Reason

July 2002

Rethinking Checked-Baggage Screening

By Viggo Butler and Robert W. Poole, Jr.

POLICY STUDY 297

Reason Public Policy Institute

A division of the Los Angeles-based Reason Foundation, Reason Public Policy Institute is a public-policy think tank promoting choice, competition, and a dynamic market economy as the foundation for human dignity and progress. Reason produces rigorous, peer-reviewed research and directly engages the policy process, seeking strategies that emphasize cooperation, flexibility, local knowledge, and results. Through practical and innovative approaches to complex problems, Reason changes the way people think about issues and promotes policies that allow and encourage individuals and voluntary institutions to flourish.

Reason Foundation

Reason Foundation is a national research and education organization that explores and promotes the twin values of rationality and freedom as the basic underpinnings of a good society. Since 1978, the Los Angeles-based Foundation has provided practical public-policy research, analysis, and commentary based upon principles of individual liberty and responsibility, limited government, and market competition. REASON, is the nation's monthly magazine of "free minds and free markets." It covers politics, culture, and ideas through a provocative mix of news, analysis, commentary, and reviews.

Reason Foundation is a tax-exempt organization as defined under IRS code 501(c)(3). Reason Foundation neither seeks nor accepts government funding, and is supported by individual, foundation, and corporate contributions. Nothing appearing in this document is to be construed as necessarily representing the views of Reason Foundation or its trustees, or as an attempt to aid or hinder the passage of any bill before any legislative body.

Policy Study No. 297

Re-Thinking Checked-Baggage Screening

By Viggo Butler and Robert W. Poole, Jr.

Executive Summary

Current law mandates that all checked bags at 429 passenger airports be screened by explosive detection systems (EDS) or alternative means by December 31, 2002. Because it will not be possible for manufacturers to produce the number of EDS machines required by that date, nor for airports to design and build the major facility modifications that would be needed, the Transportation Security Administration has called for an interim approach using a combination of EDS and explosive trace detection (ETD) machines. Both the original mandate and this interim approach to meeting it are seriously flawed.

EDS is a flawed technology. Its error rate (false-positives) is nearly 30 percent, and its throughput is a low 150-200 bags per hour under real-world conditions. Meeting the 100 percent inspection requirement solely with EDS, when taking into account peak-load conditions, machine down-time, and other constraints, would require over 6,000 machines, at a total cost of $12 billion ($6 billion for machines and $6 billion for facility modifications). TSA's proposed alternative—ETD—is even slower than EDS, and is much more labor-intensive. An all-ETD system would cost $3 billion, would require 50,000 people to operate, and would require more space than an all-EDS system. The only other approved alternatives—hand search and dog-search—are also slow and very labor-intensive.

TSA's estimated budget for this year is $8 billion—to cover all security threats to all modes of transportation. It will soon become part of a $37 billion Department of Homeland Security, which will address all domestic security threats. To focus up to $12 billion on inspecting airline baggage seems hugely disproportionate, given the enormity of the task of defending this country against terrorism here at home.

Congress should revisit the baggage-inspection issue, drawing on the experience of Europe and Israel, which have many years of experience in dealing with terrorist threats to aviation. The two key points guiding this rethinking are:

- Baggage-screening technology is a field that is in flux; much better systems are likely to be available in the next few years, making it unwise to make multi-billion-dollar investments in mediocre technology today.
- The focus of baggage inspection should be shifted from detecting objects to identifying high-risk passengers—and matching inspection technologies to those risk groups.

In the technology area, Congress should appoint a Blue-Ribbon Committee to provide technical expertise to TSA in the airport security field. This committee should review new baggage-inspection technology that is coming into use, or being approved for use, in Europe. Some of that technology appears to offer a better combination of performance and cost than EDS and ETD for mass-baggage screening, at least on an interim basis. But the committee should also recommend high-priority investments in research and development on advanced explosive-detection technologies that could replace the current generation of EDS machines.

Congress should also mandate a shift of focus in baggage and passenger inspection, making the *detection of high-risk people* the guiding principle. That means using the computer-assisted passenger pre-screening (CAPPS) system and a registered traveler program to sort passengers into at least three different risk groups—and matching baggage-inspection technologies appropriately to each group. Slow and costly technologies like EDS and ETD would be used for all passengers in the highest risk groups and on an on-exception basis for others. As in Europe, baggage processing would involve several tiers or levels, with all bags going through relatively high-speed Level 1 inspection, but only questionable bags or those from high-risk passengers going on to Level 2 or Level 3 inspection.

To implement these changes, Congress would have to take the following steps:

1. Extend the deadline for 100 percent checked-baggage inspection to December 2004;
2. Have TSA approve a shift to a multi-tiered (in-line) baggage inspection system;
3. Create a Blue-Ribbon Commission on airport security technology to make recommendations on both immediate and medium-term R&D investments; and
4. Encourage FAA to certify additional baggage-inspection technologies for implementation between now and December 2004, such as some of those approved for use in Europe.

Table of Contents

Part I

Introduction

In November 2001, Congress enacted the Aviation and Transportation Security Act (ATSA). Among other things, that law requires that the head of the new Transportation Security Administration within DOT "take all necessary action" to ensure that all checked luggage at the country's 429 leading passenger airports be screened by explosive detection systems (EDS) by December 31, 2002. While the intent of the law was to have every such bag pass through a $1 million machine that uses CT-scanning technology, the drafters of the measure recognized that this demanding goal might not be possible to meet. Thus, the law provides that "if explosive detection equipment at an airport is unavailable, all checked baggage is [to be] screened by an alternative means."

Airline, airport, and technology experts have raised serious concerns about:

- the ability of manufacturers to produce enough EDS machines to meet the mandate by the end of this year;
- the ability of airports to find the space to install these large machines;
- the ability of TSA to fund, manufacture, and install conveyor systems to accomplish in-line screening;
- the availability of sufficient funds to produce, install, and adequately staff the thousands of EDS machines that would be required; and,
- the reasonableness of purchasing existing equipment when apparently superior technology is expected to be available over the next few years.

On March 4, 2002, DOT Secretary Norman Y. Mineta announced that the TSA would use EDS machines in combination with another, lower-cost technology: explosive trace detection (ETD) systems.

This policy brief calls for a re-thinking of the current approach to checked-baggage screening. It reviews the array of currently available technologies, including the cost, speed, and accuracy of each. It also reviews European baggage-screening practices. It concludes that even if it were possible to meet Congress's Dec. 31 deadline in its strong form—putting every single checked bag at 429 airports through an EDS machine—it would not be wise to do so. It calls instead for a different approach to baggage screening, based in part on the extensive experience of Europe and Israel, both of which have been dealing with serious terrorist threats far longer than the United States.

Part 2

What Inspection Technologies Are in Use Today?

Five principal means of inspecting checked baggage for explosives are in use at airports today. They are: hand search, explosive-sniffing dogs, automated X-ray machines, explosive trace detection (ETD) systems, and explosive detection system (EDS) machines. They differ widely in cost to acquire, operating cost, processing rate, and accuracy (both false positives and false negatives). All five of these factors must be taken into account in deciding what technology or combination of technologies makes sense to use.

A. Hand Search

The oldest method of baggage inspection is to open each bag and search it by hand, using a trained operator. A major disadvantage of this method is that it is slow; since hand inspection takes two to five minutes per bag, the throughput rate is from 12 to 30 bags per hour. In addition, should the bag actually contain an explosive device, there is a danger that it will detonate when the bag is opened or when the device is disturbed. That, in turn, suggests that hand searching be done in a secure area, away from concentrations of passengers.

B. Explosive-Sniffing Dogs

As of the beginning of 2002, the FAA had 175 trained dogs, operating at 39 U.S. airports, for explosive-detection purposes. Such dogs can work for up to two hours at a time, but must take breaks every 20 minutes. Their sensing ability apparently decreases in repetitive duty such as routine bag inspection; their preferred use is for checking an airplane or terminal in the event of a bomb threat, or as a second-tier inspection device for a bag flagged as needing further scrutiny. The FAA's William J. Hughes Technical Center has sponsored tests of dogs' ability to detect both plastic and non-plastic explosives, though critics point out that none of these studies were double-blind (i.e., in which the handler did not know which bag contained an explosive sample and was therefore unable to, perhaps inadvertently, provide cues to the dog). It costs about $20,000 to purchase, train, and certify a new canine. The TSA provides airports with $40,000 per year per dog team, but the total annual cost exceeds $50,000 at most airports. To increase the number of trained dogs from 175 to 300 (and expand their use to 80 airports), the agency budgeted an additional $5 million for 2002.

C. Explosive Trace Detection (ETD) Machines

These machines can detect minute traces (e.g., a millionth of a gram) of explosive residue picked up on a swab. The swab is inserted into the machine, which heats it and samples the vapors for specific chemicals. Trace detection has been in use for some time, on a random basis, at passenger screening checkpoints, to check the outside of selected carry-on bags for explosive residues. Closed Bag trace detection was used at Salt Lake City Airport during the 2002 Olympics, in combination with EDS machines, to become the first U.S. airport at which all checked bags were subjected to some form of explosive-detection screening. Used that way, trace detection averaged 47 seconds per bag, which equates to a throughput of 76 bags per hour. Salt Lake City had to hire nearly 400 additional screeners to implement the system, more than doubling the screening workforce.

Two other forms of trace detection take longer to carry out. Open Bag trace samples both the outside of the bag and the inside lining. That takes about 2 to 2.5 minutes per bag. "Non-directed" trace[1] samples the outside, inside lining, and each item larger than a soft-drink can. This process was found to average 3 to 4 minutes, in FAA tests at Omaha and Stewart airports. Staffing requirements are directly proportional to the time required. Thus, Open Bag trace detection would require 2.8 times the work-force of Closed Bag, and Non-Directed Open-Bag would require 4.4 times as many inspectors.

The TSA reportedly plans to mandate a 40-40-20 procedure for ETD, under which 40 percent of bags would be processed as Closed Bag, 40 percent as Open Bag, and 20 percent as Non-Directed. Serious concerns have arisen about the effectiveness of this approach for mass screening.[2]

D. Automated X-ray Machines

In Europe, where 100 percent checked-luggage screening is close to being a reality, most airports use basic automated X-ray systems for the first level of baggage screening. While not as accurate as EDS machines, they are much faster and much less costly. Typically, they operate at a rate of 1,200 to 1,500 bags/hour, seven to 10 times as fast as EDS under real-world conditions. Bags flagged by the automated system as "questionable" are sent to a second X-ray machine, where a human operator reviews the image on a screen. Those bags not cleared by this second look are routed to an EDS machine. Thus, the initial automated X-ray machine is not sufficient by itself. But it permits the slow and expensive EDS machines to be used only for exceptional bags. Among the airports relying on such layered systems for 100 percent bag screening are Athens, Heathrow, and Manchester. Automated X-ray machines are not currently certified for use at US airports.

E. EDS Machines

The term "EDS" (explosive detection system) currently refers to sophisticated million-dollar machines that use computerized tomography (CT) technology similar to that used for CAT scans in hospitals. By taking the equivalent of hundreds of X-ray pictures of a suitcase from different angles, the device can create three-dimensional views of what is inside, including some indication of the relative density of objects. A trained operator can then spot items likely to be explosives. Current EDS machines weigh six to eight tons and are the size of a minivan; their processing rate is a slow 150-200 bags/hour under real-world conditions. And their rate of false-positives (flagging an item as an explosive when it is not) is around 30 percent. The high cost, large weight and space requirements, slow processing rate, and high false-positive rate have all caused concern, as has the operator's ability to reliably evaluate the X-ray picture. Some EDS machines have a down-time of up to 30 percent (as experienced at SFO's new international terminal).

F. Comparison of Technologies

To pull all of this information together, Table 1 compares the five technologies on their principal characteristics. The ideal system would have a high processing rate (bags/hour), and low initial and operating cost, while also having low rates of false readings. Note that there are two different kinds of errors which any such system can make.

- A *false positive* reading is what occurs when the system identifies a substance as explosive material when it is not. This is a problem because every such false reading leads to additional steps being taken, which slow things down, inconvenience passengers, and cost money. Such steps can include having the bag re-inspected by a different kind of system all the way to evacuation of all or a portion of a terminal. The false positive rate of EDS is particularly troubling.
- But also very important is the *false negative* rate. A false negative occurs when explosive material is actually present but the system fails to recognize it. Ideally, the false negative rate will be very close to zero, if not for a single alternative then for the set of alternatives used together as a system.

The table presents a sobering picture. The only alternative that permits speedy processing, compatible with scanning millions of checked bags, is the automated X-ray machine, which was not certified for use at U.S. airports due to the high false-negative rates of earlier versions (although one such machine is apparently now close to being certified by the FAA). Yet the next-fastest alternative is the very expensive—and still not very good, as measured by its false-positive rate—EDS machine. The other alternatives—dogs, hand-search, and trace—are much slower and have their own limitations. In short, the technology to reliably screen massive numbers of bags, at reasonable cost, is simply not available yet.

Table 1: Comparison of Baggage Inspection Alternatives

Type	Bags /hour*	False Positive Rate	False Negative Rate	Initial Cost/ Unit	Unit Operating Cost/Year
Hand Search	12-30	n.a.	n.a.	$0	$45K
Dogs	400	n.a.	n.a.	$20K	$50K
Trace (Closed)	76	n.a.	30-50%	$450K	$90K
Trace (Open)	24-30	n.a.	15%	$45K	$90K
Trace (Non-directed)	15-20	n.a.	15%	$45K	$90K
Automated X-ray**	1,200-1,500	n.a.	n.a.	$250-400K	$90K
EDS Machine	150-200	30%	n.a.	$1,000K	$510K

*not including time to "clear" false positives

**not certified for use in the United States, though approved in Europe

n.a. = no generally accepted figure available.

Part 3

Problems with the 100 Percent Mandate

A. Limitations of EDS and Trace Machines

EDS machines currently have a bag-rejection rate of around 30 percent—and as high as 50 percent in some locations. Bag rejection means that an item is either suspicious or the operator cannot identify it. (Since virtually all of these items are eventually cleared, this number is essentially the same as the false-positive rate given in Table 1.) For some items, the EDS machine cannot discern a difference between common products and known threat items. With a projected rate of 1.5 billion checked bags per year, a rejection rate of 30 percent means 450 million bags per year—more than 1.2 million per day. These bags all need either further screening by another technology or hand search. In either case, the additional machine, time, and labor requirements for more-intensive additional screening of more than a million bags per day are very onerous.

EDS technology is likely to improve somewhat in coming years, but appears likely to have an inherently high rate of false positives. Hence, it is unlikely to ever be the stand-alone silver bullet solution for baggage screening. If used as the first line of defense, it will have to be back-stopped by additional costly technology using other principles. And its inherently slow throughput and high cost makes it a poor choice for mass screening of bags.

Trace (ETD) systems currently require hand labor for each bag. When used solely on the outside of a bag (Closed-bag), ETD has unacceptable false-negative rates (i.e., failing to detect explosive materials inside up to 50 percent of the time). But opening each bag triples or quadruples the inspection time, leading to very low throughput rates. Low flow rates will cause long lines and airline delays. Therefore, huge numbers of ETD machines and operators would be required if ETD were to be used (as TSA has proposed) as a mass-screening method. Furthermore, ETD does not detect some items, even in open-bag inspection mode.

Moreover, although TSA has announced large-scale purchases of ETD machines for airports, this technology "does not meet, nor was it ever intended to meet, the FAA's rigorous EDS certification standards," according to *Aviation Week*.[3] TSA has asked the FAA's Technical Center in Atlantic City to develop certification standards for ETD in large-scale bag-clearing operations, but the needed tests will not be completed by the Dec. 31 deadline for implementing 100 percent screening. *Aviation Week* also notes that the National Academy of Sciences has called on the FAA to evaluate the effectiveness of these machines, based on a 1996 finding that the "problem in all trace-detection approaches is clearing vapors or particles of explosive materials from the sample-collecting mechanism so that subsequent readings are not influenced by previous traces of explosive materials."

B. Excessive Cost

If the current EDS and ETD technologies were highly effective, they might be worth paying the many billions of dollars required to meet the December 31 mandate for 100 percent checked-baggage inspection. But the very real limitations of these technologies, noted above, call into serious question the wisdom of such a crash program. In this subsection, we review available cost estimates.

Since the ultimate TSA plan calls for an unknown mix of EDS and ETD machines, we can get outside limits of the cost by looking first at all-EDS and all-ETD systems. The most common all-EDS figure is approximately 2,000 machines, at $1 million each, for an equipment cost of $2 billion. The Inspector General's estimate of terminal facility modification costs to accommodate that number of machines is another $2 billion[4], for a total installed cost of $4 billion. However, the Rand Corporation's analysis found that a more realistic estimate for an all-EDS system is 5-8,000 machines.[5] Using a figure of 6,000 machines, and adjusting the building modification costs accordingly, increases the total cost of an all-EDS approach to $12 billion. The IG's estimate of staffing for a 2,000-machine system is 22,670. If we assume a burdened annual cost of $45,000 per FTE, that leads to a staffing cost of $1 billion/year for a 2,000-machine system. For the Rand-estimated 6,000-machine system, the staffing would not be three times as great, because Rand's analysis takes account of machine down-time and includes significant spares. But staffing would be at least double the IG's estimate, say $2 billion/year.

The other extreme would be an all-ETD system. While no estimate of the number of machines required nationwide for an all-ETD system could be located, it is possible to make an educated guess. Unpublished analysis by an airport planning firm, based on simulation modeling for a medium hub airport, found that each ETD machine would require one operator (Open-Bag), and we do have the IG's estimate that an all-ETD system needs 50,480 FTE to operate it. Assuming this number to represent two shifts per day, that's two FTEs per machine. Hence, the derived number of ETD machines is 25,240. At an acquisition cost of $45,000 each, that totals $1.14 billion. The same airport planning firm found that an all-ETD system would take up more space than an all-EDS system handling the same baggage load. If we assume this means 1.5 times as much, and apply that factor to the IG's $2 billion facility cost estimate for an all-EDS system, the facilities cost for ETD would be $3 billion. Thus, machines plus facility cost would total $4.14 billion for all-ETD. Assuming the same burdened cost of $45,000 per FTE, the annual staffing cost would be $2.3 billion.

Tables 2A and 2B summarize the calculations of capital costs and staffing costs for the two alternatives. Late in April the TSA announced that its interim plan for complying with the December 31 deadline would be a mix of 1,100 EDS and 4,700 ETD machines. Because this combination requires fewer machines, fewer staff, and less facility modification than either of the above alternatives, this less-capable compromise will cost significantly less. Using the same cost factors as in the above analysis, we can derive the figures in the third column of Tables 2A and 2B. As can be seen, the TSA's interim approach should cost in the vicinity of $3 billion to implement and about $1 billion per year to staff, with a 22,000-person workforce.

Table 2A: Capital Costs for Meeting Dec. 31 Baggage-Screening Mandate ($billions)			
	All-EDS	All-ETD	TSA Interim
Number of EDS	6,000	0	1,100
Machine cost	$6.0 B	0	$1.1 B
Facility costs	$6.0 B	0	$1.1 B
Number of ETD	0	50,480	4,700
Machine cost	0	$1.14 B	$0.212 B
Facility costs	0	$3.0 B	$0.559 B
Total capital cost	$12.0 B	$4.14 B	$2.971 B

Table 2B: Annual Staffing Costs for Meeting Dec. 31 Baggage-Screening Mandate ($billions)			
	All-EDS	All-ETD	TSA Interim
Number of EDS staff	45,340	0	12,468
Number of ETD staff	0	50,480	9,400
Total staff	45,340	50,480	21,868
Annual staff cost	$2.04 B	$2.27 B	$0.984 B

These cost figures are very sobering. At the very least, they suggest a pause for rethinking, to put them in perspective relative to other federal expenditures on dealing with terrorism. The entire FBI annual budget is in the $4 billion range, and the TSA budget for 2002 (for all transportation security) is approaching $8 billion. Does it really make sense to spend between $3 billion and $12 billion just on airline baggage inspection systems and another $1-2 billion per year operating them? That compares to extremely modest sums currently going toward inspection of the millions of cargo containers that enter U.S. ports every year, virtually none of which are being inspected. The forthcoming cabinet agency for homeland security will have an initial budget of $37 billion, including TSA's $8 billion, to deal with the entire range of security threats—to buildings, water supply, power plants, population (chemical, radiological and biological attacks), etc. It seems hugely out of proportion to be spending up to $12 billion on airline baggage inspection, when the full scope of security threats is so enormous.

C. Unrealistic Schedule

The fact that the two FAA-certified manufacturers of EDS machines could not possibly produce 2,000 of them by December 31, 2002 was a principal factor in the DOT's decision to order instead a mix of EDS and ETD machines. But even installing the interim mix of 1,100 EDS and 4,700 ETD machines by December 31 is highly problematic. Even if this large quantity of machines can be produced and delivered before the end of the year, the major challenge is making facility modifications at the airports which will be receiving them.

As noted previously, while individual ETD machines are much smaller than EDS machines, a much larger number of them is required, given their even slower throughput. Design studies at some airports are showing lobby-based ETD installations taking up more space than the entire existing lobby, requiring expansion of the building. Those airports planning lobby installation of more than a few EDS machines face similar problems of lack of space, as well as the need to strengthen floors to handle the massive machines. And while it appears that the majority of airports are now planning to install EDS machines in-line, as part of their baggage processing systems, in many cases that will require either the construction of an entirely new building or at least an expansion of existing buildings.

These are not quick or simple terminal remodelings; they are major construction projects. The DFW Airport has estimated that expanding its semi-circular terminals to integrate 40 EDS (plus 20 spares) and 157 ETD machines will cost $193 million.[6] Port Authority of New York and New Jersey officials now estimate that facility modification costs at Newark will exceed $100 million.[7] Even mid-size airports are faced with sizeable construction projects. Louisville, San Jose, and Tulsa are each planning separate buildings to house their EDS machines, at costs ranging from $14 million (Tulsa) to $80 million (San Jose).[8]

Given the lead time involved with large construction projects (design, equipment ordering, environmental review [if required], construction, installation and testing of equipment, etc.), a realistic deadline for reconfiguring entire baggage systems with new equipment and facilities would be two and a half years from the decision point. Thus, if a decision were made this summer to adopt the revised approach outlined in this report, a revised deadline for improved checked-baggage inspection systems would be December 31, 2004.

Part 4

Rethinking the Mandate: An Alternative Approach

Two key points underlie our proposed alternative approach. The first is that the existing technology for explosive detection is relatively poor. Even if the $12 billion needed for an all-EDS approach were readily available, it would not make sense to spend this kind of money buying mediocre technology and making major modifications to passenger terminals across the country. Promising alternatives are under development, which may be available in a few years offering better performance at lower cost. And investing a small fraction of that $12 billion now in strategic R&D on promising technologies is likely to be a far better investment than premature spending on poor technology.

Second, the current approach of focusing 100 percent of inspection resources on 100 percent of passengers is fundamentally flawed. Rethinking this premise, and drawing on the experience of other countries, can lead to a smarter approach to checked-baggage inspection that targets resources to where they are most likely to be useful. This approach focuses more on *people* than on *objects*.

A. Invest in Better Inspection Technology

Instead of massive and rapid deployment of today's mediocre technology, and the accompanying major disruption to the country's airports, a more measured and moderate approach is called for. Congress should authorize and fund a Blue Ribbon Committee of industry, research, and security leaders to develop a path toward the best medium-term solution and the most promising areas for new-technology development. Strategically investing in R&D a portion of the $12 billion that might otherwise be spent on too-hasty deployment of imperfect EDS machines would be a far wiser use of those funds.

This committee should take an immediate fresh look at the latest technologies approved for use at European but not in U.S. airports, considering the overall trade-offs involved. Here are several examples:

- **Backscatter X-ray** (American Science & Engineering): This technology is currently employed by the U.S. Air Force to screen baggage and parcels before flight, as well as at some airports in Europe.
- **Coherent Scatter** (Yxylon International, Heimann Systems): This technology is in use in Germany at Cologne, Dusseldorf, and Munich airports, for Level 2 and Level 3 screening. It is slower than EDS, at 60-240 bags per hour, but claims a single-digit false-positive rate.

- **Dual-energy X-ray** (Vivid/PerkinElmer, Heimann Systems): This new type of automated X-ray system processes about 1,500 bags/hour; they are being installed in London, Dusseldorf, Munich, Zurich, Sydney, Milan, Paris, and Venice. (These systems are close to being certified for use at U.S. airports.)[9]
- **MultiView Tomography** (PerkinElmer, Heimann Systems): These new versions of computerized tomography have a much higher throughput than EDS, between 1,200 and 1,800 bags/hour. One version is being installed at Amsterdam's Schiphol Airport, and the other is in field tests at various European airports..

A number of U.S. airports have proposed the use of these technologies. For example, Jacksonville proposed a system based on MVT for Level 1 screening, with EDS to resolve bags rejected by MVT. Denver has proposed a combination of Heimann 5-view tomography machines and X-ray diffraction, with an overall flow rate of over 1,000 bags/hour. Such approaches appear to be more cost-effective than EDS plus ETD.

In addition, the Blue Ribbon Committee should review all promising advanced technologies that might offer superior performance (both throughput and false-positive and false-negative rates) at reasonable cost and with more modest space and labor requirements in the coming decade. Among these might be:

- X-ray diffraction (identifying materials by chemical composition);
- Neutron-based detection;
- Quadropole resonance (QR), using low-frequency radio waves;
- Millimeter wave imaging;
- Microwave imaging.

Some of these technologies were discussed at the Aviation Security Technology Conference in Atlantic City in November 2001. The presentations at that conference suggested that the field of baggage inspection, especially explosives detection, is in ferment, with promising approaches in the developmental stage. That is all the more reason to focus more resources on serious R&D as opposed to a premature effort to deploy very costly but very imperfect technology.

R&D should also be intensified on technologies that search suspicious people, not just their luggage. Magnetometers do not detect plastic explosives or dangerous liquids that may be carried onto planes, and carry-on bag X-ray machines may not identify these items as dangerous.

B. Change the Focus from Objects to People

The approach that has been mandated in the ATSA, and is being implemented as best it can by the TSA, implicitly assumes that every bag has an equal probability of being dangerous. Therefore, it applies the same all-out complement of resources to each and every checked bag. But that premise falls apart on closer examination.

Every passenger is already screened by CAPPS—the computer-assisted passenger pre-screening system. Prior to implementation of ATSA's 100 percent checked-baggage mandate, the only bags subject to inspection for explosives are those flagged by CAPPS as belonging to a suspicious traveler. Today, those bags are put through an EDS machine if one is available, sniffed by dogs, inspected with trace detection, or opened and hand-searched.

This pre-ATSA approach is a sensible matching of resources to the likely threat. While not 100 percent foolproof, it is a smart allocation of today's limited bag-inspection resources to where they are likely to do the most good. While this existing system can certainly be improved upon, its fundamental premise is that the problem is best addressed by identifying *which passengers*—and hence which bags—need the most scrutiny.

Three key elements need to be examined in order to devise a system of matching resources to likely threat levels:

- Improving the ability to sort passengers into different risk groups;
- Applying increased technological resources to higher-risk passengers;
- Adding technology incrementally, to improve components of an overall baggage-inspection system.

These elements are discussed in the following section.

Part 5

Integrating Baggage-Inspection and People-Inspection

A. Sorting Passengers into Risk Groups

The basic principle of using inspection resources wisely requires that the most costly resources be devoted to the most serious threats, while maintaining a basic level of inspection for all passengers. Hence, passengers must be sorted into groups of differing risk levels, based on what we know about those in each group. For example, one three-part categorization would be as follows:

- **Group 3**: passengers flagged by CAPPS as potential problems.
- **Group 2**: passengers cleared by CAPPS, but about whom detailed information is not known.
- **Group 1**: passengers cleared by CAPPS about whom extensive information is known, sufficient to make them an extremely low-risk group.

To implement this approach requires two key elements. First, there must be ongoing improvement and fine-tuning of CAPPS, to ensure that its selection criteria are always current and that it is able to access all relevant federal databases that might indicate the need for serious scrutiny of a passenger. And CAPPS must be accessible at each possible check-in point: telephone, curbside, ticket counter, and boarding gate. Second, there needs to be a program under which travelers can opt to submit to a background investigation and, if cleared, be issued a tamper-proof identification card as a certified or registered traveler.

B. Matching Inspection Resources to Risk Groups

A sensible allocation of baggage-screening resources would devote extensive scrutiny to those in Group 3, using all available resources to ensure that no explosives were in their checked baggage. With today's technology, that would include EDS (if available at the airport in question) or Directed/non-Directed Trace. In addition, such individuals would also be subjected to more-intrusive passenger screening than other passengers, such as backscatter X-ray (which can see through clothing) and/or explosive-detection booths (see Figures 1 and 2). These latter passenger-inspection devices are too costly, too time-consuming, and too intrusive to be used on all passengers—but their use makes sense when confined to the relatively small numbers in the potentially high-risk group.

Figure 1: Passenger Screening, by Risk Group

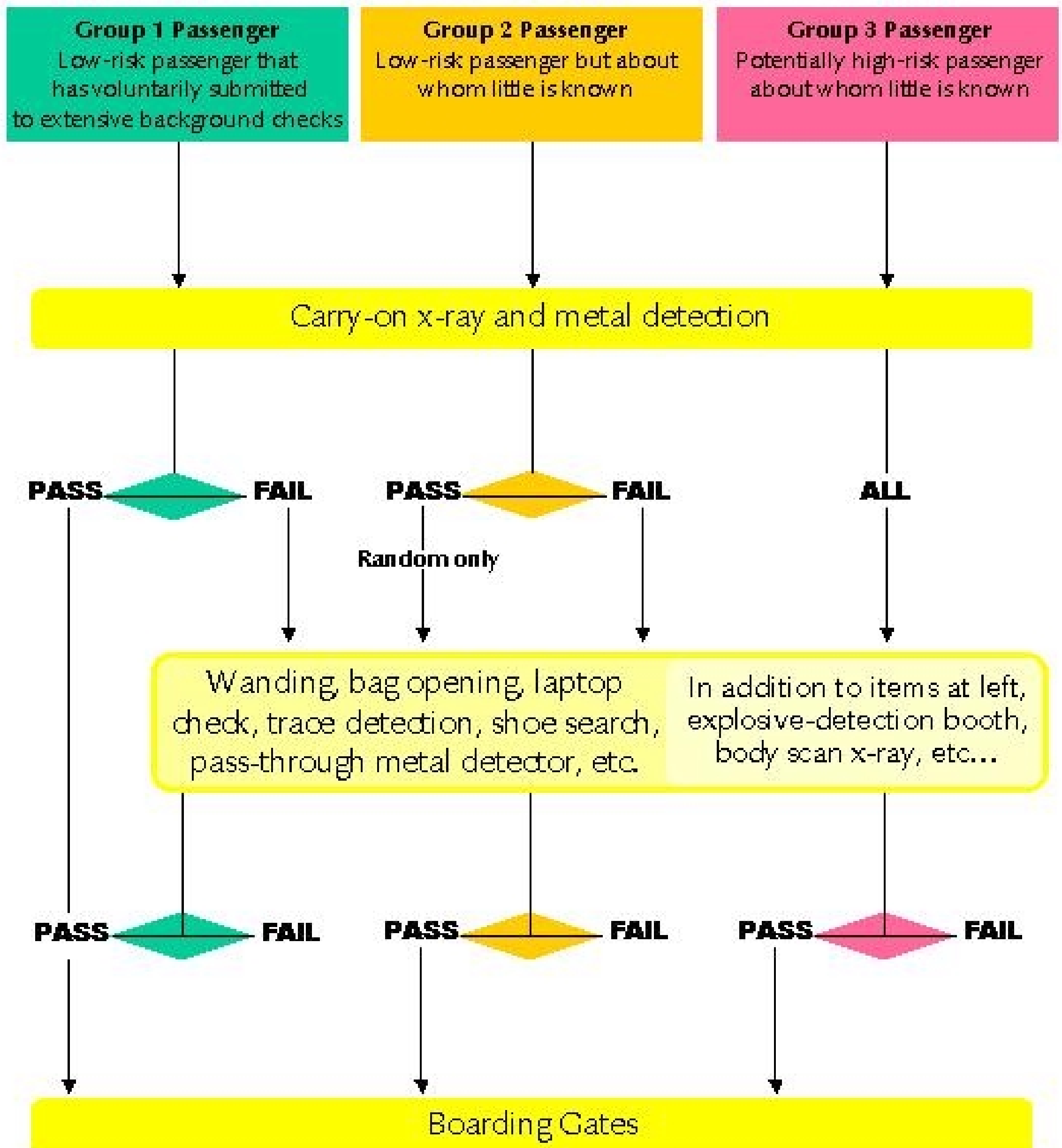
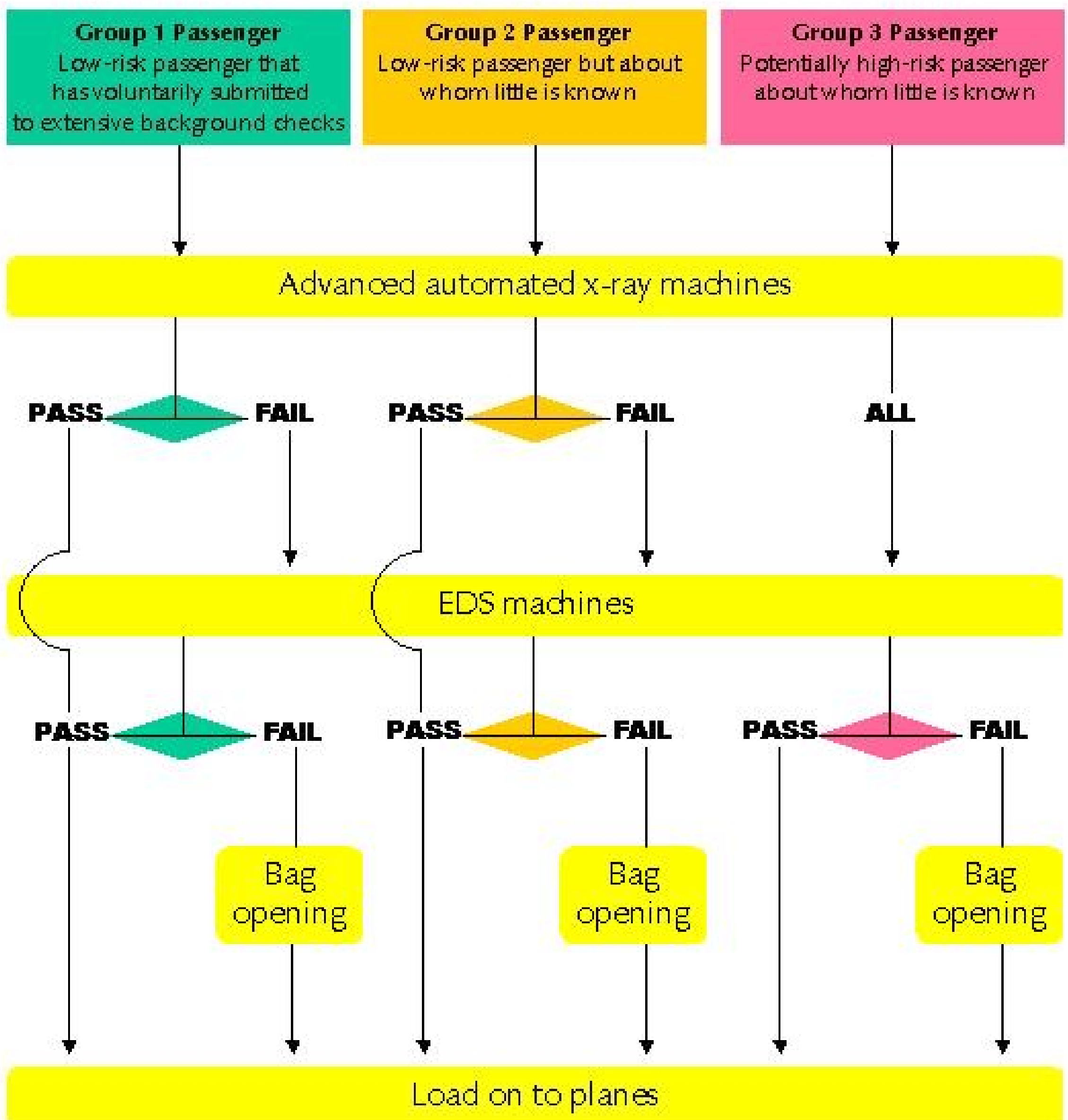


Figure 2: Tiered Checked-Baggage Screening System, by Risk Group



Those in Group 2 would have their checked luggage put through Level 1 advanced automated X-ray machines, capable of processing 1,500 bags per hour, nearly 10 times the rate of EDS. Bags flagged as suspicious by the X-ray machines could be routed to EDS or ETD for further scrutiny, with bag-opening available for those not cleared. Group 2 passengers would pass through baseline passenger screening, including metal detector and carry-on X-ray machine. They would also be subject to random Open Bag trace detection inspection of their carry-ons.

People in Group 1 would be those who have agreed to a background inspection that might include both a criminal-history check and a credit check. Upon passing those checks they would be issued a biometric card to present upon arrival at a special passenger-screening checkpoint. Once their identity as a certified traveler was verified, they would be go through an expedited baseline level of passenger screening—i.e., magnetometer and carry-on X-ray but without having to remove their laptops and without being subjected to wanding, pat-downs, trace-detection of carry-ons, or shoe inspections (unless flagged by the screening equipment). They would also be exempt from selectee status or boarding-gate inspections. Checked baggage of Group 1 travelers would be inspected in the same way as those in Group 2.

C. European and Israeli Precedents for a Risk-Based System

Europe and Israel have been coping with terrorism for several decades. Over time, their airport security systems have evolved, based on a process of trial and error learning, in order to be both as effective as possible but also to be cost-effective (to avoid using resources wastefully or in ways that burden passengers but produce negligible security benefits). Two key features of many of these airport security systems are (1) some form of certified-traveler program, and (2) a several-tier baggage system, matching resources to risk levels.

Israel pioneered the certified traveler concept, when it became clear that its rigorous passenger screening protocols were overkill for Israeli citizens who were frequent air travelers. Developed by the U.S. firm EDS, the “Express Entry” program has been in use since 1998 at Ben-Gurion International Airport in Tel Aviv. According to a recent news article, some 80,000 Israeli citizens were enrolled as of the beginning of 2002.[10] That represents about 15 percent of passenger traffic, but an EDS representative was quoted as estimating that the volume could grow to 30 to 50 percent. Prospective members apply in person, submitting to a background check and a hand scan. If approved for the program they receive an ID card encoding about 90 hand measurements. At the airport, the enrolled passenger checks in at a special kiosk, which accepts the card and measures the hand geometry, to verify that the person presenting the card is the actual enrolled person. The system has cut check-in time for card-holders from two hours to 15 minutes.

The requirement for 100 percent screening of checked baggage has been a priority in Europe for a number of years. First to act was the United Kingdom, in response to the 1988 Lockerbie bombing. The government set the goal, but provided *eight years* for it to be implemented, from 1990 through 1998. More recently, the European Civil Aviation Conference (ECAC) set a five-year deadline of Dec. 31, 2002 for more than 400 European airports in 38 countries. That voluntary goal was made mandatory by the EC’s Transport Council in December 2001.[11]

European airports, including those in the UK, are generally adopting a multi-tiered approach to baggage screening. It generally avoids lobby installation of EDS machines. Instead, all explosive detection equipment is installed in-line, as part of the baggage-handling system. For example, the system developed by BAA for the three main London airports (Heathrow, Gatwick, and Stansted) uses automated X-ray machines as Level 1 screening devices. About 30 percent of bags are flagged by those devices and routed to a Level 2 X-ray machine, where an operator reviews the image on a screen. About three percent of those bags require scrutiny by Level 3 technology, an EDS (CT) machine. Bags flagged by EDS are matched with passengers and opened in a separate location. The system was developed and installed, in all seven of BAA's UK airports, for under $300 million.[12]

The all-new $2 billion Athens airport, which opened in March 2001, employs a similar three-tiered system. In this system, the Level 1 automated X-ray machines clear 80-90 percent of bags, with the remainder sent to operator-attended machines. Between 200 and 1,000 bags are flagged by these operators each day and sent to the two EDS machines in a special room with reinforced walls. If the EDS operator decides a bag needs to be opened, the passenger is summoned to that underground room and must open the bag in the presence of a police officer. Bomb squad personnel are also available, on-call.

The European model illustrates the principle of matching resources to risk levels. It also illustrates the principle of setting realistic timetables for making major changes to baggage and passenger processing, so that needed facility modifications can be made after careful planning and design. Moreover, a multi-tier system is inherently upgradable, tier by tier, as new and better technologies become available.

Part 6

Recommendations

The United States should implement policies for baggage and passenger screening that draw on best practices from European and Israeli airport security. That would mean shifting the underlying philosophy from looking for dangerous objects to identifying and dealing with dangerous people. The latter approach, relying on an improved CAPPS and implementation of a certified traveler system, would permit the development of multi-tiered checked-baggage systems. All checked bags would receive a basic level of screening, using the best available technology consistent with rapid processing rates. Bags flagged by that initial technology would be routed to a second or third level of inspection. So would bags checked in by people in the high-risk group. But the system would not have to purchase enough equipment or employ enough people to provide high-risk type inspection to low-risk bags.

Under this kind of approach, Congress should revisit the current December 31 deadline for all checked baggage to be inspected for explosives. Since the deadline cannot be met even via the TSA's interim mix of EDS and ETD (that is, without hugely costly and in part unnecessary modifications to hundreds of airport terminals and huge disruptions in passenger processing), Congress should set a more realistic deadline—perhaps December of 2004.

While Congress should avoid trying to specify particular technologies in this evolving field, it should nonetheless encourage the TSA to certify additional technologies (such as the latest generation of automated X-ray machines) that can provide a basic level of inspection for ordinary travelers more cost-effectively. Congress should also create a Blue-Ribbon Committee to both advise the TSA on certifying existing technology and to direct significant R&D funds to speeding the development of promising airport security technologies.

A more realistic deadline for 100 percent inspection and a broader choice of technologies would permit airports to design new baggage systems and develop the required facilities in a coherent, orderly manner. Given the wide array of types and sizes of passenger terminals, this approach would permit baggage systems to be tailored to the functional requirements and physical constraints of these different terminals.

In addition, since these baggage systems would not be putting all their eggs in one technological basket (e.g., EDS or ETD), they would be easier to upgrade as new and better technologies came along and won federal certification. Thus, baggage inspection systems would be subject to continual improvement as the technology progressed. This approach would provide for both (a) an immediate improvement in airport security, and (b) more resources available in three, five, or 10 years when much better technology becomes available. A multi-tiered system would not have to be replaced all at once; rather, an individual tier could be replaced, or a new tier added, depending on how much improvement a particular new technology could make.

About the Authors

Viggo Butler is chairman of United Airports Limited, Inc. and the retired CEO of Airport Group International and its predecessor, Lockheed Air Terminal. He holds a B.A. from California Polytechnic and an MBA from Pepperdine University. Early in his career, he served as a U.S. Air Force captain supervising air traffic control. He is currently a member of the FAA's Research, Engineering & Development Advisory Committee and has chaired its security subcommittee.

Robert Poole is Director of Transportation Studies at the Reason Public Policy Institute, with over 22 years of public policy research experience. A former aerospace engineer, he holds B.S. and M.S. degrees from MIT. He has authored a number of policy studies on airport and air traffic control issues and has advised the Reagan, Bush, Clinton, and Bush White Houses on various transportation issues.

Other Relevant Reason Foundation Policy Studies

Fixing Airport Security, 21st-Century Strategies for 21st-Century Threats. By Robert W. Poole, Jr. and Viggo Butler, Rapid Response #106, September 2001.

How to Commercialize Air Traffic Control. By Robert W. Poole, Jr. and Viggo Butler, Policy Study No. 278, February 2001.

Airline Deregulation: The Unfinished Revolution. By Robert W. Poole, Jr. and Viggo Butler, Policy Study No. 255, March 1999.

Passenger-Friendly Airports: Another Reason for Airport Privatization. By Asheesh Advani, Policy Study No. 254, March 1999.

Reinventing Air Traffic Control: A New Blueprint for a Better System. By Robert W. Poole, Jr. and Viggo Butler, Policy Study No. 206, May 1996.

Endnotes

1 When ETD is used alone to inspect the inside of a bag, such use is called "non-directed." When ETD is used following a previous X-ray inspection that detects a suspicious object, that use is called "directed" trace detection.

2 Matthew L. Wald, "Baggage Bomb Detector Is Unreliable, Experts Say," *New York Times*, June 7, 2002.

3 John Croft, "Guns, Trace Detection in Senate Crosshairs," *Aviation Week & Space Technology*, May 27, 2002, p. 41.

4 Testimony of Inspector General Kenneth Mead before the House Transportation Appropriations Subcommittee, April 17, 2002.

5 "Safer Skies: Baggage Systems and Beyond," by Gerry Kauver, Bernard Rostker, and Russ Shaver, Santa Monica: Rand Corporation (unpublished draft report, completed in March 2002, in response to a request by the FAA Associate Administrator for Civil Aviation Security).

6 "DFW: EDS Installation to Cost $193 Million for Facility," *Airports*, April 23, 2002.

7 Associated Press, "Cost of Adding Security Equipment at Newark Airport Could Exceed $100 Million," *Boston Globe*, May 7, 2002.

8 "Funding, Operations Lead Security Questions," *Airports*, March 19, 2002.

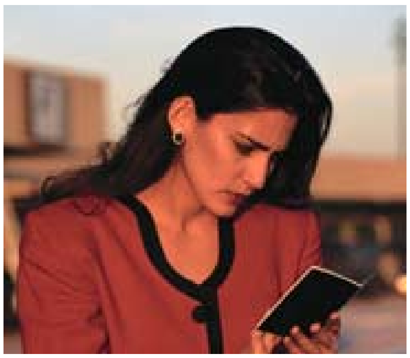
9 "Companies and Contracts," *Airports*, May 28, 2002, p. 7.

10 Ricardo Alonso-Zaldivar, "Trusted Air Travelers Would Minimize Wait," *Los Angeles Times*, Feb. 5, 2002.

11 "Europe Gearing Up for 100% Baggage Screening Requirement," *Airports*, Dec. 18, 2001.

12 John Croft, "Baggage Deadline to Refocus Standards," *Aviation Week & Space Technology*, January 7, 2002.






Reason

Reason Public Policy Institute
3415 S. Sepulveda Blvd., Suite 400
Los Angeles, CA 90034
310/391-2245
310/391-4395 (fax)
www.rppi.org