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Opportunities to Improve Airport Passenger Screening with Mass Spectrometry—*Summary*

NATIONAL MATERIALS ADVISORY BOARD

Background

The central mission of the Transportation Security Administration (TSA) is detection and prevention of terrorist attacks on the nation's transportation system. The TSA is relying heavily on the development of increasingly sophisticated technology to meet this mission. To help reach this objective, the TSA asked the National Research Council (NRC) to assess a variety of such technological opportunities. Specifically the NRC was asked to identify potential applications for technology in transportation security; evaluate technology approaches to threat detection; and assess the need for research, development, and deployment to enable these approaches. To carry out this task, the NRC decided to issue a series of reports on selected technology applications. The focus of the reports is technological capabilities rather than specific security system instruments. In addition to assessing the technology, the studies will suggest R&D and implementation paths for promising areas. This first report focuses on mass spectrometry.

Findings and Recommendations

Background. Currently, detection technology consists of explosive detection systems (EDS) designed to detect bulk explosive quantities, and explosive trace detection (EDT) designed to detect explosive vapors or particles that may have contaminated personal items as a result of bomb fabrication and transportation. EDTs now in use employ an ion mobility spectrometer (IMS). Samples are collected by wiping luggage or carry-on items with a dry pad and are inserted in the IMS for measurement. The trace chemical patterns collected in the IMS are compared to a library of known patterns for identification.

Current Systems. EDT methods are subject to inherent limitations and common to all such technologies and IMS detectors have some specific limitations.

The efficacy of a trace detection method is dependent on there being sufficient quantities of explosive residue to be sampled. Because the sample is usually collected by wiping a portion of the luggage, collection of an adequate sample size may fail if the luggage has

been cleaned or the material is missed in the wiping process. Also, current systems do not screen a passenger's skin or clothing, leaving a primary source of trace chemicals untouched. . Finally, trace detectors might sound an alarm in response to individuals exposed to materials in a non-threatening manner such as someone taking nitroglycerin heart medicine.

IMS detectors are vulnerable to high false alarm rates when set to a low threshold level because of their inherently low capability to discriminate among different chemicals (chemical specificity). In addition, only a limited number of threat agents can be detected during a given run (concurrent detection) because IMS systems are currently designed to detect a limited set of selected explosives.

To address these limitations, **TSA should develop and deploy automated trace sampling hardware, decrease the threat alarm threshold, deploy passenger screening portals, and explore new technologies with higher chemical specificity.**

Mass Spectrometer Systems. Mass spectrometry (MS) is an obvious candidate for improving EDT systems. These instruments are currently used in a number of important detection applications. Combined with a gas or liquid chomatograph at the input, these systems provide high chemical specificity, typically 10,000 times greater than an IMS instrument. While having the same generic limitations as IMS EDT systems, an MS system could operate at a threshold detection rate about 1000 times lower than an IMS system while achieving the same false alarm rate. In addition, a much broader range of threat substances could be detected concurrently than with current IMS systems.

There are several challenges, however, to be met before MS systems can be deployed:

- Cost and complexity must be reduced, and the systems must become more rugged. While the Department of Defense has invested in the development of rugged, field-ready, MS systems that could be used by the TSA, the latter needs to focus development on its unique needs. In particular, TSA systems will have to operate in harsh environments and be operated by TSA personnel.
- The detailed configuration of the MS system—including the inlet chromatograph—depends on the detection objectives. Selecting the appropriate configurations will require additional research, particularly to maximize coverage of potential threats.
- Target molecules are identified by comparing their spectra to a library of reference spectra using specially designed software. Existing libraries and software will have to be expanded and modified to meet requirements of airport screening.

Tests have indicated that MS-based EDT systems are capable of low detection limits and low false alarm rates. **TSA should establish mass spectrometry as a core technology for identifying a broad array of explosives as well as chemical and biological agents.** TSA may want to consider purchase of the best available field-deployed MS instrument to gain experience and test system applications.

Implementation. TSA will not be able to deploy MS-based detectors in airports immediately. Rather, **it should deploy them in a phased fashion, with successive generations of instruments addressing lower quantities of an expanded list of threat materials and more sophisticated security tasks.**

A plausible phased deployment plan at a large, urban airport is the following:

- Phase 1 (one to three years). Deploy a limited number of sampling systems with both IMS- and first-generation MS-based detectors.
- Phase 2 (three to five years). Develop a second-generation MS instrument with a single configuration that can detect a variety of threat agents.
- Phase 3 (five to ten years). Replace current IMS EDTs with lower cost, fully automated MS systems that would support both passenger and carry-on screening.
- Phase 4 (beyond 10 years). Develop MS-based detectors for use in monitoring for terrorist attacks on terminal and vehicle air handling equipment.

For Further Information

Copies of *Opportunities to Improve Airport Passenger Screening with Mass Spectrometry* can be obtained from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, DC 20418, 201-334-3313, < http://books.nap.edu/catalog/10996.html>.

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