonance can be used to screen liquids in containers in carry-on and checked baggage for explosives.

[2]Backscatter X-ray detects reflected X-ray energy, providing an image that highlights organic materials, such as explosives. Millimeter wave energy analysis provides a 360-degree image of a person or object in order to detect weapons and explosives.

GAO's Panel of Transportation Security and Technology Experts

Name	Affiliation	Expertise
Norm Abramson - Chair	Southwest Research Institute	Research policy
David Albright	New Mexico Department of Transportation	Surface transportation
Cheryl Bitner	AAI Corporation	Human factors, passenger screening technologies
Joedy Cambridge	National Research Council, Transportation Research Board	Transportation policy
Robert Gallamore	Northwestern University	Railroads, cybersecurity
Patrick Griffin	Sandia National Laboratories	Transportation security technologies, neutron spectroscopy
Yacov Haimes	University of Virginia	Risk analysis
Daniel Hall	Washington Metropolitan Area Transit Authority	Mass transit
Douglas Harris	Anacapa Sciences	Human factors
William Harris	Consultant	Commissioner - President's Council on Critical Infrastructure Protection
Thomas Hartwick	Consultant	Transportation security technologies
Sandra Hyland	Tokyo Electron Massachusetts	Transportation security technologies
James Killian	National Research Council, National Materials Advisory Board	Transportation security
Eva Lerner-Lam	Palisades Consulting Group	Maritime/Land security
Len Limmer	Consultant	Airports, passenger screening technologies
Terry Lowe	Los Alamos National Laboratory	Organization
Toni Marechaux	National Research Council, National Materials Advisory Board	Transportation security technologies
Harry Martz	Lawrence Livermore National Laboratory	X-ray technologies, nondestructive evaluation
Emily Ann Meyer	National Research Council, National Materials Advisory Board	Technology policy
Dan Murray	American Transportation Research Institute	Trucking and freight transportation security and technologies
Daniel O'Neil	CRADA International	Chair, Transportation Research Board Committee on Critical Transportation Infrastructure Protection
Clint Oster	Indiana University, School of Public & Environmental Affairs	Cargo/Baggage Screening, Aviation, Transportation Infrastructure
Joseph Schofer	Northwestern University	Incident response and management on transportation networks
Eric Schwartz	The Boeing Company	Aviation and aircraft technology
Edmund Soliday	Consultant	Airlines, passenger screening technologies

(Continued From Previous Page)

Name	Affiliation	Expertise
Mike Story	Consultant	Mass spectrometry, passenger screening technologies
Joyce Wenger	Science Applications International Corporation	Freight, intelligent transportation, traffic modeling
Jeffery Western	Wisconsin Department of Transportation	Surface Transportation - Highways

Source: National Research Council.

Note: These experts either attended the March 2, 2004, meeting or provided written comments after reviewing information that we provided to them.

Comments from the Department of Homeland Security

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

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

Homeland Security

September 10, 2004

Ms. Katherine Siggerud
Director, Physical Infrastructure
U.S. Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548

Re: GAO-04-890, Transportation Security R&D: TSA and DHS Are Researching and Developing Technologies, but Need to Improve R&D Management, September 2004, GAO Case 540068

Dear Ms. Siggerud:

Thank you for the opportunity to comment on the draft report referenced above. The Department of Homeland Security (DHS) appreciates the work done in this report to identify areas where transportation security R&D management can be improved. DHS believes that GAO's identification of areas for improvements will contribute to the efficiency and effectiveness of R&D management at TSA and throughout the DHS. We generally concur with the report and its recommendations and appreciate the discussion of challenges and next steps this report contains. However, there are areas within the report about which we would like to comment.

DHS believes that the report does not provide sufficient recognition of recent changes that have taken place, particularly at TSA. In March of 2003, the TSA took over the operational management of the R&D program previously operated by the Federal Aviation Administration (FAA). Since that transition, TSA has made great strides in defining R&D projects and linking them to mission needs and identified gaps. While we recognize that there is a great deal of work ahead, it is important to bear in mind that designing a program that will support the many needs of DHS and TSA cannot happen in a haphazard manner and must be built over time. While immediate needs were associated with the aviation sector, since 2003, TSA's R&D and operational testing and evaluation programs have expanded to include the other transportation modes, recognizing that the role of TSA is much different for those modes than it is for aviation.

Comments on GAO Recommendations

GAO made the following five recommendations regarding Transportation Security R&D:

1. Ensure that their transportation security R&D portfolios include all phases of R&D including some basic research;

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2. Complete (1) strategic plans containing measurable objectives for TSA's and DHS's transportation security R&D programs and (2) risk assessments-threat, vulnerability and criticality-for all modes of transportation and that they use the results of the risk assessments to help select and prioritize R&D priorities;
3. Develop a database/management information system that will provide accurate, complete, current, and readily accessible project information for monitoring and managing their R&D portfolios;
4. Develop a process with DOT to coordinate transportation security R&D, such as memorandums of understanding identifying roles and responsibilities with transportation stakeholders; and
5. Develop a vehicle to communicate with the transportation industry to ensure that its R&D security needs have been identified and considered.

We agree that these recommendations are key to a successful R&D program. Since its inception, TSA has been conducting R&D using these processes and philosophies and continues to improve on them as TSA and DHS mature.

1. TSA's Transportation Security Laboratory (TSL) currently conducts basic research and has done so over the years it was operating under the Department of Transportation (DOT) umbrella. A number of our projects under the Human Factors Program are basic research and the results apply to several of our transportation security programs. Additionally, the TSL issues numerous grants per year that support basic research. We also recognize we need to expand basic research to include technology, and have done so in our Next Generation EDS Manhattan II project, and our air cargo security R&D.

2. In 2004, DHS finalized their strategic plan. The plan defined the missions and goals for all of the agencies under DHS to include the TSA. Based on the DHS strategic plan, TSA is currently finalizing its strategic plan, and TSA's Office of Security Technology (OST) specifically is developing its strategic plan that outlines measurable objectives. The OST plan will include measurable goals and milestones regarding R&D projects.

3. The TSA OST developed a Project Tracking System built specifically to track R&D projects goals and milestones, acquisition, funding, testing, and deployment information. This system will allow TSA to more accurately track R&D initiatives. To establish the overall framework for OST technology programs and to set the stage for the implementation of the processes and mechanisms described above, higher-level management documents are developed. The highest-level OST technical document is this Technology Master Plan. At the next level, Product Area Master Plans are developed to provide a framework for all of the programs within a product area. Each Product Area Master Plan outlines the scope of the product area, summarizes the programs defined under the product area, presents high-level schedules for the programs and provides high-level budgetary information for the programs.

4. TSA works with the DOT to ensure there are no duplicative R&D efforts. TSA will assess the benefits associated with an MOU with DOT to determine if in fact one should be initiated.

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5. TSA does and will continue to communicate with the transportation industry. In addition to the Aviation Security Advisory Committee discussed by the GAO, TSA also works directly with industry stakeholders on specific R&D efforts. The TSA OST is also a presenter and participant in the weekly Intermodal Conference Call held by the TSA's Assistant Secretary to provide an update on technology, and solicit input from industry. This call typically attracts Federal Railroad Administration, Federal Transit Administration, DOT, and multiple industry leaders ranging from the National Association for School Buses, to AMTRAK, to the American Trucking Association.

General Comments on the GAO Report

- The GAO commented that TSA used a majority of its R&D funding on aviation security versus other modes of transportation. While aviation security is currently the primary focus of TSA's R&D projects, many aviation projects provide data that is useful for other transportation security programs. Much of what is learned from these projects is easily adapted for other modes of transportation. For example, funding was categorized as aviation security for explosive trace portals and these portals were recently used in a rail security initiative.

See comment 1.

- GAO outlined three projects that panelists from their transportation and security panel suggested be considered for future funding.

  - The first recommendation is for a project that combines neutron inspection technology with traditional transmission x-ray and backscatter x-ray technologies to enhance air cargo security. The TSA is already looking at pulsed fast neutron analysis (PFNA), which is a technology that utilizes x-ray images in conjunction with neutrons interrogation and substance identification. TSA has already spent close to $3 million supporting this technology, and is currently working with U.S. Customs and Border Patrol and the Department of Defense to demonstrate the utility of this technology.

See comment 2.

  - The second recommendation was for a multifunctional portal that tests for metal, explosives, narcotics, and chemicals in near real-time. The TSA agrees with this recommendation. Pursuing technology fusion is critical, and this has certainly been an R&D goal for security transportation for some time. TSA has prototypes from two different vendors, with whom TSA is working to integrate automated metal/explosives detection portals. These next generation portals will demonstrate true integration. At this point in their R&D program, TSA is in the process of identifying and addressing the strengths and weaknesses of subcomponent technology before trying to integrate two systems into one. TSA is examining quadruple resonance, x-ray backscatter, and millimeter wave technology as sub-elements to metal and trace explosives detection portals now commercially available.

See comment 2.

  - Lastly, the panelists recommended the development of a standard piece of luggage for testing deployed explosives detection systems (EDS) to ensure that

See comment 2.

they maintain acceptable performance capabilities. TSA does implement a system validation process for all technology it deploys, including EDS.

See comment 3.

- We believe that the report should indicate that TSA does have two overview committees, the National Academy of Sciences and the Security Advisory Panel, that contain experts from elements of transportation.

- GAO reported that one of their security expert panelists did not agree with funding a $30,000 project to test a prototype of a new, hand-held ion mobility spectrometry explosives trace detector because, according to the panelist, at least two very good ion mobility spectrometry hand-held units can be purchased off the shelf. The reason TSA funded this project was that the vendor demonstrated a novel vortex sampler that showed promise as an advanced sample collector. TSA is actively seeking automated trace sampling technology that can be used with any detection platform. In this instance the detector happened to be an ion mobility spectrometer, but the focus of this R&D effort was to demonstrate a device that could find explosives residues in an automated fashion.

See comment 4.

- The report states that TSA has focused its R&D efforts on near-term development, however, during FY 2004 TSA embarked on several long-term research projects. Specifically, TSA will go to award on some proposals received for the Manhattan II project. Manhattan II is designed to explore next-generation technology to create revolutionary approaches to screening checked baggage. TSA expects to award Phase I feasibility studies in September to a number of bidders who submitted proposals under a Broad Agency Announcement (BAA) for next generation technology. Additionally, the TSA will go to award under some proposals for development of air cargo screening technologies. Although to date, still in the procurement-sensitive stage, the TSA is exploring a number of approaches with varying levels of technical risk but potential high payoff.

- The report states that "Strategic Plans for TSA's and DHS's R&D Programs do not yet contain measurable objectives." TSA has adopted a strategic planning process that allows it to sharpen its organizational and operational focus, providing the basis for establishing and maintaining a performance-driven organization. The process begins with the formulation of a strategic mission, vision, and values. After assessing the internal and external environment, strategic goals, objectives, and activities are formulated and written in a Strategic Plan to help guide TSA's efforts in achieving its mission and values. The general goals and objectives in the Strategic Plan are linked to the annual performance goals in the budget.

See comment 5.

A critical component of the TSA planning process is the monitoring and reporting of progress in achieving strategic goals. TSA has established performance measures that link directly to the goals and objectives in the Strategic Plan. Currently, these measures are not included in the strategic plan. However, TSA has developed performance monitoring and reporting systems that collect performance measures and other data continuously and report periodically. Progress on achieving performance targets are reported periodically to DHS, external policy makers, and the public.

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Results are used to evaluate programs and to determine if any corrective actions need to be taken.

- The report states that Congress has no reasonable assurances that the hundreds of millions of dollars that are being invested in transportation security R&D are being spent as cost-effectively as possible to address the highest-priority transportation security risks. This reference contradicts this two-year study by GAO on this very issue, as described in the report. Taken in total, this report does not paint a picture of irresponsibility; rather, we believe it paints a picture of the difficulties of integrating multiple new agencies' missions, resources, and approaches. TSA has established databases that are used to track individual projects, critical milestones, and funding spent. Additionally, as mentioned in the response to recommendation 3, TSA OST has adopted a Project Tracking System built specifically to track R&D projects, goals, milestones, acquisitions, funding, testing, and deployment information. This is a web-based system, which can be accessed by both the Tech Lab in Atlantic City and TSA headquarters in Arlington, VA.

See comment 6.

- GAO reported that several private companies commented that they had experienced difficulty in navigating TSA's website regarding communicating innovative technology ideas. TSA recently established a working group tasked to update and improve the current website regarding Technology Ideas, Products, and Services to make it more user-friendly and provide more information to users. The improvements will be implemented early next year.

We appreciate your review of transportation security R&D management at DHS and thank you for the thorough analysis and discussion that comprises this report. We will continue to reevaluate our R&D processes in light of the findings and recommendations of this report.

Thank you for the opportunity to contribute comments to the draft report.

Sincerely,

Michael C. McPoland

for Anna F. Dixon
Director, GAO/OIG Liaison

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The following are GAO's comments on the Department of Homeland Security's letter dated August 31, 2004.

GAO Comments

1. We agree with DHS that aviation security is currently the primary focus of TSA's R&D projects, and that many aviation projects provide data that are useful for other transportation security programs. Because these topics were discussed in the draft report, we made no change.

2. DHS provided comments on three projects that members of our panel of transportation security experts suggested should be considered for future funding. We added this information to the report.

3. DHS said that the report should indicate that TSA has two advisory committees—the National Academy of Sciences and the Security Advisory Panel—that contain experts from various modes of transportation. We added this information to the report.

4. DHS commented on a project that one of our panelist believed should not be funded (a $30,000 project to test a prototype of a new, handheld ion mobility spectrometry explosives trace detector) because it could be purchased off the shelf. According to DHS, TSA funded this project because the vendor demonstrated a promising technology. We added this comment to our report.

5. We continue to believe that DHS's and TSA's R&D strategic plans should contain measurable objectives. Similarly, the National Academy of Science indicated that research programs should be described in strategic and performance plans. Therefore, we made no changes to the report in response to this comment.

6. DHS noted that TSA recently established a working group to update and improve the current Web site that addresses technology ideas, products, and services to make it more user-friendly. TSA plans to implement the improvements early next year. We added this information to the report.

GAO Contacts and Staff Acknowledgments

GAO Contacts

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