INFRASTRUCTURE, SAFETY AND ENVIRONMENT

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BRIEFING

Near-Term Options for Improving Security at Los Angeles International Airport

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The research described in this report was conducted by RAND Infrastructure, Safety, and Environment (ISE), a unit of the RAND Corporation, for Los Angeles World Airports.

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PREFACE

This document assesses near-term security improvements that can be made to counter the threat of terrorism at Los Angeles International Airport (LAX).

In July 2004, Los Angeles World Airports commissioned the RAND Corporation to conduct a two-phase study on security issues at LAX. The first phase is an eight-week effort to address the best near-term options for improving security at LAX. Here we provide the documentation for Phase 1. The second phase will examine long-term security options.

This document will be of interest to decisionmakers and staff at Los Angeles World Airports; the Transportation Security Agency; the Los Angeles International Airport Police Department; the Los Angeles Police Department; the Los Angeles mayor's office; the Los Angeles City Council; similar staff at other airports; and those in the general public interested in LAX, terrorism, and airport security.

This research was conducted within RAND Infrastructure, Safety, and Environment (ISE), a unit of the RAND Corporation. The mission of RAND ISE is to improve the development, operation, use, and protection of society's essential built and natural assets; and to enhance the related social assets of safety and security of individuals in transit and in their workplaces and communities. The ISE research portfolio encompasses research and analysis on a broad range of policy areas including homeland security, criminal justice, public safety, occupational safety, the environment, energy, natural resources, climate, agriculture, economic development, transportation, information and telecommunications technologies, space exploration, and other aspects of science and technology policy.

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CONTENTS

SUMMARY

Commissioned by Los Angeles World Airports (LAWA), this study examines near-term options for reducing the terrorist threat to LAX. Although the study has considered many possible terrorist threats and responses, the study results presented here focus on actions that can be taken at LAX to reduce the terrorist threat. We have not attempted a review of the overall effectiveness of Transportation Security Administration (TSA) procedures nor have we considered general national antiterrorist strategy. Terrorism is a complex international problem; here we are examining it only from LAWA's point of view.

Terrorism has long been a serious problem for the air transportation system of the United States and the world. We note that of 5,347 deaths that have resulted from terrorist attacks on civil aviation since 1980, only 195 occurred in attacks on airports themselves, as opposed to aircraft.

LAX is one of the safest places in Los Angeles. It was one of the first airports to implement baggage screening procedures, an on-site bomb squad, high police presence, a distributed terminal layout, and large numbers of bomb-sniffing dogs. Despite this high level of security, there are good reasons to believe that LAX is viewed by at least some terrorists as a particularly attractive target. Since 1974, LAX has been the site of two bombings, two attempted bombings, and one gun attack.

In meeting the terrorist threat, we find that the problem is how to influence the behavior of an unpredictable enemy. The logical structure of the problem is similar to that of preventing nuclear war, which RAND has studied extensively over many years. The solution is to shape the situation so that in any scenario the outcomes from the terrorist's point of view will be unsatisfactory. The primary goal of this strategy is deterrence. Terrorists will see the airport as an unsatisfactory target that is not worth their effort.

Operationally, the key to implementing a successful strategy of deterrence is to understand and reduce LAX's vulnerabilities. We analyze a wide range of possible terrorist actions and assess LAX's level of vulnerability. We then examine possible alternative courses of action LAX can take to reduce these vulnerabilities.

We do not construct a formal cost-effectiveness measure to evaluate different courses of action because it is not possible to formally evaluate

the chance of any type of attack. In addition, actions taken at LAX will alter the chances of different types of attacks. We analyze scenarios and possible actions in a relative way. Our goal is to identify the most dangerous vulnerabilities and the security improvements that can make them less dangerous. We particularly seek to identify dangerous vulnerabilities that can be mitigated at a relatively low cost.

In this document, we focus on fatalities as an indicator of airport vulnerabilities. We have also investigated economic measures of vulnerability (e.g., reconstruction costs, long-term disruption, and lost earnings) and find that they correspond with the number of fatalities. That is, the attacks that have the largest economic impact are those that result in the largest loss of life. Because of this, the primary conclusions of the study do not depend on which type of vulnerability measure is used.

ATTACK SCENARIOS

Our formal analytic approach begins by constructing a series of attack scenarios—descriptions of ways in which terrorists could attack LAX. This list was compiled based on history, discussions with security professionals at LAX and elsewhere, and our own judgment. Therefore, we focus on the attack scenarios that we found most threatening, a subset of those that we actually studied. We then constructed a list of security improvement options and assessed their impact on each attack scenario. This was an iterative process—the implementation of one security improvement option may change the overall situation in ways that modify the effectiveness of other options. Our iterative approach in assessing options enabled us to understand possible synergies.

We identified 11 major classes of attack. These are not the only possible attacks, but they are the ones that we assess to be most likely and most dangerous. Starting with the scenarios most threatening to LAX with its current security procedures and making very rough estimates of expected civilian deaths, we list the threats as follows:

1. **Large truck bomb.** A large bomb could be concealed in a truck. If the bomb was detonated at the lower level, we expect a large number of deaths, using observed passenger concentrations. This includes deaths from the curbside and baggage claim areas and at the departure level. The front portion of the terminal would be lost (both the arrival and departure levels), along with two sections of elevated roadway.

2. **Curbside car bomb.** A medium sized bomb detonated in the right lane in front of the line for a skycap might cause a large number of deaths. The number of deaths is very sensitive to the density and number of people standing in line.

3. **Luggage bomb.** A small bomb detonated in a large screening line could also produce a large number of deaths. The number of deaths is very sensitive to the density and number of people standing in line.

4. **Uninspected cargo bomb**. A bomb is placed inside uninspected cargo and detonates in a passenger aircraft during flight, killing hundreds of passengers.

5. **Insider-planted cargo bomb.** With the assistance of an employee with access to the airport, a bomb is placed inside a large passenger aircraft, causing it to be destroyed in flight, and killing hundreds of passengers.

6. **Air operations attack.** A well-armed group of terrorists could enter the air operations area by scaling the fence and attacking the fuel area, runways, and aircraft.

7. **Public grounds attack.** A well coordinated, armed, and equipped terrorist group blocks the exit to LAX and attempts to kill as many civilians as possible. Current airport police equipment would be of limited effectiveness against well-equipped attackers.

8. **Air traffic control tower/utility plant bomb.** We assume a car or truck bombing occurs with enough explosives to destroy the air traffic control tower or utility plant.

9. **Man Portable Air Defense System (MANPADS) attack.** We assume that a properly aimed and launched MANPADS attack (small, portable surface-to-air missiles) will result in destruction of an airliner less than 10 percent of the time.

10. **Sniper attack.** A sniper set up on airport-adjacent property with a .50-caliber sniper rifle shoots at loaded planes, firing approximately 50 shots over five minutes.

11. **Mortar attack.** This might be an attack similar to the Irish Republican Army attack on London's Heathrow Airport in which terrorists fired mortar shells along the length of the runway. The attack might disrupt operations for several days, but it would kill few people on average. However, it is possible, albeit unlikely, that a mortar round could hit a loaded plane.

SECURITY IMPROVEMENT OPTIONS

We evaluated a series of possible security improvement options that make the threat scenarios less dangerous. Different security improvement options will have different consequences depending on the threat scenario. We focus on security options that offer the greatest effectiveness against the most threatening attacks. We then estimate costs, both initial and recurring, for each security improvement option.

One fact that consistently emerges from our analysis is the following: **It is not the size of the bomb that matters most; it is where it is detonated.** All of the most dangerous terrorist attacks involve terrorists placing a bomb in close proximity to a vulnerable crowd of people. There are two general ways to reduce this vulnerability: Move the possible bomb detonation away from the people or move the people away from the possible bomb detonation. Both approaches are valid, and we provide specific recommendations for both.

Security improvement options fall into four broad categories. The first group contains low-cost options that greatly reduce LAX's vulnerability. These should be acted upon immediately. The second includes high-cost options that greatly reduce LAX's vulnerability and should be studied to identify affordable, time-phased solutions. The third includes low-cost solutions that modestly reduce LAX's vulnerability and can be addressed in a more deliberate fashion as opportunities arise during planned modernization. The fourth group includes expensive solutions to modest problems that we do not recommend.

Low-Cost Options That Greatly Reduce Vulnerability: Clearly Recommended

Limit density of people in unsecured areas—where baggage has not been inspected or areas near uninspected vehicles. Eliminating lines at baggage check-in is very effective because these lines are an attractive target. For example, a terrorist could bring a substantial bomb concealed in luggage with little risk of arousing suspicion. Similarly, lines outside terminals (e.g., for curbside check-in) are dangerous because they make an attractive target for a vehicle bomb.

It may be surprising to some that the costs of eliminating check-in lines are quite modest according to our assessments. Overall airport efficiency, including the operations of LAWA, the airlines, and TSA, is not enhanced by having people stand in line. The amount of actual work required to check bags, etc. remains the same whether people have waited or not. Substantial reduction of lines can be implemented immediately with small

changes to airline and TSA staffing policies. This is our strongest recommendation.

Add permanent vehicle security checkpoints with bomb detection capability. Large vehicle bombs can be detected by quick examination of vehicles entering the airport. Improved technology is becoming available, but even simple vehicle scales can identify suspicious vehicles, which can then be diverted before entering the airport proper. This procedure will greatly reduce the threat from large vehicle bombs and provide some effectiveness against smaller bombs. It will not be effective against small bombs concealed in luggage, which would require a detailed, expensive search operation.

High-Cost Options That Greatly Reduce Vulnerability: Possible Recommendations

Implement additional inspections of cargo on passenger flights. Additional equipment and staff could be used to increase the probability that explosives in air cargo carried on passenger flights would be detected. Such a screening program would be expensive, on the order of $100 million per year at LAX. Determining the optimum level of cargo screening is a TSA responsibility, and such a program should logically be implemented at a national level.

Enhance screening of airport personnel. Background checks on personnel allowed unrestricted access to the airport operations area could be more thorough than they are at present. For example, all personnel employed in catering, etc. could be required to undergo the same background screening as is currently required for TSA screeners. This would be expensive. The cost of the investigations themselves would be large because of the large number of people who would need to be investigated. Moreover, security clearance procedures have the effect of disqualifying people who are not actual terrorists but have had some problem in their lives, usually involving money, which makes them more vulnerable to pressure or recruitment by terrorists.

Low-Cost Options That Modestly Reduce Vulnerability: Possible Recommendations

Enhance training of airport rapid reaction team. There is a possibility that well-trained terrorists with automatic weapons and body armor could attack either the passenger terminals or the operations area. There is a distinct possibility that the existing airport police force might not be able to respond effectively to such an attack. Development of an airport police

SWAT (special weapons and tactics) capability could reduce this vulnerability. This is relatively inexpensive. However, we believe that such an armed incursion is, from the terrorists' point of view, a poor strategy. It will probably kill fewer people than a well-placed bomb, and it will be difficult for the terrorists to get away.

Improve perimeter fence. A double fence with motion detection capability would improve LAX's ability to respond to intruders attacking the air operations area. Particularly coupled with the enhanced rapid response team described above, this could make attacking over the fence even less attractive to terrorists than it already is.

Options Not Recommended

We have examined a wide range of possible security enhancements that we do not recommend because their likely effectiveness is relatively low compared to their cost. That does not mean that they are bad ideas. It means that they are relatively bad compared with the options we recommend. For example, diverting all vehicles to remote lots and busing passengers to terminals would reduce vulnerability to vehicle bombs, but it would cost a great deal more than reducing the size and density of vulnerable lines and screening for large bombs.

This study has focused on near-term options. We assess that LAX, which is already one of the more secure airports in the United States, can be made significantly more secure by the following high-priority actions.

Low cost:

> **Greatly reduce the number and density of people standing in line in unsecured areas.**

> **Establish vehicle checkpoints to search for large vehicle bombs.**

Higher cost:

> **Enhance screening of airport personnel.**

> **Enhance inspection of cargo.**

Finally, the security of LAX is the joint responsibility of many agencies. LAWA should continue to work closely with national and international airport security organizations to raise the level of security across the entire air transportation system.

INTRODUCTION

Los Angeles International Airport (LAX) is vital to Southern California. It is the airport of choice for over 50 million passengers every year. According to Los Angeles World Airports (LAWA), it provides the Southern California economy with over $70 billion in revenue each year. It is vital to Southern California that LAX is a safe and secure airport.

Since 1980, there have been over 8,000 terrorist attacks against aviation targets worldwide, killing over 5,000 people. Since 1974, LAX has been the target of two bombings, two attempted bombings, and one gun attack. In August 1974, the Alphabet Bomber, Muharem Kurbegovic, detonated a bomb in a locker that killed three and injured 36. Another bomb was detonated in the China Air baggage processing facility in January 1980. In May 1982, three members of the Armenian Secret Army for the Liberation of Armenia were arrested attempting to place a bomb in the Air Canada cargo office. In December 1999, the Millennium bomber, Ahmed Ressam, was caught crossing into the United States with bomb-making equipment. Ressam's plan was to detonate four, timed luggage bombs at curbsides and inside terminals at LAX. His al Qaeda trainers in Afghanistan suggested that he attack an airport. He chose LAX because he had flown through Los Angeles and was familiar with the airport. In July 2002, Hesham Hadayet brought a .45-caliber handgun into the Tom Bradley terminal and opened fire while waiting in line at the El Al ticket counter. Two people were killed and four were injured before Hadayet was killed by El Al security personnel.

Although it is very difficult to predict exactly what a terrorist will attack at LAX, we developed a list of attacks that are feasible for a terrorist group to carry out against key airport components. The list, shown in the table, contains the most likely threat scenarios, the breadth of possible threat scenarios, and the scenarios that are the most difficult for LAX to prevent and deter.

Scenarios	
Title	**Description**
Large truck bomb	A truck bomb is detonated on the lower level next to a column supporting the upper roadway
Curbside car bomb	A car bomb is detonated on the upper roadway in front of a crowded terminal
Luggage bomb	A luggage bomb is detonated curbside or at the check-in line inside a busy terminal
Uninspected cargo bomb	A bomb is placed inside uninspected cargo and detonates in a passenger aircraft during flight
Insider-planted cargo bomb	An insider places a cargo bomb on a passenger flight and detonates the bomb during flight.
Air operations attack	A well armed and equipped terrorist group scales the perimeter fence and attacks the fuel area, runways, and aircraft
Public grounds attack	A well coordinated, armed, and equipped terrorist group blocks the exit to LAX and attempts to kill as many civilians as possible
Tower/utility plant bomb	Terrorists hope to destroy either the tower or the utility plant with a car bomb
Man Portable Air Defense System (MANPADS) attack	Two surface-to-air missiles are launched from a boat in the bay, from the beach, or from the sand dunes, at an aircraft taking off from LAX
Sniper attack	From a roof of a high-rise building on the airport perimeter, a sniper using a .50-caliber rifle fires at parked and taxiing aircraft
Mortar attack	Two large mortars fire shells along the length of the runway

LAX has a master plan that outlines a variety of ways to meet the long-term aviation needs of Southern California. Within the plan, one of the alternatives has been called the safety and security alternative. Even the most optimistic proponents of this alternative recognize that the safety and security aspects of the plan would not be in place until well into the next decade. There are options available for improving LAX security long before the security aspects of this alternative may be in place. This study focuses on these near-term (two to five years) options.

Our study was designed to provide useful input to decisionmakers about the operation of LAX. Security from terrorist attack is only one of a long list of requirements for safe and effective airport operations. Therefore, major decisions about LAX need to be made based on a broad range of

information. We believe that our analysis will be a useful piece of this necessarily complex decisionmaking process.

Study Background

- RAND has been conducting research on terrorism since the 1970s

- In July 2004, LAWA commissioned RAND to conduct a two-phase study on security issues at LAX
  - Phase 1: provide a rigorous and objective cost-benefit analysis of near-term options (next 2 years) for improving LAX security
  - Phase 2: examine long-term options

- This is the final briefing for Phase 1

RAND

LAX Security Study-2 09/04

RAND has a long history of studies on terrorism, stretching back to the early 1970s.

In July 2004, Los Angeles World Airports (LAWA) to commission the RAND Corporation to conduct a two-phase study on security issues at LAX. The first phase, which this briefing documents, examines near-term options that could be implemented within the next two years. The second phase will examine long-term issues for improving LAX security.

Outline

- **Defining the problem**

- **Study Approach**

- **Assessing LAX vulnerabilities**

- **Cost / benefits analysis of possible solutions**

- **Our recommendations**

The Problem: Terrorist Attacks on Civil Aviation and LAX

Fatalities

- **Deaths due to attacks on aviation targets are of great concern**
  - **5,347 deaths in attacks on aircraft, 1980-2004**
  - **195 deaths in attacks on airports**

- **Since 1974, LAX has been the target of**
  - **Two bombings**
  - **Two attempted bombings**
  - **One gun attack**

- **It is unknown how future terrorists will attack airports and aircraft**
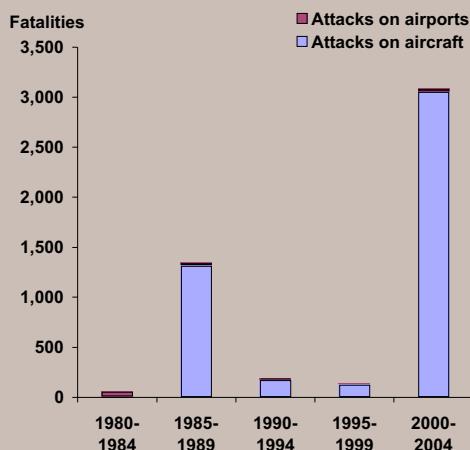
Source: RAND-MIPT Terrorism Knowledge Base, http://db.mipt.org.

RAND

LAX Security Study-4 09/04

Even though LAX is one of the most secure airports in the world, we should be concerned about LAX's security needs.

First of all, although attacks on aviation targets account for less than 5 percent of the attacks,[1] the historical data suggest that attacks on airports and aircraft have been very costly in human lives. This chart presents data on fatalities associated with terrorist attacks on aircraft and airports in five-year increments through June 2004. These attacks have caused more than 5,500 deaths worldwide since 1980, or, on average, more than 200 deaths a year.[2] (About 3,000 of these deaths were the result of the 9/11 attacks.)

We should also be concerned about LAX security because of LAX's own history of attacks. Since 1974, LAX has been the site of two bombings (the

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[1] As of August 2004, the RAND and the Oklahoma City National Memorial Institute for the Prevention of Terrorism (MIPT) terrorism database included 7,029 international incidents from 1980 through June 2004 and 9,687 domestic incidents from 1998 through June 2004, for a total of 16,716 attacks, 524 of which (3.1 percent) were attacks on aviation-related targets (aircraft, airports, or airline offices), http://db.mipt.org/Home.jsp.

[2] The chart includes deaths in both incidents of international terrorism, which the RAND-MIPT terrorism database has tracked since 1968, and incidents of domestic terrorism, which have been tracked only since 1998, but which are far more frequent. Thus, readers should keep in mind that domestic incidents are included only after 1997.

International terminal in August 1974 and the China Air baggage processing area in January 1980), two attempted bombings (the Air Canada terminal in May 1982 and the Millennium bombing plot in December 1999), and one gun attack (the July 2002 armed attack at the El Al ticket counter).

Many Sources Suggest LAX Would Be A Highly-Valued Terrorist Target

History of attacks on LAX—
- Tom Bradley Terminal (8/74)
- China Air (1/80)*
- Air Canada (5/82)*
- Millennium bomb plot (12/99)**
- Hedayet attack (7/02)

Possible Target of Surveillance

LAX Meets Terrorists' Criteria—
- "attacking vital economic centers" a mission (AQO training manual)
- Airports among "strategic buildings, important establishments, and military bases" (AQO training manual)
- "an airport is sensitive politically and economically" (Ressam)

*Bomb defused
**Prevented

Terrorists Train Against Airports—
- Ressam testimony
- AQO training manuals

Pattern of Revisiting Prime Targets—
- e.g., World Trade Center

High on Security Officials' Lists of Likely Targets—
- LAX of high concern to law enforcement and security officials
- Reportedly, of high concern to U.S. intelligence agencies
- #1 of 624 on California AG target list

Hard to find a better target than LAX that meets sensible criteria for targeting

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LAX Security Study-5 09/04

We were asked to address the question of whether LAX is a higher-risk terrorist target in Los Angeles than others in the city; our research on the matter suggests that there are many reasons to believe that it may well be higher risk, including the following:

1. The history of attacks on LAX suggests that there is something special about the airport that has led to attacks by different groups over a relatively long span of time.

2. Law enforcement and security officials we spoke with stated their belief that LAX continues to be the subject of surveillance.

3. It is worth noting that LAX fits many of the key criteria that terrorists themselves have indicated should be used in choosing targets.

4. There is evidence that terrorists train specifically to attack airports.

5. The case of the World Trade Center, which was attacked in 1993 and 2001, suggests that jihad terrorists have a pattern of revisiting particularly attractive targets.

6. Citing threat assessments, briefings, and other sources, many California law enforcement and security officials have concluded

that LAX is at or near the top of the list of potential targets that they are most concerned about.

As one security official we spoke with said, it's hard to find a better target than LAX that meets the sort of targeting criteria that we think terrorists use.

Finally, given the adaptive nature of terrorism, we simply do not know how future terrorists might attack airports and aircraft—it is simply prudent to consider the various ways in which LAX might be attacked to ensure that it is prepared for a wide range of plausible attack scenarios.

General Strategy for Defending Against Terrorism at LAX

Issue:	Terrorists plans are unknown; how can we best prepare?
Solution:	Shape the situation so that terrorists have no good opportunities. Reduce their chances of success and the damage they can inflict and increase their costs and risks.
Result:	• **Deterrence:** Terrorists will avoid targets with little vulnerability
	• **Damage limitation:** If deterrence fails, damage will be less

The keys to achieving both deterrence and damage limitation are *controlling and reducing vulnerability*

RAND   LAX Security Study-6 09/04

There are two significant features of the terrorist threat which shape a proper response:

1. We have no reliable ability to control or predict what terrorists might do.

2. We strongly prefer they do nothing. There are no scenarios leading to "good" terrorist attacks.

This is a situation familiar to law enforcement and in preventing nuclear war. The solution is to shape the situation so that in any scenario the outcomes from the terrorists' point of view will be unsatisfactory. This will achieve the primary goal of deterrence. Terrorists will look at the airport and decide that attacking is not worthwhile.

This solution may lead to the objection that this really does not solve the problem. Terrorists who are aware that LAX is a poor target for attack might decide to attack elsewhere—Dodger Stadium, for example.

This is true. However, by diverting terrorists from their most favored target we have presumably made the entire terrorist enterprise less attractive. Perhaps they will attack elsewhere, or perhaps they will give up terrorism. Moreover, diverting terrorists away from LAX is the most that LAWA can do. Diverting terrorists from LAX does not solve the

overall problem of terrorism, but it is a step in the right direction and an example to others tasked with security enforcement.

Operationally, the key to implementing a successful strategy of deterrence is to understand and reduce LAX's vulnerabilities. We create a situation in which terrorists have no good options.

We Used a Mixed Quantitative and Qualitative Approach

- **LAX facilities and operations vary widely in their importance and vulnerability**
- **These differences lead to dramatically different consequences after an attack**
- **We cannot and need not precisely quantify the probability of different types of attacks or their consequences**
- **Relative quantitative and qualitative assessments are appropriate**

RAND

LAX Security Study-8 09/04

LAWA's goal is to improve security at LAX as cost-effectively as possible. Unfortunately, given the uncertainties associated with the limited directly relevant historical data on threats and the adaptable nature of terrorists, cost-benefit assessment processes (similar to those used to manage risks against common criminal acts, accidents, and natural phenomena such as storms and earthquakes) are not applicable. Risk is the product of *consequences* and *likelihood*. *Consequences* for various assumed terrorist attacks are measurable or can be estimated (with the greatest controversy associated with putting a monetary "value" on human lives), but the *likelihood* cannot be meaningfully quantified. Because of this, we have associated risks with vulnerabilities, assuming that terrorists have the time and motivation to find and exploit weaknesses in LAX's security—particularly those vulnerabilities that can be exploited by those terrorists at modest costs (in dollars and human capital) and, most important, those vulnerabilities that expose them to the lowest risk of failure.

From the perspectives of vulnerabilities and consequences, LAX facilities and operations vary widely. We identified the most vulnerable locations with quantitative engineering and operational analyses of attack effects, and then made qualitative judgments of the relative risks and costs associated with mounting these attacks. Security enhancement opportunities and a sense of investment priorities emerge naturally from

this multistage quantitative and qualitative filtering process. The goal is to eliminate the most glaring weaknesses in order to put security measures into better *balance* for a given overall investment level. Another difficult question, of course, is what should this overall investment level be, but that determination was beyond the scope of this effort.

Approach Combined RAND Expertise, Site Visits, Interviews, Literature Review, and Data Analysis
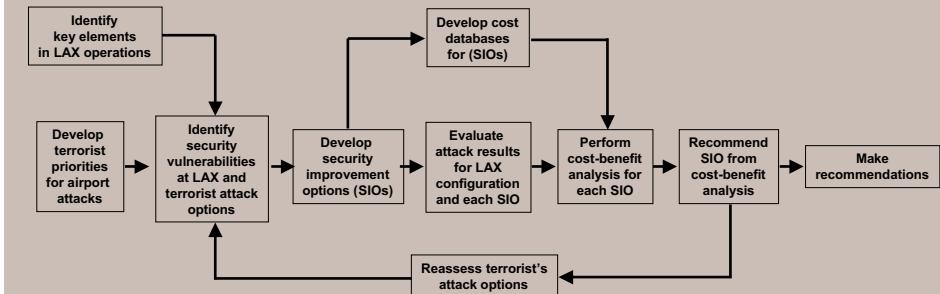
Shown above is the analytic approach we used in this study.

We began by looking at terrorists' historic priorities and options for attacking airports. We combined our findings with what we determined were LAX's key elements for operations (e.g., terminals, airliners, control towers, etc.) to develop a list of security vulnerabilities at LAX. From the list of vulnerabilities, we developed a suite of attack options for each vulnerability. This suite of attack options was based on the vulnerability of LAX and historic priorities for airports by terrorist organizations. We obtained feedback on this list of attack options from security professionals at LAWA, the Transportation Security Administration (TSA), the Los Angeles Police Department (LAPD), and LAX to make sure the list was reasonable. We assessed the damage (measured in fatalities, damage to the airport, and service interruption) for each of these attacks against LAX as it is today. From the list of attack options, we developed a list of security improvement options (SIOs) for each attack option. For each SIO we developed a cost estimate and a benefit (in terms of fatalities, damage, and service interruption averted should that attack be attempted) for implementing the option at LAX. We assessed the benefits of the SIO for all the attack options, not just the SIO for which it seemed the most effective. Next we conducted a cost-benefit analysis and selected the preferred SIO. This gave us our first preferred SIO.

To find our next preferred SIO, we assumed that LAX implemented our first SIO, and we went back and identified security vulnerabilities and terrorist options and repeated the process. It is important to reassess the terrorist's options after each SIO is implemented to capture the effect of terrorists adapting their attack options when LAX implements security improvement options.

From this iterative process, we developed our recommended security improvement options.

Before we can examine security improvement options at LAX, we need a suite of possible terrorist attack options. Shown above is the method we used for developing the list of attack options.

We began by identifying the key components of the airport that present a likely target for a terrorist attack. These components were selected based on the likelihood that, if they were attacked, the results would be a large number of fatalities, damage to the airport infrastructure, and interruption of airport operations.

Next we identified the effective ways the terrorists could attack each of the key components. The list of combinations of attack options and targets was narrowed by factoring in the feasibility of terrorists being able to carry out the attack.

Finally, we reduced the list further by considering the historic tendencies and expertise of the terrorist organizations, based on information we gained from intelligence organizations.

Applying this methodology we developed the list of 11 attack scenarios shown on the following page. This list includes the most likely threat scenarios, the breadth of possible threat scenarios, and the most challenging scenarios for us to defend against.

It is important to note again that this process was iterative; we applied this methodology after each LAX security improvement option was "implemented" in our model to account for terrorists adapting their strategies in response to any security enhancements LAX makes.

Terrorist Scenarios Examined

MANPADS · North runways · Air operations attack · Mortar attack · Terminals 1-3 · Truck bomb · Public grounds attack · Luggage bomb · Control tower/utility plant bomb · Curbside car bomb · Terminals 4-7 · Cargo bomb · Sniper attack · South runways · Insider-planted cargo bomb

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LAX Security Study-11 09/04
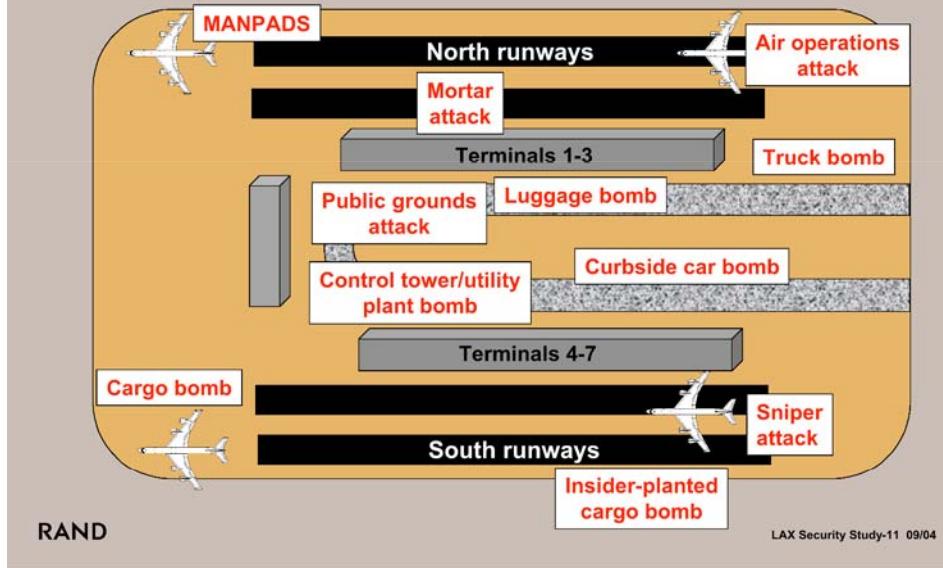
Shown above are the 11 attack options that emerged from the methodology described on the previous slide. The attack options are described below, starting with a MANPADS attack in the upper left of the slide and working our way around clockwise:

To evaluate the threat from a **MANPADS attack**, we examined the scenario where two surface-to-air missiles are launched from a boat in the bay adjacent to LAX, from the beach, or from the sand dunes, at a Boeing 777 taking off from LAX.

For the **mortar attack**, two homemade mortars are fitted into the back of a van. Terrorists fire mortar shells along the length of the runway.

For the **air operations attack,** a well-trained and well-equipped terrorist group scales the perimeter fence and attacks the fuel area, runways, and passenger aircraft. This is similar to an attack by the Tamil Tigers that occurred in Sri Lanka in 2001.

For the **large truck bomb,** a bomb is detonated inside a truck on the lower level next to a column supporting the upper roadway. The terrorists hope to collapse the upper roadway closing the airport for an extended period of time.

For the **curbside car bomb,** a car bomb is detonated on the upper level in front of a crowded terminal.

For the **luggage bomb,** a luggage bomb is detonated in either the curbside check-in line or the line inside a crowded terminal.

For the **sniper attack,** a sniper using a .50-caliber rifle fires at parked and taxiing aircraft from the roof of a high-rise building on the airport perimeter.

There were **two cargo bomb scenarios.** In the first, a bomb is placed in uninspected cargo. In the second, an insider places a cargo bomb in a passenger aircraft. In both cases the bomb is detonated during flight.

For the **air traffic control tower/utility plant bomb,** the terrorists hope to destroy either the tower or the utility plant with a car bomb.

For the **public grounds attack,** a terrorist jumps security controls, forcing evacuation of a terminal. This is coordinated with well-armed terrorists coming from vehicles blocking the entrance and exit to the airport and from the Tom Bradley terminal. The terrorists' goal is to kill as many civilians as possible.

An Unmodernized LAX Is Most Vulnerable to Cargo Bombs, Truck Bombs, and Luggage Bombs

Potential Fatalities

Major Threats ← | → Lesser Threats

0

Insider-planted bomb | Uninspected Cargo bomb | Large truck bomb | Luggage bomb | Curbside car bomb | Public grounds attack | Air operations attack | MANPADs attack | Control tower/ utility plant bomb | Sniper attack | Mortar attack

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LAX Security Study-13 09/04
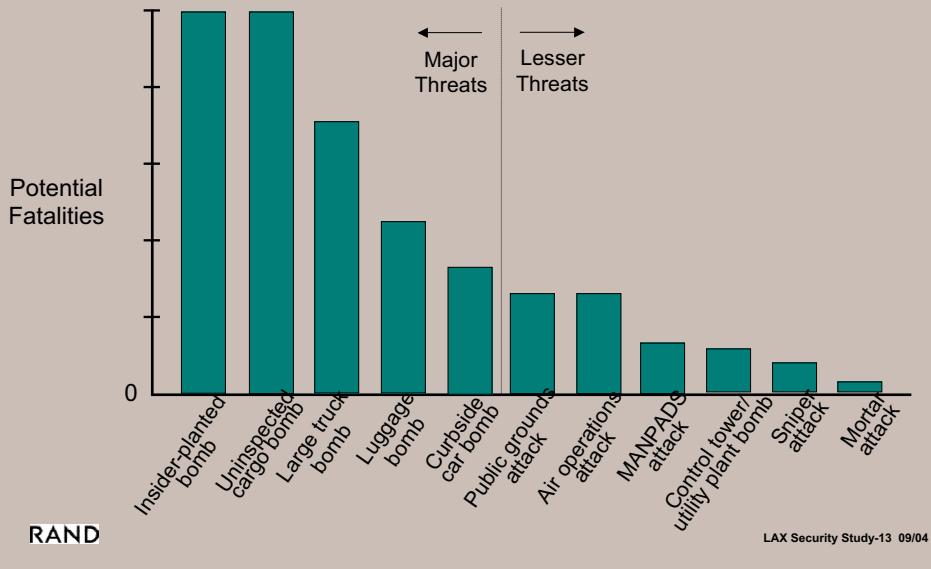
Shown above are the relative fatalities for each of the attack options against LAX before our recommended security enhancements. We note that the attacks fall into two categories, those that kill a large number of people which we call "major" threats and those that kill fewer people, which we call "lesser" threats. We refer to major and lesser threats again later.

We also examined other measures besides fatalities, such as "damage to the airport" and "interruptions to airport operations." For simplicity, we use fatalities averted as our measure of merit.

Example: Crowded Terminal

Ticket Counter
• 19 of the 30 windows are open
• Handling 240 people per hour

TSA
• Busy but no wait
• 7 lanes open
• Handling 1400 people per hour

Line for Ticket Counter
• 75 people in line
• Average wait: 20 minutes
• Average time at window: 6 minutes

Kiosks
• No wait

Inside Terminal
• 140 milling about appear lost
• Very crowded, hectic, unpleasant

X-ray Machines
• No wait

Passengers
• 50% don't check luggage
• 25% use skycaps
• 25% use ticket counter

Line for Skycaps
• 70 people in line
• Average wait: 17 minutes

Skycaps
• 3 of 4 skycap locations manned
• 2 people per skycap location
• Handling 240 people per hour

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LAX Security Study -15 09/04

This slide and the following slide show an example of how we conducted the analysis that went into the previous chart on LAX vulnerability. We began by describing a crowded terminal and then showed its vulnerability to luggage and curbside bombs.

This chart summarizes our observations of the situation at a crowded terminal around the check-in area on several weekday mornings in the summer of 2004. We note that the check-in area and the sidewalk outside are often quite crowded, with 300–400 people crowded into a small area. The striking thing about this crowd is that at any given time, most of these people are not doing anything except waiting in line. There are about 35 airport personnel who are checking and screening passengers' bags, and about 25 passengers are being processed at any given time, but the vast majority of those in the terminal and on the sidewalk are simply waiting in line for the opportunity to check in their baggage.

Passengers can check baggage at either the inside ticket counter or with the skycaps on the sidewalk. In either case, the wait is typically about 20 minutes. In our observations, neither the ticket counters nor the skycap stations were fully staffed.

We also note that many of the passengers waiting in the terminal have with them large pieces of luggage, none of which has yet been screened.

22

This is just one example; other terminals may have slightly different problems. In addition, these peak densities may occur in several terminals simultaneously.

Example: Luggage Bombs in Crowded Terminal

Luggage Bombs
- A luggage bomb in either the skycap line or check-in line will cause a significant number of fatalities and injuries
- These bombs could be coordinated with other bombs in other terminals increasing the number of fatalities

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LAX Security Study-16 09/04
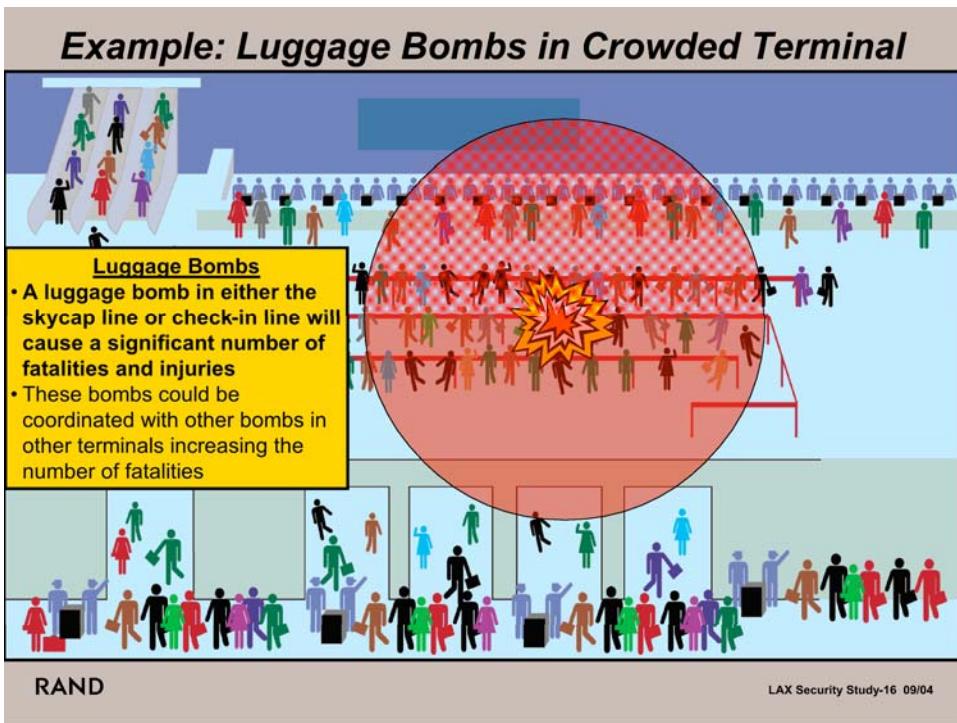
We consider two possible scenarios for attacks on a crowded terminal. In one, a bomb concealed in a suitcase explodes in the line of people waiting inside the terminal to check in luggage. In this case, a large number of people are killed and seriously injured. A luggage bomb exploding on the sidewalk would produce roughly the same number of casualties. The glass wall separating the interior from the sidewalk provides little protection, and, in any case, there is a dense crowd on the sidewalk as well as inside. These estimates are based on observed passenger densities in each region (approximately 12 square feet per person in screening lines, 16 square feet per person in check-in or skycap lines, and 80 square feet per person elsewhere in the terminals).

Recall that this concept, using bombs to attack people standing in line, is precisely what Ahmed Ressam (the millennium bomber) testified that he intended to implement. Ressam had no intention of committing suicide. He assessed that he could execute this type of attack and have a good chance of surviving.

We note that this type of attack could either be executed by a suicide bomber or by detonating the bomb without causing the death of the attacker. Simply walking away from a piece of luggage may not be immediately noticed in the generally confused conditions inside the terminal. Even if those in the crowd panicked and ran for the exits, they

24

would not be able to exit the interior quickly enough to avoid a bomb. Of course, an unsuspecting person could be asked to "watch" a terrorist's luggage while the terrorist claimed to be visiting the restroom, for example.

We found that our list of possible security improvement options for LAX easily fell into three categories.

In the first category are options that improve airport processes. These options tend to have small capital improvement costs and relatively low risk of failure. Some require an increase in personnel, which has a recurring cost.

In the second category are options requiring new technology. These options tend to have moderate capital and recurring costs but force us to assume some technical risk of the system(s) operating as planned.

The third category is new construction. These options have high capital expenses (relative to our technology or processes options), but most have low recurring costs because they do not increase the number of employees required. They also tend to involve lower technological risks than the technology solutions.

Options Examined for Improving LAX Security

- **Changing Processes**
  - **Operations**
    - **Hasten check-in and screening**
    - **Physically search packages entering terminals**
    - **Screen all cargo going into passenger planes**
    - **Inspect vehicles entering airport**
    - **Divert vehicles to remote lots for passenger pickup and drop-off.**
  - **Police**
    - **Increase combat training of LAWA police officers**
    - **Conduct background checks on all personnel with air operations access**
    - **Establish security relationship with buildings adjacent to LAX**
    - **Examine people in terminals with bomb-sniffing dogs**
    - **Increase patrol around airport**
- **New Technology**
  - **Add bomb detection capabilities to passenger or vehicle inspection**
  - **MANPADS countermeasures**
  - **Artillery-locating sensors to locate snipers or mortar**
- **New Construction**
  - **Harden curbside area with blast deflection and shatterproof glass**
  - **Add motion detection capability to perimeter fence**
  - **Isolate or modify pilings supporting upper roadway**
  - **Eliminate lane of traffic on upper roadway**
  - **Restrict access to central roads**
  - **Harden tower and utility plant**

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LAX Security Study-18 09/04

Potential defenses were identified by examining each attack scenario and seeking ways to reduce vulnerability by limiting exposure to attack, hardening the target to withstand attack, or intercepting the attacker. The options explored included the following.

CHANGING PROCESSES

Improving airport processes, the first category of possible security improvement options, can be further divided loosely into two categories: changes to operations—i.e., changing the way the airport manages vehicles, passengers, employees, delivery people, etc. (and therefore changing the experience these people have at the airport)—and changes to the security procedures used by the airport police.

Operations

Hasten check-in: By adding additional ticket agents and skycaps during peak periods (we estimate ~20 total positions), as well as one more TSA screening lane to each terminal (staffed for one net shift), queues in the terminals can be largely eliminated. Reducing the lines in the terminals will reduce the density of people within the terminals. Bombing attacks are less effective against dispersed passengers.

Physically search: Searching bags carried into each terminal will produce a vulnerable line at the doorway (simply changing the location of a bombing) unless the search is very highly staffed. Under this assumption, cursory searches (30 seconds) can require ~15 stations per terminal during peak hours; thorough searches (three minutes) can require almost 80. The resulting staffing requirements for long searches are not cost-effective.

Inspect cargo: Roughly 75 percent of the cargo carried on passenger planes can be inspected using luggage screening machines; we explored what the results would be in terms of costs and benefits if *only* screenable cargo were to be allowed on passenger planes, and the other 25 percent was searched manually.

Inspect vehicles: By establishing permanent security checkpoints at five airport access points, vehicles entering the airport can be searched for bombs. Staffing requirements are again driven by the need to avoid queues. Brief (10 seconds) examinations require ~20 total screening lanes and allow the largest bombs to be filtered. More thorough searches (one minute) require) require 65 screening lanes.

Divert vehicles: Rather than searching vehicles, the airport may opt to have traffic officers direct large vehicles to a remote lot in an attempt to prevent vehicles capable of carrying the largest bombs from approaching vulnerable areas. Passengers would board secure buses that would take them into the terminal area.

Police

Increase rapid reaction training: A portion of the LAWA department undertakes intense marksmanship and tactical training. We assume this consumes 15 percent of their duty time (requiring additional officers to be hired). These tactical officers will be more heavily armed and armored. As a baseline, we assume enough officers to maintain one on duty per terminal, as well as a squad able to quickly respond to events in the air operations area (AOA).

Conduct background checks: Personnel with access to the AOA are subjected to the same type of checks as applicants for secret security clearance (credit history, residence checks, and interviews), every five years.

Establish security relationship: The security of adjacent buildings is a concern to LAX because they can be used as firing positions. LAX should arrange to be notified immediately of security breaches (via special telephones reserved for that purpose—i.e., "red phones"), and community

security standards that would be followed by LAX and its neighbors should be established by municipal authorities.

Bomb-sniffing dogs: Officers with dogs trained to detect bombs move through terminal entrances and lobbies, randomly examining people (dogs, on average, can inspect one person per minute). Our initial costing was for ~ one dog and handler per terminal.

Increased patrol: Units of plainclothes security personnel in autos, boats, etc. are deployed to patrol the areas where MANPADS might be launched, with particular emphasis on vantage points where terrorists might be in range to strike planes mid-takeoff and landing. Unfortunately, this is an enormous area, and so patrols have very little chance of intercepting an attacker.

New Technology

Bomb detection: When bomb-detection equipment that is fast and reliable becomes available, it can be added to vehicle or personal inspections (replacing dogs), allowing highly effective probability of detection with rapid inspections (i.e., low manpower requirements). This will allow searches to intercept most any weapon brought to the airport.

MANPADS countermeasures: Defenses *based at LAX* can contribute only to the protection of planes taking off and landing, but these are particularly vulnerable conditions. Unfortunately, the location of the airport in a civilian area makes most countermeasure options undesirable, and of the few remaining, none are very effective. The only promising airport-based countermeasure is a high-energy laser, but these are still only in the prototype phase.

Artillery sensors: Acoustic systems can immediately locate the source of mortar and sniper fire to within a 5x5 meter location, allowing a chance to disrupt an attack if a patrol is close (and at the very least, raising the likelihood that the attacker will be caught). These are simple to use (on laptop computers) and very affordable.

New Construction

Harden curbside: Currently, glass walls are a major shrapnel hazard that add to the lethality of car bombs; changing materials and adding blast deflectors at the curb will reduce the severity of such attacks.

Enhance perimeter fence: A "leaky" coax-cable motion-detection system, isolated within a second fence inside the reinforced fence already being

constructed, provides a very reliable intrusion detection system. Police can respond immediately to intrusion and confront assailants before they venture close to aircraft.

Isolate pilings: Reinforcing support for upper roadways is considered very difficult by airport officials; few places remain to sink columns. An equally effective alternative is restructuring the lanes on the lower deck and using barriers to prevent vehicles from approaching closely. Unfortunately, to be even slightly effective this option consumes three lanes of traffic.

Eliminate upper lanes of traffic: Closing the right lane on the upper roadway reduces the effect of car bombs on terminal lobbies.

Restrict central access: Closing the entrance to the inner roadways to all but authorized LAWA personnel (using a gated entrance) makes it impossible to bring a car bomb adjacent to the tower or utility plant.

Harden air traffic control tower and utility plant: Geometric restrictions make it impossible to harden these buildings effectively without consuming road area around them, which makes hardening redundant.

Searching Luggage and Reducing the Density of People in Terminals Are Most Effective Solutions to Luggage Bombs

Fatalities Averted[1]

Search all luggage entering terminals | Reduce density of people in terminals | Add 30 handheld bomb detectors | Add permanent vehicle checkpoints w/bomb detection | Add 30 additional bomb sniffing dogs

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[1]Potential fatalities averted if attack were to occur.

LAX Security Study-21 09/04
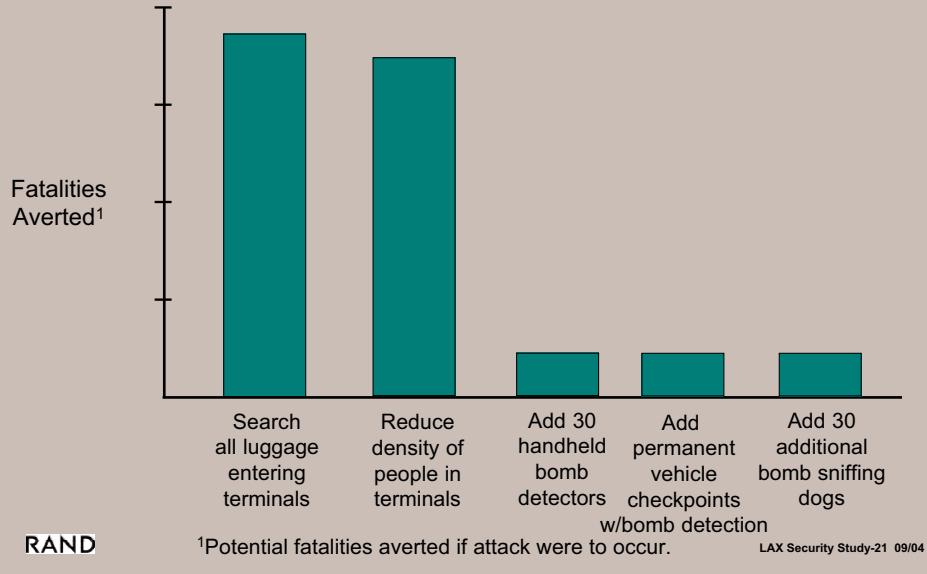
Shown above is the number of potential fatalities averted for a luggage bomb in a crowded terminal if one of the security improvement options is implemented.

Two options appear very effective, and three appear not very effective.

For the left-hand bar "Search all luggage entering terminals," we assumed everyone entering a terminal is subjected to a 30-second search of their luggage. Although this appears effective, it is very expensive.

The second bar pertains to a case where the airlines reduce the density of people in the terminal lobbies and at curbside check-in by hiring additional check-in personnel. As we will show later, this is our preferred option for dealing with luggage bombs and curbside car bombs.

Adding handheld bomb detection devices or bomb sniffing dogs with handlers wandering around the terminal checking for explosives is not very effective. There are too many people to check, and it takes too long to check a person's luggage. It would require ~100 dogs (with handlers) to effectively check all the luggage in a terminal.

Adding permanent checkpoints for automobiles does not help a lot with luggage bombs, but checkpoints are valuable for other scenarios (truck and car bombs). So, as we see later, they will be on our recommended list.

Increasing Check-In Personnel by 5% Could Reduce Fatalities by 80% Against Luggage Bomb

Service rate: 0.2 customers/min

Average Number in Queue
140
120
100
80
60
40
20

- - 3.73 arr/min
— 3.75 arr/min
...... 3.77 arr/min

Current, Add 1, Add 2, Add 3, Add 4, Add 5, Add 6, Add 7, Add 8, Add 9, Add 10

Number of check-in stations

Solid line is rate observed by RAND analysts
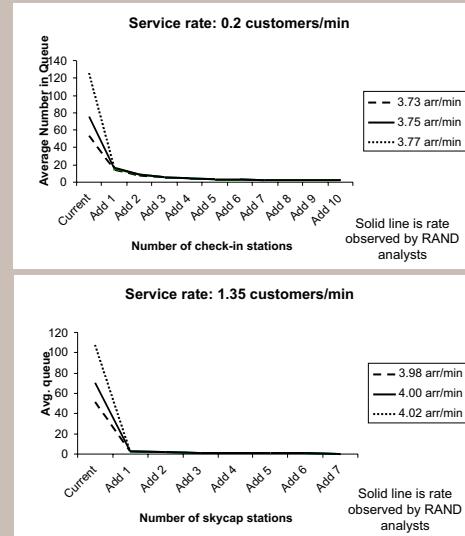
Currently:
- At crowded terminals the line at the skycaps and luggage check has 70-75 people in it
- A luggage bomb in either the skycap line or check-in line would kill a significant number of people

Service rate: 1.35 customers/min

Avg. queue
120
100
80
60
40
20
0

- - 3.98 arr/min
— 4.00 arr/min
...... 4.02 arr/min

Current, Add 1, Add 2, Add 3, Add 4, Add 5, Add 6, Add 7

Number of skycap stations

Solid line is rate observed by RAND analysts

By increasing the skycap and check-in personnel by one station each:
- Line lengths are reduced by 80-90%
- Density in the terminal is reduced by 75%
- **Fatalities from luggage bombs would be reduced by 80%**

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LAX Security Study-22 09/04

This chart shows how sensitive the lengths of the check-in and skycap lines are to the number of people checking-in luggage. The top figure shows the line length inside the terminal and the bottom figure is for curbside check-in. This chart shows that by increasing the number of personnel checking-in passengers by 5 percent we can reduce the density of people in the lobbies and on the curb by 75 percent, and the potential fatalities to luggage bombs by 80 percent.

During peak travel hours, check-in lines at the curbside skycaps and at the lobby ticket counters may become long. In addition to being an inconvenience to passengers, these lines are a safety and security concern. Large numbers of passengers gathered in a small space present a tempting target for terrorists seeking a high number of casualties. RAND researchers observed crowded terminals during busy periods and found lines at the skycaps and at ticket counters to be 70–75 people. If luggage bombs were used to attack those lines, a substantial number of people would be killed.

The overall goal should be to move passengers away from the curb and lobby as quickly as possible, and send them through screening and into the secure area, where they would be less vulnerable to attack. Reducing the check-in lines at the curbside skycaps and ticket counters would enable LAX to reduce the passenger densities in those areas, reducing the

number of casualties in the event of an attack, and thus presenting less temptation for an attack to occur in the first place. Passengers would spend less time waiting in line, reducing their inconvenience as well as the amount of time they are vulnerable to attack.

Reducing the line lengths does not require a large increase in staffing levels. If stations are staffed so that the overall service rate barely keeps up with passengers arriving for service, lines will build up to large numbers. Adding just a few more stations can have dramatic effects on line lengths. Standard mathematical queuing models (Markovian) were applied to the passenger arrival rates, waiting times, and line lengths observed by researchers. The models indicate that increasing the staffing level by one ticket counter station (from 19 to 20) would reduce average line length from 75 to 15. Similarly, increasing the staffing level by one skycap station (from three to four) would reduce the average line length from 70 to 3. These additions reduce the number of passengers vulnerable to attack at those locations by 80–90 percent.

The results are also sensitive to the rate at which passengers arrive. In our visits to the crowded terminals, the rate at which passengers arrived was 225 people per hour (3.75/minute) at the check-in counter and 240 passengers per hour (2.4/minute) at the curbside skycaps. These numbers correspond to the solid lines on the chart on the previous page. These rates were very predictable over the periods we examined. We also examined slightly lower and higher arrival rates as shown by the dashed lines.

Shown above are the cost estimates for the security improvement options we considered. All costs are in millions of FY2004 dollars. The first column shows the one-time capital expenditure cost. The second column shows the annual recurring costs. Most of the annual recurring costs are salary and benefits for additional employees. The right-hand column shows the total annual costs. The total annual cost is the annual cost of capital expenditures per year over a 10-year period after applying a 4.5 percent compounded annual interest rate over the 10-year timeframe (or a factor of 1.55) and the recurring operating cost. We used a 10-year time horizon because LAWA intends to make substantial changes to the airport in 10 years. When the table shows a range for the costs, we used the midpoint between the high and low cost estimates for our calculations.

These cost estimates are designed to be relative figures of merit to allow comparisons across various alternatives. The actual cost of implementing the proposed measures may vary from these estimates. Discussed below are the major assumptions and cost drivers that went into these calculations.

Add permanent checkpoint vehicle search with bomb detection capability (add shelter/restroom facilities, bomb sniffers, and LAWA inspectors). *The capital costs* include (1) the purchase of barriers to set up inspection lanes for 20 stations across five different locations (at $0.8

34

million), (2) the construction cost of shelter/restroom facilities (12 ft. x 12 ft. each at all five locations) (at $0.8 million), (3) 77 sets of bomb detection-related equipment at $25,000 each ($1.9 million), and (4) roadway construction cost to add one lane of traffic on the lower level on-ramp entry to the airport after leaving the Sepulveda northbound tunnel (at $3.0 million). The *annual recurring cost* is equal to the average number of inspectors—between 40 (20 per shift assuming as an average over 16 hrs/day) and 153 at a salary including benefits of ~$100,000 per year ($4.0 million to $15.3 million) plus $5,000 per year per inspector for training ($0.2 million to $.77 million), and an additional $0.5M for maintenance of the shelter and restroom facilities and roadway repairs or an average total recurring cost of $10.6 million.

Direct all vehicles to remote lots (add LAWA inspectors, buses, and parking attendants). The *capital costs* include (1) two-fifths of the same construction cost as above for one 24 x 24 square feet consolidated shelter/restrooms facility adjacent to a new remote parking lot plus two-fifths the quantity or 26 of the bomb-detection equipment cost (at $0.9 million), (2) the average construction cost for either (a) a parking lot expansion using only existing LAX land consisting of earth leveling and paving for 8,000 to 10,000 spaces (same as the equivalent number of spaces as the current center garages inside the roadway loop) (estimated at $50 million minimum) or (b) a large garage with up to five levels for the same equivalent number of spaces as the current center garages inside the roadway loop (estimated at $450 million maximum or $250 million), and (3) purchase of close to the same number of (natural gas–fueled) buses (50) that are already in the fleet that are assumed to be currently operating for LAX parking lots B and C (which include 11,000 spaces) (at an average purchase cost of $150,000 per bus) ($7.5 million). *Annual recurring cost* is the sum of (1) the average number of parking lot attendees/vehicle inspectors of ~ 33 at a salary including benefits of ~$100,000 per year ($3.3 million) plus $5,000 per year per inspector for training ($0.17 million or $3.5 million), (2) the salary (plus benefits) of the additional drivers based on 45 additional buses operating at peak, which requires 90 drivers available over an average day of 16 hours at $60,000 per year salary (including benefits) ($5.4 million), and (3) bus maintenance at $0.75 average cost per mile x 30,000 miles per year per bus for the 45 buses (at $1.0 million).

Curbside blast barrier deflection plus shatter-resistant glass (add LAWA maintenance). The *capital cost* is estimated between $6 million (25 percent weighting) to $21 million (75 percent weighting) or $17.3 million for (1) the purchase and installation of 6-feet high blast barriers (of concrete-reinforced steel and sand) near curbside on the lower and upper-level

roadways across all terminals with openings for existing pedestrian crosswalks (estimated at 24,165 linear feet at a range of between $175 and $666 per square foot or $4.2 million to $16.1 million) and (2) the purchase and installation of shatter-resistant film coatings on all eight terminal front glass windows (at between $1.8 million to $4.9 million). The annual *recurring cost* assumes two additional LAWA maintenance personnel per year at $100,000 (salary plus benefits) each to maintain barriers and shatter-resistant film coatings (at $0.2 million).

Eliminate lane closest to terminals on upper roadways (add air carrier skycaps). The *capital expense* consists of putting up traffic barriers on upper roadway estimated at $0.5 million. The *annual recurring cost* consists of adding one curbside station per terminal of two skycaps each or 32 skycaps over the eight terminals based on 16 hours per day at a salary of $60,000 (with benefits) per skycap or $1.9 million.

Add pilings on lower-level roadways (add LAWA maintenance). The *capital cost expenditure* is estimated at a range between $21.6 million (with a 25 percent weighting) to $32.4 million (with a 75 percent weighting) to add one structural concrete-reinforced piling an equal distance between each existing piling below the LAX upper-level roadways including the on-ramps from Century Boulevard and Sky Way where the upper roadways begin (prior to Terminal 1 and ending at the off-ramps to Sepulveda Boulevard after Terminal 8). The construction cost is based on an estimated cost of $270,000 per piling for an estimated quantity of between 80 and 120 pilings. *Recurring operating expense* assumes two additional LAWA maintenance personnel per year at $100,000 each or $0.2 million.

Search all packages entering terminals (add TSA inspectors). *Assumed no capital cost.* For *recurring annual cost*, if the search takes three minutes/passenger, an estimate of 77 search stations per terminal at peak are needed. If the search takes 30 seconds per passenger, an estimated 14 search stations at peak per terminal are needed. On average, we assumed that 14 inspectors are needed over one eight-hour shift or 28 inspectors over an average of 16 hours per day for each terminal. A TSA inspector salary of $80,000 (including benefits and training) is applied for 28 x 8 terminals or 224 inspectors at a cost of $17.9 million.

Add handheld bomb sniffers (TSA purchase plus training). The recurring cost of adding TSA inspectors in the above paragraph is based on an average number needed over a 24-hour period, but the *capital cost* for procuring the bomb detection devices for these inspectors is estimated at $25,000 each to handle the peak of 77 inspectors for three terminals (#1, Bradley, and #7) and 14 inspectors at peak at the remaining five terminals

or $7.5 million. The *recurring annual cost* is estimated as the training cost for the total number of 224 TSA inspectors estimated at $10,000 per year for each or $2.2 million.

Add bomb-sniffing dogs (LAX Police Department). The *annual recurring cost* is estimated based on the upkeep and food for 30 K-9 dogs at an expense of $11,000 per year (at $.33 million) plus the salary of 30 LAWA Police Department handlers (with benefits and training at $110,000 per year, with 11 deployed per 12-hour shift (at $3.3 million).

Speed check-in, TSA lines (TSA plus air carriers). The *capital cost* is estimated based on (1) purchasing and installing one explosive trace detection (ETD) machine (at $120,000 each plus 16 percent of $120,000 for installation cost) in three of the eight terminals (#1, #7, and Bradley) at $0.42 million and (2) the estimated cost of remodeling each terminal to make additional floor space estimated at $150,000 per terminal or $0.45 million. The *annual recurring cost* is based on (1) adding 12 TSA inspectors per shift (four per ETD station) or 24 inspectors over a 16-hour average work day at a salary with benefits of $80,000 per year at $1.9 million and (2) adding one skycap station with two skycaps and four ticket agents over the same three terminals per 8-hour shift, with an average working day of 16 hours at a salary with benefits at $60,000 per year, estimated at $2.2 million.

Inspect all cargo going into passenger planes (TSA screening equipment plus additional inspectors). We assumed on average, cargo screening cost on passenger aircraft is equivalent to ~ 50 percent of the capital cost estimate of procuring and installing baggage screening equipment and ~ 33 percent of the recurring cost of adding TSA inspectors' labor salary of $80,000 including benefits. TSA has a new fiscal year 2004 screening level (head count) of 2,695 employees at LAX, which represents an annual operating expense at LAX of $216 million. LAX currently has 270 ETD systems and 60 explosive detection systems (EDS). The current unit procurement cost for EDS machines is ~ $0.9 million each (based on a July 2004 procurement of 37 machines from L-3 Communication) and ETD system cost at ~$0.5 million. Therefore, the *capital cost* for (1) purchasing half the quantity of the same mix of ETD and EDS machines at LAX for cargo screening would be ~$94.5 million, (2) another 16 percent of the purchase price for installation or $15.1 million, and (3) an estimate of the cost of remodeling and/or minor construction needed for the cargo screening at an existing facility of $1.6 million for a total capital expense of $111 million. The annual operating expense is based on (1) adding one-third more TSA inspectors or 889 at a salary of $80,000 per year (including benefits) estimated at $71.1 million and (2) an annual maintenance cost of these screening machines estimated at 4 percent of the purchase cost of

ETD equipment and 8 percent of the purchase cost of EDS equipment or $4.9 million per year.

Add motion-detection system near all aircraft. The *capital cost* is estimated by assuming ~ 110 aircraft at each of LAX's gates/jet way areas and that each motion detector system is estimated at ~$1,000 per gate purchased initially at $0.11 million along with one central workstation for monitoring alerts estimated at $0.9 million. The *annual recurring cost* consists of (1) two additional LAWA employees needed (one per shift or two over a 16-hour day) that are trained to monitor alerts at the central control station at $0.2 million and (2) the estimated cost of replacing these motion detectors at the same fiscal year 2004 cost, on average, once every three years at $0.05 million.

Background checks on airport personnel. As of August 23, 2002, 39,150 employees at LAX held SIDA (Security ID Display Area) badges. We assumed the *capital cost* for the development of a centralized personnel information data base at $2 million and an *annual recurring cost* of $5,000 for each background investigation initially for ~ 40,000 employees and then again repeated once every seven years for a total of $34 million yearly.

Add motion sensors to second perimeter fence. The *capital cost* was estimated by (1) assuming the cost of the second perimeter fence is $17.50 per linear foot over the 15-mile perimeter or $1.4 million, (2) an estimated cost of $175 per linear foot over 50 percent of the 15 mile perimeter or $6.9 million for initial purchase and underground installation of a coaxial cable motion detector system and removal of obstructions in between the two fences, (3) an estimated cost of $700 per linear foot over 50 percent of the 15-mile perimeter or $27.7 million; and (4) a central workstation with software installed for monitoring alerts at $200,000. The *annually recurring cost* was estimated by (1) adding two additional LAWA employees trained to monitor alerts at a central control station at a salary of $100 thousand per year including benefits or $0.2 million; and (2) repairing and/or replacing the second perimeter fence with coaxial cable motion detector sensor system using a service contract estimated at $0.3 million.

Antiterrorist rapid reaction force (15 trained LAX Police Department personnel). The *capital cost* consisted of procuring special weapons and setting up the initial training courses estimated at a total cost of $200,000. The *annual recurring cost* is based on a force of 15 existing officers receiving incentive pay each for two 12-hour shifts and recurring continuous training of three days per month estimated at a total cost of $1.55 million for a total of $2 million yearly.

Patrol MANPADS-vulnerable areas (LAPD). The *capital cost* is estimated as an average procurement cost of between 24 and 36 patrol cars at $50,000 each monitoring 8 km of roadway with two LAPD officers per vehicle over two 12-hour shifts. The *annual recurring cost* is (1) the salary plus benefits of the additional police force of an average between 48 and 72 officers (average of 60) at $6 million, (2) training at $0.9 million, and (3) patrol car maintenance cost estimated at $0.3 million, and (4) the re-procurement of new patrol cars, on average, approximately every three years at a cost of $0.6 million.

Add ground laser for MANPADS detection (Department of Homeland Security expense). The *capital cost* is estimated as the acquisition cost for procuring one Northrop Grumman Hunter high-powered laser system at a cost of between $30 million and $100 million. The *annual recurring cost* is estimated assuming up to five operators/maintainers assumed each shift or a total of 10 over two 12-hour shifts at an average salary of $110,000 including benefits and training. The equivalent of Hunter (MTHEL) is now going through demo testing with the U.S. Army.

Sensors to locate mortars. The *capital cost* estimate is based on one-fifth to one-tenth the cost of the U.S. Army's Firefinder Radar TLQ-37's cost, where the "full" system with vehicles, spares, and generators is estimated to cost up to $20 million.

Restrict roadway near air traffic control tower and utility plant. The *capital cost* includes closing the center roadway, setting up permanent traffic barriers, and restricting access with security fence(s) to allow only LAWA and air traffic control employees to enter near the air traffic control tower and utility plant. The *annual recurring operating expense* includes, on average, two additional LAWA security officers over a 16-hour day at a salary with benefits and training at $110,000 per year.

Reducing Density of People in Terminals Is the Most Cost-Effective Solution to Luggage Bombs

Fatalities Averted[1]

Annual Cost of LAX Modification ($M)

| 0 |
| 4 |
| 8 |
| 12 |
| 16 |
| 20 |

Search all luggage entering terminals | Reduce density of people in terminals | Add 30 handheld bomb detectors | Add permanent vehicle checkpoints w/bomb det. | Add 30 additional bomb sniffing dogs

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[1]Potential fatalities averted if attack occurred.

LAX Security Study-29 09/04
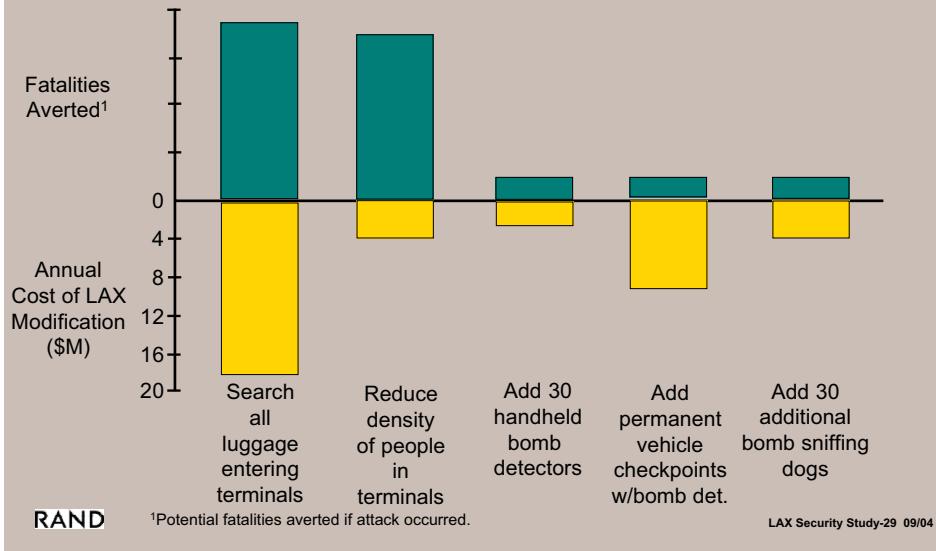
Shown above is the cost (expressed as annualized cost of the LAX modification) and benefit (expressed as the fatalities averted if the attack were attempted) for each of the five security improvement options we considered for luggage bombs.

Notice that searching all the baggage entering terminals costs about $18 million per year. Nearly 225 screeners would be required to process all the passengers without allowing a line of three people or longer to develop.

Reducing the density of people in the terminals appears to be the most cost-effective because it is both very effective and inexpensive.

Searching all automobiles is not particularly cost-effective for finding luggage bombs, but it is for other threat scenarios so its advantages appear evident in those scenarios.

Handheld bomb detection devices and bomb sniffing dogs do not appear to be very cost-effective. The primary cost component is the salary of the handlers.

For this scenario, reducing the density of people in terminals is the most cost-effective solution.

Several Options Are Effective Against Curbside Car Bombs

Fatalities Averted[1]

Annualized Cost of LAX Modification ($M)

0
10
20
30
40
50

Add permanent checkpoints with bomb detection

Divert all vehicles to remote parking lots

Add curbside blast deflectors and shatterproof glass

Reduce density of people in terminals

[1]Potential fatalities averted if attack occurred.

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LAX Security Study-30 09/04
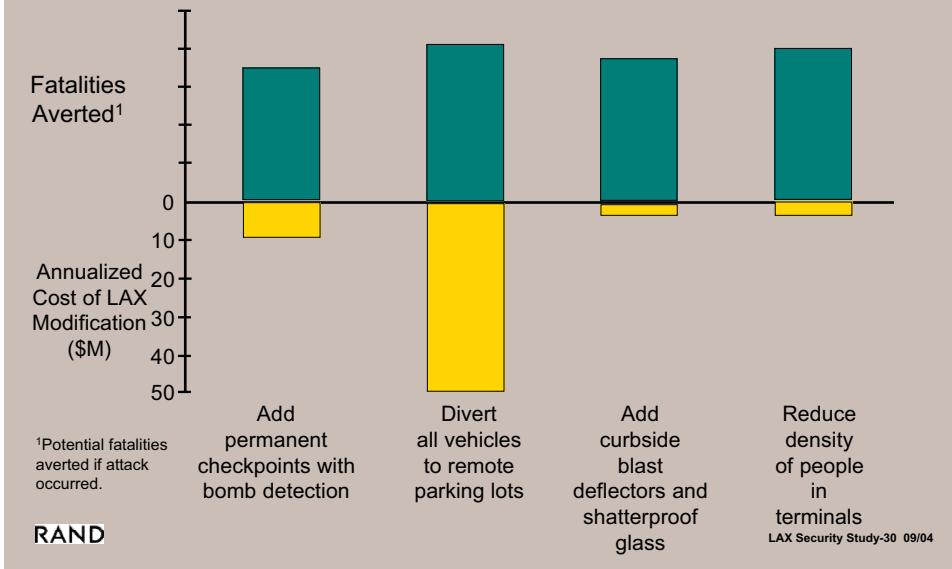
Shown above are the costs and benefits for different security improvement options against curbside car bombs.

All of the options look cost-effective relative to diverting all vehicles to remote parking lots. The capital cost of $260 million and the recurring cost of $12 million per year make diverting all vehicles unaffordable, especially since there are cheaper (and nearly as effective) alternatives in each scenario.

The other three SIOs appear roughly equal in this scenario. The difference between them is in the other scenarios where they help.

Reducing the density of people in the terminal lobbies helps with this scenario and any scenario involving public grounds bombs. It is also the only SIO that helps with luggage bombs.

Adding permanent checkpoints helps with this scenario and any scenario involving large bombs (large car bombs or truck bombs).

Adding curbside blast deflectors and shatter-resistant glass appears about as cost-effective as permanent checkpoints and reducing the density of people in terminals for this scenario. This is the only scenario where this option improves survivability.

Cost Benefit Assessment of LAX Security Options

	Insider-placed bomb	Cargo bomb	Truck bomb	Luggage bomb	Curbside car bomb	Public grounds attack	Air operations attack	Tower/utility bombing	MANPADS attack	Sniper attack	Mortar attack
Speed check-in, TSA lines			G	G	G	Y					
Vehicle checkpoints w/bomb detect			G		G	Y		G			
Inspect all air cargo		G									
Background checks on personnel	G										
Restrict tower and utility plant								G			
Additional pilings			Y								
Bomb-sniffing dogs at terminals				Y							
Curbside blast deflect + glass			Y	Y	Y						
Divert all vehicles to remote lots			Y		Y			Y			
Double fence w/ motion detection							Y				
Eliminate lane closest to terminals					Y						
Handheld bomb sniffers at terminals				Y							
MANPADs countermeasures (ground)									Y		
Manually search packages entering											
Motion detection systems at aircraft	Y										
Patrol vulnerable areas									Y		Y
Rapid-reaction training						Y	Y				
Secure nearby bldgs + obscure LOS[1]										Y	
Sensors to locate mortar											Y

[1]Line of sight

G	Most cost effective solutions
Y	Less cost effective solutions

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This matrix summarizes our assessments of the 19 SIOs in terms of their potential cost-benefits against each of the 11 threat scenarios we considered. The darkest (G for green) boxes represent the most attractive solutions (from cost-effectiveness perspectives) to individual threats. The lightest boxes (Y for yellow) are less attractive than the darker boxes, but are nevertheless worth considering. The unmarked boxes are not interesting (i.e., they are either too costly for the benefit or of no [or possibly even negative] utility).

SIOs (e.g., speeding check-ins) that are marked G for a number of threats are obviously of relatively greater utility than those that do not (e.g., additional pilings), while others (e.g., curbside blast deflectors/shatter-resistant glass) may not be totally adequate (G) for any particular threat, but may be somewhat useful (Y) for many.

For a specific threat (e.g., an insider-planted bomb), there may be only one or two SIOs that have some benefit (e.g., background checks—G, and motion detection systems—Y). For other threats (e.g., sniper attacks), we were unable to identify any truly satisfactory solutions (e.g., secure nearby buildings—Y).

We are aware that there has been a lot of concern focused on the size of bombs that may threaten LAX. Our view, however, is that the size is relevant, but the location is everything. A small bomb, placed to exploit particular vulnerabilities, can be more effective than a much larger bomb with less access to sensitive areas.

When issues of threat opportunity, demonstrated capabilities, and consequences are considered, we believe that the five areas of vulnerability outlined in the chart above should be of the most immediate concern to LAX.

Finally, solutions to these vulnerabilities fall into four categories as shown in the last part of this chart. Some are "best buys" and can and should be acted on immediately. Others are more difficult and/or expensive but still address major problems. These should be studied further to identify affordable, time-phased solutions (or even partial solutions). Other more minor problems may be addressed in a more deliberate fashion as opportunities arise from planned modernization changes to LAX operations and facilities. Obviously, expensive solutions to minor problems should be deferred pending attention to the more immediate problems.

Rating Security Improvement Options

Inexpensive solutions to major problems
  1. **Limit density of people in terminals**
     - Hasten check-in by adding skycaps, check-in, and TSA personnel
     - Reduces vulnerability to luggage and curbside car bombs
  2. **Add permanent automobile security checkpoints with bomb detection capability**
     - Add bomb detection capability as technology becomes available
     - Reduces vulnerability to large car bombs

Expensive solutions to major problems
  1. **Inspect all cargo on passenger flights**
     - Reduces vulnerability to the most lethal threat (cargo bomb)
  2. **Enhance screening of airport personnel**
     - Reduces insider threat

Inexpensive solutions to minor problems
  1. **Enhance training of airport rapid reaction team**
     - Enhance training of airport quick reaction team to SWAT team level
     - Reduces vulnerability to heavily armed terrorists
  2. **Improve perimeter fence**
     - Double fence with motion detection between fences
     - Reduces vulnerability of air operations attack

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LAX Security Study-33 09/04

Two security improvement options fall into the category of inexpensive solutions to major problems. The first is to limit the density of people in terminals. This can be accomplished by adding about 20 additional personnel. This will greatly reduce LAX's vulnerability to curbside and luggage bombs.

Adding permanent automobile checkpoints with bomb detection equipment is the second inexpensive solution to a major problem. It would reduce LAX's vulnerability to large car and truck bombs. LAWA should go forward with the currently unfunded program to add permanent automobile checkpoints.

Enhancing the inspection of cargo on passenger flights is more expensive than the previous two options, but it will significantly reduce LAX's vulnerability to cargo bombs. Enhancing the screening of airport personnel is also more expensive than the first two options but it will reduce LAX's vulnerability to cargo bombs or any threat that is enhanced with insider support.

Finally there are two options that are inexpensive and probably worthwhile, but they do not reduce LAX's vulnerability to major threats. The first is to improve the perimeter fence. This will reduce LAX's vulnerability to over-the-fence attacks. It will also greatly reduce the number of "crazies" wandering onto the runways. Finally, enhancing the

44

training of the airport rapid reaction team will allow LAX to quickly respond to heavily armed terrorist attacks.

Recommended LAWA Security Initiatives

- **Reduce human exposure to public grounds car and truck bomb threats**
  - Lower terminal densities
  - Implement permanent checkpoint vehicle search
- **Address air operations terrorist (including insider) threats to the aircraft**
  - Enhance screening of airport personnel
- **Work with local and federal agencies to mitigate threats beyond LAWA's sole jurisdiction**
  - Inspect cargo and mail
- **Develop reconstitution plans and capabilities to address the impact of attacks on airport operations**
- **Conduct periodic independent security assessments and address findings**
- **Work with national and international airport security organizations to raise the level of security across the industry**

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LAX Security Study-34 09/04

We recommend that the most glaring, easily fixed issues be addressed first, namely the risks associated with unnecessarily overcrowded terminals.

Next, we believe it is important to bring air operations security up to the same generally high standards as the terminal operations. Solution directions are generally clear, but their costs and effectiveness are less clear. We recommend that the process of implementing the actions outlined here should begin immediately, with further study and phased investments flowing from these studies.

Unfortunately, there are a number of vulnerabilities to LAX operations that LAWA cannot address unilaterally. These will require cooperative initiatives with other local, state, and federal agencies as organized and coordinated by LAWA.

Since no security measures can be perfect, LAWA must also plan and equip for rapid damage control and service reconstitution following an attack. These plans must anticipate the political and social aftermath of an attack, and they must be designed to help rebuild public confidence.

Terrorist threats will change and react to our changes at LAX; therefore, security at the airport must be periodically examined and tested by independent entities with no direct stake in airport operations.

Finally, since LAX is only one element of the international air transport system, its security affects and is affected by security at other airports. LAWA must conduct outreach and information sharing efforts to help raise the security bar across the industry.