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# Detection of Explosives on Airline Passengers: Recommendation of the 9/11 Commission and Related Issues

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## Summary

The National Commission on Terrorist Attacks Upon the United States, known as the 9/11 Commission, recommended that Congress and the Transportation Security Administration give priority attention to screening airline passengers for explosives. The key issue for Congress is balancing the costs of mandating passenger explosives detection against other aviation security needs. Passenger explosives screening technologies have been under development for several years and are now being deployed in selected airports. Their technical capabilities are not fully established, and operational and policy issues have not yet been resolved. Critical factors for implementation in airports include reliability, passenger throughput, and passenger privacy concerns. Presuming the successful development and deployment of this technology, certification standards, operational policy, and screening procedures for federal use will need to be established. This topic continues to be of congressional interest, particularly as the 110th Congress reexamines implementation of the 9/11 Commission's recommendations via H.R. 1 and S. 4.

## Introduction

In its discussion of strategies for aviation security, the 9/11 Commission recommended that:

> The TSA [Transportation Security Administration] and the Congress must give priority attention to improving the ability of screening checkpoints to detect explosives on passengers. As a start, each individual selected for special screening should be screened for explosives.[1]

[1] *Final Report of the National Commission on Terrorist Attacks Upon the United States*, July 2004, p. 393.

The Intelligence Reform and Terrorism Prevention Act of 2004 (P.L. 108-458) directed the Department of Homeland Security (DHS) to place high priority on developing and deploying equipment for passenger explosives screening; required TSA, part of DHS, to submit a strategic plan for deploying such equipment; and authorized additional research funding. It also required that passengers who are selected for additional screening be screened for explosives, as an interim measure until all passengers can be screened for explosives. Congressional interest in this topic continues, particularly as the 110th Congress reexamines implementation of the 9/11 Commission's recommendations. The Implementing the 9/11 Commission Recommendations Act of 2007 (H.R. 1) would require TSA to issue the strategic plan called for by P.L. 108-458 within seven days of passage and would establish a Checkpoint Screening Security Fund, paid for with fees on airline passengers, to develop and deploy equipment for explosives detection at screening checkpoints. The Improving America's Security Act of 2007 (S. 4) would require DHS to issue the same strategic plan within 90 days of passage and begin its implementation within one year of passage. The U.S. Troop Readiness, Veterans' Health, and Iraq Accountability Act, 2007 (H.R. 1591, the FY2007 supplemental appropriations bill) would provide an additional $45 million for expansion of checkpoint explosives detection pilot systems. This report discusses the current state of passenger explosives trace detection and related policy issues.

## Current State of Passenger Explosives Trace Detection

Explosives detection for aviation security has been an area of federal concern for many years. Much effort has been focused on direct detection of explosive materials in carry-on and checked luggage, but techniques have also been developed to detect and identify residual traces that may indicate a passenger's recent contact with explosive materials. These techniques use separation and detection technologies, such as mass spectrometry, gas chromatography, chemical luminescence, or ion mobility spectrometry, to measure the chemical properties of vapor or particulate matter collected from passengers or their carry-on luggage. Several technologies have been developed and deployed on a test or pilot basis. Parallel efforts in explosives vapor detection have employed specially trained animals, usually dogs.

The effectiveness of chemical trace analysis is highly dependent on three distinct steps: (1) sample collection, (2) sample analysis, and (3) comparison of results with known standards.[2] If any of these steps is suboptimal, the test may fail to detect explosives that are present. When trace analysis is used for passenger screening, additional goals may include nonintrusive or minimally intrusive sample collection, fast sample analysis and identification, and low cost. While no universal solution has yet been achieved, ion mobility spectrometry is most often used in currently deployed equipment.

In 2004, TSA began pilot projects to deploy portal trace detection equipment for operational testing and evaluation. In the portal approach, passengers pass through a device like a large doorframe that can collect, analyze, and identify explosive residues on the person's body or clothing. The portal may rely on the passenger's own body heat to

[2] National Research Council, *Configuration Management and Performance Verification of Explosives-Detection Systems*, 1998.

volatilize traces of explosive material for detection as a vapor, or it may use puffs of air that can dislodge small particles as an aerosol. Portal deployment is ongoing.[3]

One alternative to portals is to collect the chemical sample using a handheld vacuum "wand". Another is to test an object handled by the passenger, such as a boarding pass, for residues transferred from the passenger's hands. In this case, the secondary object is used as the carrier between the passenger and the analyzing equipment.[4]

The olfactory ability of dogs is sensitive enough to detect trace amounts of many compounds, but several factors have inhibited the regular use of canines for passenger screening. Dogs trained in explosives detection can generally only work for brief periods, have significant upkeep costs, are unable to communicate the identity of the detected explosives residue, and require a human handler when performing their detection role.[5] In addition, direct contact between dogs and airline passengers raises liability concerns.

**Detection of Bulk Explosives.** Direct detection of explosives concealed on passengers in bulk quantities has been another area of federal interest. Technology development efforts in this area include portal systems based on techniques such as x-ray backscatter imaging, millimeter wave energy analysis, and terahertz imaging.[6] As such systems detect only bulk quantities of explosives, they would not raise "nuisance alarms" on passengers who have recently handled explosives for innocuous reasons. Some versions could simultaneously detect other threats, such as nonmetallic weapons. On the other hand, trace detection techniques are also likely to detect bulk quantities of explosives and may alert screening personnel to security concerns about a passenger who has had contact with explosives but is not actually carrying an explosive device when screened. Current deployments for passenger screening are focused on trace detection, and the remainder of this report does not discuss bulk detection. However, many of the policy issues discussed below would apply similarly to bulk detection equipment.

## Policy Issues

Any strategy for deploying and operating passenger explosives detection portals must consider a number of challenges. Organizational challenges include deciding where and how detectors are used, projecting costs, and developing technical and regulatory standards. Operational challenges include maximizing passenger throughput, responding to erroneous and innocuous detections, ensuring passenger acceptance of new procedures,

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[3] As of August 2006, TSA had reportedly deployed 93 detection portals in 36 airports. Jon Hilkevitch, "Midway Gets an Extra Blast of Security," *Chicago Tribune*, August 7, 2006.

[4] The TSA has implemented pilot projects for operational testing and evaluation of document scanners that detect traces of explosives on boarding passes. Asa Hutchinson, Under Secretary for Border and Transportation Security, Department of Homeland Security, testimony before the Senate Committee on Commerce, Science, and Transportation, August 16, 2004.

[5] National Institute of Justice, *Guide for the Selection of Commercial Explosives Detection Systems for Law Enforcement Applications*, NIJ Guide 100-99, September, 1999, p. 36.

[6] In December 2006, TSA began a pilot project to test x-ray backscatter imaging in airports. Matthew M. Johnson, "TSA to Begin 'See-Through' Scanning Technology Pilot Program at Phoenix Airport," *CQ Homeland Security*, December 5, 2006.

minimizing the potential for intentional disruption of the screening process, and providing for research and development into future generations of detection equipment, including techniques for detecting novel explosives. For security reasons, many technical details of equipment performance are not publicly available, which makes independent analysis of technical performance challenging.

**Equipment Location and Use.** An important component of a deployment strategy is identifying where and how passenger explosives detection equipment will be used. Portals could be deployed widely, so that all locations benefit from them, or they could be used only at selected locations, where they can most effectively address and mitigate risk. In any given location, portals could be used as a primary screening technology for all passengers, or as a secondary screening technology for selected passengers only. Widespread deployment and use for primary screening might provide more uniform risk reduction, but would require many more portals and thus increase costs.

**Cost of Operation.** The total cost of deploying explosives detection equipment for passenger screening is unknown. According to TSA, the portal systems currently being deployed in U.S. airports cost more than $160,000 each.[7] Document scanning systems are somewhat less expensive; according to a 2002 GAO study, similar tabletop systems used for screening carry-on baggage can cost from $20,000 to $65,000.[8] It is possible that technology improvements or bulk purchasing could lower costs. The number of devices required would depend on throughput rates, device reliability and lifetime, and deployment strategy. The United States has more than 400 commercial passenger airports; if equally distributed, several thousand devices might be required, corresponding to a total capital cost for equipment of up to hundreds of millions of dollars. Installation and maintenance costs would be additional. Operating the equipment would require additional screening procedures and might lead to costs for additional screening personnel, or else create indirect costs by increasing passenger wait times. It is unknown whether the personnel limit for TSA screeners, currently set at 45,000 full time equivalent screeners nationwide (P.L. 108-90), could accommodate the potential additional staffing requirements.

**Standards, Certification, Regulation, and the Establishment of Screening Procedures.** Standards for the performance of passenger explosives trace detection equipment, procedures for evaluation and certification of the equipment, and regulations for its use are all yet to be established. Regulations and screening procedures have been established for explosives trace detection on luggage.[9] Detection on passengers is a more complicated venture, involving possible privacy concerns, greater difficulty in sampling, and potentially different sensitivity requirements. Nevertheless, the current luggage regulations could be a model for future certification criteria for passenger screening. Procedures will also need to be established for the use of the equipment, such

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[7] Transportation Security Administration press release, "Trace Portal Machines Deployed to Pittsburgh Airport," October 13, 2005.

[8] General Accounting Office, *National Preparedness: Technologies to Secure Federal Buildings*, GAO-02-687T, April 25, 2002.

[9] 67 *Fed. Reg.* 48506-48509.

as how an operator should resolve detector alarms to distinguish genuine security threats from false positives and innocuous true positives.

**Impact on Screening Time.** When multiplied by the large number of airline passengers each day, even small increases in screening times may be logistically prohibitive. The TSA goal for passenger wait time at airports is less than 10 minutes, and screening systems reportedly operate at a rate between 7 to 10 passengers per minute;[10] additional screening that slows passenger throughput and increases passenger wait time may add to airport congestion and have a detrimental economic impact. A 1996 GAO study stated that throughput goals for portal technologies at that time were equivalent to 6 passengers per minute.[11] According to the same study, non-portal technologies, such as secondary object analysis, had slightly higher throughput goals.

The TSA's pilot deployment of passenger explosives trace detection equipment will likely provide useful information on passenger throughput. If no appreciable increase in screening times occurs, then passenger explosives screening may involve few additional direct economic costs beyond those of procuring, deploying, operating, and maintaining the equipment. If passenger throughput is drastically decreased, then alternatives for passenger screening may need to be considered. In between these extremes, it may be possible to moderate the economic impact by adding screening lanes or by using explosives detection equipment only on those passengers who are selected for secondary screening, as recommended by the 9/11 Commission as a possible initial step.

**Erroneous and Innocuous Detection.** A potential complication of explosives trace detection is the accuracy of detector performance. False positives, false negatives, and innocuous true positives are all challenges. If the detection system often detects the presence of an explosive when there actually is none (a false positive) then there will be a high burden in verifying results through additional procedures. Because of the large volume of air passengers, even small false positive rates may be unacceptable. Conversely, if the system fails to detect the presence of an explosive (a false negative) then the potential consequences may be serious. Assuming the system has adequate sensitivity to detect explosives traces in an operational environment, the detection threshold or criteria required for an alarm can generally be adjusted, enabling a tradeoff between false positives and false negatives, but neither can be eliminated entirely; the appropriate balance may be a matter of debate.

Innocuous true positives occur when a passenger has been in contact with explosives, but for legitimate reasons. Examples include individuals who take nitroglycerin for medical purposes or individuals in the mining or construction industry who use explosives in their work. Such passengers would be regularly subject to additional security scrutiny. Similar issues arise from the current use of trace detection equipment on some airline passenger carry-on baggage, and innocuous true positives in such cases are generally handled without incident. The impact of innocuous true positives will likely depend on their frequency and on the proportion of passengers subject to explosives trace detection.

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[10] General Accounting Office, *National Preparedness: Technologies to Secure Federal Buildings*, GAO-02-687T, April 25, 2002.

[11] General Accounting Office, *Terrorism and Drug Trafficking: Technologies for Detecting Explosives and Narcotics*, GAO/NSIAD/RCED-96-252, September 1996.

**Passenger Acceptance.** Some passengers may have personal concerns about the addition of passenger explosives trace detection to the screening process. Issues of privacy may be raised by the connection between innocuous true positives and passenger medical status or field of employment. Also, equipment that uses a vacuum "wand" or puffs of air for sample collection may offend some passengers' sense of propriety or modesty. Passenger reluctance could then increase screening times. Allowing alternative forms of screening, such as within privacy enclosures or through different imaging technology, might mitigate passenger concerns in some cases.

**Potential for Intentional Disruption.** Another concern is the possibility that a passenger screening regimen that includes explosives trace detection could be exploited to intentionally disrupt the operation of an airport. The dissemination of trace quantities of an explosive material on commonly touched objects within the airport might lead to many positive detections on passengers. This would make trace detection less effective or ineffective for security screening, and might disrupt airport operations generally until alternative screening procedures, such as enhanced baggage screening by TSA personnel, could be put in place or the contamination source could be identified and eliminated.

**Research and Development.** The DHS and its predecessor agencies have historically been the main funders of research on explosives detection for airport use. (Most of this research has focused on detecting explosives in baggage rather than on passengers.) Several other federal agencies, however, also fund research related to trace explosives detection. These include the Departments of Energy and Justice, the National Institute for Standards and Technology, and the interagency Technical Support Working Group. Much of this research has been dedicated to overcoming technical challenges, such as increasing sensitivity and reducing the time required for sample analysis.

A different research challenge is the detection of novel explosives. Detectors are generally designed to look for specific explosives, both to limit the number of false or innocuous positives and to allow a determination of which explosive has been detected. As a result, novel explosives are unlikely to be detected until identifying characteristics and reference standards have been developed and incorporated into equipment designs. Unlike imaging techniques for detecting bulk quantities of explosives, trace analysis provides no opportunity for a human operator to identify a suspicious material based on experience or intuition.

Liquid explosives are a novel threat that has been of particular interest since August 2006, when British police disrupted a plot to bomb aircraft using liquids. The DHS is evaluating technologies to detect liquid explosives.[12] Its efforts are mainly focused on bulk detection, such as scanners to test the contents of bottles. Like solid explosives, however, liquids might be found through trace detection, if the trace detection system is designed to look for them.

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[12] Jay Cohen, Under Secretary for Science and Technology, Department of Homeland Security, testimony before the House Committee on Homeland Security, Subcommittee on Emergency Preparedness, Science, and Technology, September 7, 2006.