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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 various costs of mandating passenger explosives trace detection against other needs related to air travel security. Passenger explosives screening technologies have been under development for several years and are now being tested for suitability in airport operation. These systems' technical capabilities have not been fully established, and operational and policy issues have not yet been resolved. Critical factors for implementation in airport settings 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 report will be updated as events warrant.

Introduction

In its discussion of strategies for aviation and transportation security, the National Commission on Terrorist Attacks Upon the United States, commonly known as 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.

For several years, the TSA and other federal agencies have been concerned about detection of explosives on airline passengers. This report discusses the current state of passenger explosives trace detection, ongoing federal research and development efforts, pilot deployments of detection equipment, and related policy issues.

Current State of Trace Explosives Detection Technology

Explosives detection on commercial aircraft 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 trace detection 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 carried luggage. Parallel efforts in explosives vapor detection have focused on developing and using specially trained animals, usually dogs, as detectors.

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 are 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.

Several different technology approaches have been developed and deployed on a test or prototype basis. One approach has been to direct passengers through a portal, similar to a large doorframe, which contains detectors able to collect, analyze, and identify explosive residues that may be present on the person's body or clothing. The portal may rely on the passenger's own body heat to 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. Alternatively, a handheld vacuum "wand" may be used to collect a sample. In both cases, the collected samples are subsequently chemically analyzed. A different approach has been 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.

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 as passenger explosives trace detectors. Dogs trained in explosives detection generally can work for a short time period, have significant upkeep costs, cannot communicate the identity of the detected explosives residue, and require a human handler when performing their detection

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

role.³ 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. Federal and industry efforts in this area include the development of portal systems utilizing techniques such as x-ray backscatter imaging, millimeter wave energy analysis, or terahertz imaging. 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 would likely also 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 research efforts are focused on trace detection, and the 9/11 Commission recommendation is generally interpreted as referring to trace detection. The remainder of this report does not discuss bulk detection.

Federal R&D Activities and Deployed Equipment

Multiple federal agencies, including the TSA in the Department of Homeland Security, its predecessor organization formerly in the Federal Aviation Administration, the Department of Energy, the Department of Justice, the National Institute for Standards and Technology, and the interagency Technical Support Working Group, fund research related to trace explosives detection. Explosives trace detection portals have been considered as potential solutions to other homeland security needs, such as securing federal buildings and monuments. Much of this research has been dedicated to overcoming technical challenges such as increasing sensitivity and reducing the time required for sample analysis.

The TSA is the main funder of research on explosives detection for airport use. However, most of this research has focused on detecting explosives in baggage rather than testing passengers. Some of the underlying technology for passenger explosives trace detection was developed at Department of Energy national laboratories. Commercial equipment vendors using such technology under license have incorporated research performed at Los Alamos National Laboratory and Oak Ridge National Laboratory into equipment currently being evaluated by TSA for airport use.

TSA pilot projects have deployed portal equipment for operational testing and evaluation in airports in Warwick, RI; Rochester, NY; San Diego, CA; Tampa, FL; and Gulfport, MS;⁴ as well as a train station in New Carrollton, MD.⁵ TSA is also

³ 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.

⁴ Transportation Security Administration, “Five Airports to Serve as TSA Test Bed for Explosives Trace Detection Portals”, Press Release, June 17, 2004.

⁵ Transportation Security Administration, “TSA Launches New Passenger Rail Security Pilot Program,” Press Release, May 4, 2004.

implementing pilot projects for operational testing and evaluation of document scanners that detect traces of explosives on boarding passes.⁶

Policy Issues

Operational issues for trace detection include the impact of increased screening time, the consequences of erroneous and innocuous detections, the ability to detect novel explosives, and the potential for intentional disruption of the screening process. Future cost implications and needs for technical and regulatory standards are also of congressional interest. For security reasons, many technical details of equipment performance are not publicly available, which makes independent analysis of technical performance challenging.

Impact on Screening Time. When multiplied by the large number of airline passengers each day, even small increases in screening times may become 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;⁷ additional screening that slows passenger throughput and increases passenger wait time may add to airport congestion and have a detrimental economic impact. A 1996 General Accounting Office (GAO) study of explosives detection equipment for airline security states that throughput goals for portal technologies at that time were equivalent to 6 passengers per minute.⁸ 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 shed light on the question of passenger throughput. If no appreciable increase in screening times occurs, then passenger explosives screening would seemingly involve few additional direct economic costs beyond the costs 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

⁶ 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; "Knoxville Airport to Test Oak Ridge Explosives Sniffer," *USA Today*, July 21, 2004.

⁷ General Accounting Office, *National Preparedness: Technologies to Secure Federal Buildings*, GAO-02-687T, April 25, 2002 and John E. Parmeter, David W. Hannum, Kevin L. Linker, and Charles L. Rhykerd, Jr., *Overview of Explosives Detection Research and Development in Department 5848 at Sandia National Laboratories*, 16th Annual NDIA Security Technology Symposium & Exhibition, June 26-29, 2000.

⁸ General Accounting Office, *Terrorism and Drug Trafficking: Technologies for Detecting Explosives and Narcotics*, GAO/NSIAD/RCED-96-252, September 1996.

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.⁹ On the other hand, 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 who are subject to explosives trace detection.

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.

Detection of Novel Explosives. Explosives detectors are generally designed to detect specific explosives, both to limit the number of false positives and so that a determination can be made regarding the identity of the explosive detected. As a result, novel explosive materials will probably not be detected by these systems. Only after identifying characteristics and reference standards are developed for the novel explosives will detection and identification become practical. Unlike detection of bulk quantities of explosives, where human intervention may identify a suspicious device, trace analysis provides no comparable detection through operator experience or intuition. While too narrow a detection window may exclude novel or binary explosives and therefore increase risk,¹⁰ too wide a detection window, in an attempt to detect all possible explosives, will likely increase the rate of false positives and innocuous true positives. Such results would limit passenger throughput and increasing the potential for negative economic impact.

⁹ An analogous incident occurred in the New York City subway system. A passenger who was being treated with radioisotopes set off radiation detectors in the subway. The passenger was repeatedly stopped and held by law enforcement until his medical status could be verified. Christoph Buettner and Martin I. Surks, “Police Detainment of a Patient Following Treatment With Radioactive Iodine.” *Journal of the American Medical Association*, Vol. 288, 2002, p. 2687.

¹⁰ Binary explosives are mixtures of two substances that are not explosive separately but become so when mixed.

Potential for Intentional Disruption. Another concern is the possibility that a passenger screening regimen that includes explosives trace detection could be exploited intentionally to 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.

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 areas yet to be established. Regulations and screening procedures have been established for explosives trace detection on luggage.¹¹ 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 as how an operator should resolve detector alarms to distinguish genuine security threats from false positives and innocuous true positives.

Cost of Operation. The cost of deploying explosives detection equipment for passenger screening is unknown. According to a 2002 GAO study, each portal can cost from \$80,000 to \$400,000.¹² The cost of the portal systems currently being tested in TSA pilot programs is reportedly toward the lower end of this range.¹³ Document scanning systems are somewhat less expensive; according to the 2002 GAO study, similar tabletop systems used for screening carry-on baggage can cost from \$20,000 to \$65,000. 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. Alternative deployment strategies might screen all passengers or just a select subgroup, and might conduct screening at all airports or just those where the perceived threat is greatest. There are over 400 commercial passenger airports in the United States; possibly several thousand devices could 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.

¹¹ 67 *Fed. Reg.* 48506-48509.

¹² General Accounting Office, *National Preparedness: Technologies to Secure Federal Buildings*, GAO-02-687T, April 25, 2002.

¹³ Jean Heller, "High-tech Puff Seeks Explosives at TIA [Tampa International Airport]," *St. Petersburg Times*, August 5, 2004 (citing a cost of \$150,000); "San Diego Airport Tests Explosive Detection Device," *Associated Press*, July 14, 2004 (citing a cost of \$132,000).