11-1-2005

Designing and Operating Safe and Secure Transit Systems: Assessing Current Practices in the United States and Abroad, MTI Report 04-05

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MTI

Mineta Transportation Institute

Created by Congress in 1991

MTI REPORT 04-05

DESIGNING AND OPERATING SAFE AND SECURE TRANSIT SYSTEMS: ASSESSING CURRENT PRACTICES IN THE UNITED STATES AND ABROAD

November 2005

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A Report Cosponsored by the UCLA International Institute

a publication of the
Mineta Transportation Institute
College of Business
San José State University
San Jose, CA 95192-0219

Technical Report Documentation Page

1. Report No. FHWA/CA/OR-2005-107	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Designing and Operating Safe and Secure Transit Systems: Assessing Current Practices in the United States and Abroad		5. Report Date November 2005 6. Performing Organization Code
7. Authors Brian D. Taylor, Ph.D., Anastasia Loukaitou-Sideris, Ph.D., et al.		8. Performing Organization Report MTI 04-05
9. Performing Organization Name and Address Mineta Transportation Institute College of Business San José State University		10. Work Unit No. 11. Contract or Grant No. 65W136
12. Sponsoring Agency Name and Address California Department of Transportation Sacramento, CA 95819	U.S. Department of Transportation Research and Special Programs Administration 400 7th Street, SW Washington, DC 20590-0001	13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Public transit systems around the world have for decades served as a principal venue for terrorist acts. Today, transit security is widely viewed as an important public policy issue and is a high priority at most large transit systems and at smaller systems operating in large metropolitan areas. Research on transit security in the United States has mushroomed since 9/11; this study is part of that new wave of research. This study contributes to our understanding of transit security by (1) reviewing and synthesizing nearly all previously published research on transit terrorism; (2) conducting detailed case studies of transit systems in London, Madrid, New York, Paris, Tokyo, and Washington, D.C.; (3) interviewing federal officials here in the United States responsible for overseeing transit security and transit industry representatives both here and abroad to learn about efforts to coordinate and finance transit security planning; and (4) surveying 113 of the largest transit operators in the United States. Our major findings include: (1) the threat of transit terrorism is probably not universal—most major attacks in the developed world have been on the largest systems in the largest cities; (2) this asymmetry of risk does not square with fiscal politics that seek to spread security funding among many jurisdictions; (3) transit managers are struggling to balance the costs and (uncertain) benefits of increased security against the costs and (certain) benefits of attracting passengers; (4) coordination and cooperation between security and transit agencies is improving, but far from complete; (5) enlisting passengers in surveillance has benefits, but fearful passengers may stop using public transit; (6) the role of crime prevention through environmental design in security planning is waxing; and (7) given the uncertain effectiveness of antitransit terrorism efforts, the most tangible benefits of increased attention to and spending on transit security may be a reduction in transit-related person and property crimes.

17. Key Words Bombings; Building materials; Case studies; Chemical attack; Public transit; Safety and security; Terrorism	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 290	22. Price $15.00

Form DOT F 1700.7 (8-72)

Library of Congress Catalog Card Number: 2005924526

To order this publication, please contact the following:
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ACKNOWLEDGMENTS

This study was a joint endeavor of faculty and students in the Department of Urban Planning and Institute of Transportation Studies at the University of California, Los Angeles (UCLA); the Institute of Transportation Studies at the University of California, Berkeley; and the Mineta Transportation Institute at San José State University (SJSU). Research funding was provided by the Mineta Transportation Institute and the UCLA International Institute. The authors are grateful for this support.

The work of this report was a truly collaborative effort by faculty, staff, and graduate students at these three academic institutions. The introduction to the study was written by Anastasia Loukaitou-Sideris with contributions by Brian Taylor and input from other team members. The second section, “Securing Urban Rail Transit Systems against Terrorism: A Review of the Literature,” was written by Ellen Cavanagh and edited by Martin Wachs and Camille Fink. Camille Fink, with input from other team members, created the survey instrument administered to transit operators in the United States. Norman Wong coded the survey instrument and prepared its electronic format, set up and managed the survey Website, and generated the survey sample. Robin Liggett analyzed the results of the survey and coauthored the third section with Brian Taylor. The interviews for the fourth section were conducted by Peter Haas, Camille Fink, and Ellen Cavanagh; the section was written by Peter Haas and Camille Fink. The fifth section, “Case Studies of Contemporary Terrorist Incidents,” was primarily written by Christopher Cherry and edited by Martin Wachs and Anastasia Loukaitou-Sideris, who also wrote the Madrid case study in this section. The interviews for the section “Transit Security Strategies of International Agencies” were conducted by Rachel Factor, Camille Fink, Babak Hedjazi, and Kimiko Shiki; the section was written by Anastasia Loukaitou-Sideris. The concluding section and executive summary were written by Brian Taylor, with input from Anastasia Loukaitou-Sideris and Camille Fink. Norman Wong provided significant support in the compilation, formatting, and editing of the full document. Douglas Ng designed the letterhead that was sent out to the transit agency operators. Photos of the Madrid, Paris, Tokyo, and Hong Kong subway stations were taken by Rachel Factor, Babak Hedjazi, Kimiko Shiki, and Norman Wong.

The authors are especially grateful for the work of urban planning Ph.D. students Babak Hedjazi and Kimiko Shiki, and urban planning M.A. student Rachel Factor for conducting, translating, and transcripting the Paris, Tokyo, and Madrid field interviews in French, Japanese, and Spanish, respectively. Without the exceptional programming and computer skills of Norman Wong, our extensive online survey would not have been possible.

The authors thank our project advisory board—Annabelle Boyd, Frances Edwards, Greg Hull, Brian Jenkins, John Sullivan, and Amy Zegart—for their helpful comments and suggestions on earlier drafts of this report. We also wish to thank all the transit managers, chiefs of security, planners, and architects who took time to share their thoughts and opinions in our interviews and survey.

Thanks are also offered to MTI staff, including Research Director Trixie Johnson, Research and Publications Assistant Sonya Cardenas, Webmaster Barney Murray, and Graphic Artist Shun Nelson. Editing and publication services were provided by Catherine Frazier, Irene Rush, and Beth Blevins.

EDITOR'S NOTE

The attacks on the London subway and bus systems in July 2005 occurred as this report was being prepared for publication. A complete case study of the event will be done by the Mineta Transportation Institute (MTI) through the National Transportation Security Center at MTI.

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EXECUTIVE SUMMARY

> *(CNN)—U.S. mass transit systems were put on higher alert after Thursday's bombings in London, with officials in major cities urging Americans to go about their business but be on the lookout for anything suspicious… New York Police Commissioner Ray Kelly told CNN his officers were "doing everything that's prudent, everything that we reasonably can do to protect the city." But he said it was impossible to put a police officer "on every train all the time, or one on every station all the time."*
>
> (http://www.cnn.com/2005/US/07/07/us.response/; Posted: Thursday, July 7, 2005, 11:41 pm EDT (03:41 GMT))

While the most significant terrorist attacks—such as the sarin attack in Tokyo or the bombing of the Paris Metro—garnered worldwide public attention during the 1990s, popular and political response in the United States was generally muted. Perhaps this was because attacks on U.S. transit systems were still quite rare; perhaps this was due to Americans' legendary parochialism; or perhaps it simply reflected wishful thinking. Whatever the reasons for this indifference, it was not justified.

During the mid-1990s, four separate acts of terrorism and extreme violence on U.S. transit and rail systems killed fourteen and injured more than one thousand.[*] While police and intelligence officials who oversee transit properties grew much more vigilant and vocal in the late-1990s in calling for increased attention to the vulnerability of public transit systems to terrorist acts, the issue still had not caught the attention of most transit passengers, voters, members of the media, or elected officials.

This all changed, of course, on September 11, 2001. While the focus of the 9/11 attacks was on a different part of the transportation system, the effects on the affected public transit systems were dramatic and, in the case of New York, long-lasting. The vulnerability of open, accessible public transit systems and their passengers to terrorist acts was cast in the sharpest possible relief. Concern over the vulnerability of transit systems has been heightened further by the more recent, deadly, March 11, 2004, attacks on commuter rail trains in Madrid, Spain, and the July 2005 attacks on the London Underground and bus systems. The London attacks, in particular, dominated news coverage for at least a week and raised popular concern over

[*] Annabelle Boyd and John P. Sullivan, "Emergency Preparedness for Transit Terrorism," in *TCRP Synthesis 27*. Washington, D.C.: National Research Council, 1997.

transit terrorism in the United States such that transit security in the United States is now widely viewed as an important public policy issue.

The attention and subsequent fear generated by these attacks have clearly motivated policymakers into action. Indeed, one of the more sobering lessons from the research reported here is that significant system- or industry-wide changes in security planning have often required either prolonged exposure to lower-scale attacks (such as those perpetrated by the Irish Republican Army (IRA) against transit systems in greater London) or a mass casualty event (such as in Tokyo, Madrid, or most recently, London). Absent such events, concerns—even repeated, dire warnings by vigilant police and intelligence officials—have too often gone unheeded by many elected officials.

Research Approach

Research on transit security in the United States has mushroomed since 9/11; this study is part of that new wave of research. This study contributes to our understanding of transit security in several ways. Perhaps most important, we employ a wide array of approaches and methods to examine a complicated issue: How are transit managers around the United States and around the world working to better protect their systems and passengers from terrorist attacks? To address this question, we have pursued a multipronged research approach.

1. We reviewed and synthesized nearly all previously published research on transit terrorism and updated previous efforts to systematically chronicle previous terrorist attacks on transit systems around the globe.
2. We complemented these detailed case studies and interviews with a comprehensive survey of 113 of the largest transit operators in the United States regarding prior threats and attacks, past and current security planning and policing efforts, and approaches to four security strategies: policing, technology/hardware, public education/outreach, and crime prevention through environmental design (CPTED).
3. We conducted detailed interviews with federal officials here in the United States responsible for overseeing transit security, and with transit industry representatives both here and abroad, to learn about efforts to coordinate and finance transit security planning.
4. We conducted detailed case studies of terrorist attacks on transit systems in London (prior to July 2005), Madrid, New York, Paris, Tokyo, and Washington, D.C. These case studies

involved reviews of documentary evidence and other written materials, and in-depth interviews with transit officials and other key stakeholders.

Thus, our multipronged research approach is both domestic and international, as well as qualitative and quantitative, all in an effort to increase the reliability of our findings on this complex issue.

A second distinguishing feature of this research reflects the experience and expertise of the research team. We are scholars of architecture and urban design, civil and transportation engineering, and transportation and urban planning, and not intelligence, policing, or security. We have, therefore, approached this research from the perspective of the people who finance, design, build, operate, and use public transit systems, rather than from the perspective of those who police them.

For example, the role of system design in transit security has received far less attention in most previous research on transit security than policing or surveillance. A specific focus of this work is on system design. We conducted inspections of transit stations in each of the systems studied, and we collected detailed information on attitudes toward and applications of CPTED strategies in our survey of U.S. transit operators.

A third and final distinguishing feature of this research is that it updates the findings and conclusions of many previous studies in this fast moving and rapidly evolving literature. We found from our survey, for example, that security planning efforts have progressed significantly at U.S. transit systems since a 2002 U.S. Government Accountability Office (GAO) survey of transit operators was published in 2003.

Layout of the Study

The study is composed of six sections. Following the introduction, the second section presents a comprehensive look at "Securing Urban Rail Transit Systems against Terrorism: A Review of the Literature." This research-literature review gives particular emphasis to design strategies. Building on two earlier Mineta Transportation Institute reports, the section includes a history and chronology of terrorist attacks on railway systems, extending the inventory of terrorist attacks to 2004,[†] and providing basic information about the medium of attack, the type of

[†] But not including the July 2005 terrorist attacks in London, which occurred too close to the publication date of this report to be analyzed as part of this research.

transit system attacked (heavy rail, commuter rail, light rail), and the impact of the attack (number of casualties).

The next section, "Securing Transit Systems in the Post-9/11 Era: A Survey of U.S. Transit Operators," presents the results of a Web-based survey administered to 120 transit agencies in 108 cities in the United States. The survey assesses (1) how the threat of terrorism affects the transportation security decisions of agencies; (2) how such decisions have changed after the events of September 11, 2001; (3) how agencies effectively identify and assess vulnerabilities in their transportation systems; (4) what measures they are taking to increase transit security; and (5) the relative importance they place on different security strategies such as CPTED, public education and user outreach, policing, and security hardware and technology.

Transit agencies do not operate in a policy vacuum. Their planning efforts against terrorism are determined largely by policies and funding allocations at the state and federal levels. The fourth section, "Institutional Responses to Increasing Transit Security Threats: Interviews with Key U.S. Stakeholders," assesses the federal government's role in the security of urban rail transit in the United States. Drawing from interviews with officials in a number of federal agencies, this section discusses and analyzes initiatives taken by the Department of Homeland Security, the Federal Transit Administration, and the Federal Railroad Administration. The section also reports on interviews with officials from the American Public Transportation Association (APTA) and security personnel from Amtrak, the New York Metropolitan Transportation Authority (MTA), and the Port Authority of New York and New Jersey.

"Case Studies of Contemporary Terrorist Incidents," the next section, draws from the literature and first-hand interviews with transit officials in five cities—London, New York, Tokyo, Paris, and Madrid—to present five case studies of contemporary terrorist incidents: (1) the terrorist attacks waged by the Irish Republican Army against the London Underground, (2) the Fulton Street Station fire bombing in New York, (3) the sarin chemical agent release by members of the Aum Shinrikyo cult on the Tokyo subway system, (4) the bombings on the Paris rail system by Algerian terrorists, and (5) the Al Qaeda attack on the Madrid rail line. The case studies detail the incidents and discuss the emergency and long-term design and policy responses to them.

The last section, "Transit Security Strategies of International Agencies," reports on interviews with transit officials from Paris, Tokyo, London, Madrid, and Brussels to better assess the role of transit system design and operation in both exacerbating and minimizing terrorist attacks.

This section also compares transit security policies in different countries and elaborates the goals of the different international transit agencies, their security measures and strategies, and the challenges they face in securing their systems.

From the hundreds of pages of interview transcripts, survey results, and fieldwork notes, we distill the analyses in these six sections into what we see as twelve important lessons from the recent experience of efforts to prepare for, discourage, mitigate, and respond to terrorist attacks on urban public transit systems around the world.

Findings: A Dozen Lessons Learned

1. **Public transit systems are open, dynamic, and inherently vulnerable to terrorist attacks; they simply cannot be closed and secured like other parts of the transportation system.**

Public transit systems are a central part of urban life. They assemble strangers from diverse economic, social, ethnic, and religious backgrounds and convey them though a wide array of neighborhoods and districts. They are, by definition, open, dynamic systems that cannot be closed and regulated like the air transport system.[‡] Such sentiments were expressed repeatedly by the hundreds of people interviewed and surveyed for this research. Not surprisingly, most of the transit managers and security officials who responded to our survey viewed their transit systems as "very vulnerable" to terrorist attacks.

While public officials understandably call for efforts to make transit systems 100 percent safe, it is simply impossible to secure the thousands of bus stops, hundreds of miles of bus routes, many dozens of miles of rail rights-of-way, and the hundreds of stations used daily by millions of passengers in most large metropolitan areas. The challenge is especially daunting given a growing wave of suicide bombers who are willing to risk capture or death to execute an attack. According to an official interviewed in Madrid,

> I have to say that security does not exist. What does exist are methods to lessen insecurity. You never know what is going to happen. I am telling you this because

‡ While some intercity and commuter rail systems, because they handle fewer, longer-distance passengers, have instituted airport-like screening of passengers and their baggage, such efforts could not be extended to local transit operations serving dozens, hundreds, and even thousands of stops.

> when the politicians tell you that these methods will guarantee our security, it is all false.

Said another Madrid official,

> You should accept that there is an inherent vulnerability to the system, and if you want to run an open mass transit system you live with the vulnerabilities and try to tackle them through intelligence and stopping these people before they actually get in.

Such sentiments raise legitimate, and perhaps troubling, questions about whether transit security planning efforts are perceived by transit officials as more symbolically effective (at creating a sense of safety among the public) than substantively effective (in reducing the likelihood and/or magnitude of a terrorist attack). At the very least, they reflect the daunting challenges to security planning for open, accessible transit systems.

2. The threat of transit terrorism is probably not universal; most attacks in the developed world have been on the largest systems in the largest cities.

While the chronology of terrorist attacks on transit systems reviewed in the section "Securing Urban Rail Transit Systems against Terrorism: A Review of the Literature" documents hundreds of incidents occurring over many decades, the deadliest and most politically influential of these have occurred on the largest transit systems in the most politically and economically powerful world cities, such as London, Madrid, Moscow, New York, Paris, and Tokyo. This suggests that efforts to combat transit terrorism should be focused on cities and transit systems where the likelihood and potential effects of terrorism are greatest.

This observed asymmetry of risk likely reflects both the symbolic importance of particular world cities, and the fact that transit use tends to be concentrated in the largest and most densely developed metropolitan areas. As noted in the third section, "Securing Transit Systems in the Post-9/11 Era: A Survey of U.S. Transit Operators," the ten largest U.S. transit systems (operating in nine metropolitan areas) carried 65 percent of all transit trips reported to the Federal Transit Administration for 2002, while the hundreds of remaining transit systems carry the remaining 35 percent. Of all 2002 U.S. transit trips, 39 percent occurred in one metropolitan area, New York, and 31 percent of all U.S. transit trips were carried by just one system, the New York MTA.[**]

While the most dramatic attacks have occurred mostly on major systems in world cities, this does not mean, of course, that local bus service or smaller cities are safe from attack. In the developing world, terrorist attacks on transit are more likely to occur on buses than on trains. Further, as noted in the sections "Securing Urban Rail Transit Systems against Terrorism: A Review of the Literature," and "Institutional Responses to Increasing Transit Security Threats: Interviews with Key U.S. Stakeholders," security experts report that some terrorists have on occasion chosen to attack unexpected targets in order to elevate fear and anxiety among the general population. But while smaller U.S. cities—like Oklahoma City—are clearly not safe from terrorist attacks, the very small role played by public transit in these cities (where the mode share of trips can dip below 1 percent) suggests that they are a far less likely venue for an attack than larger cities where the role and visibility of public transit are proportionally much greater.

3. The asymmetry of transit terrorism risk is at odds with a political system of public finance that favors distributing funding somewhat equally across jurisdictions.

Given the observed asymmetry of risk, how should security resources be deployed? If strategic transit security policies start from the premise that attacks will inevitably occur, then "success" is not elimination of all attacks, but preventing and/or minimizing the most damaging attacks, which are most likely and most deadly on the largest transit systems. While focusing security efforts on large transit systems in New York, Washington, D.C., and Los Angeles, for example, may motivate terrorists to shift their focus to smaller systems and smaller cities, such a shift could be viewed as evidence of success in securing the most symbolically significant and attractive targets.

However, there is a strong tendency in the public finance of transportation, and indeed in most realms of public finance, to distribute funding widely among political districts and jurisdictions. This helps to explain why federal per-rider transit subsidies tend to be far higher in places like Chapel Hill, North Carolina, than in places like New York City. This natural tendency to spread out money evenly does not square with the asymmetry of transit systems' risk of terrorist attack, and may undermine the effectiveness of federal and state transit security policies and programs. Thus, despite New York's domination of U.S. public transit patronage, it is unlikely that the U.S. Congress—comprising entirely geographically based

[**] American Public Transportation Association, "Transit Agency Data," http://www.apta.com/research/stats.

representatives concerned with the distribution of resources among their competing jurisdictions—will see fit to devote a third or more of all federal transit security resources to the New York metropolitan area.

4. Transit managers are struggling to balance the costs and (uncertain) benefits of increased security against the costs and (certain) benefits of attracting passengers.

Transit managers are in the business of attracting and conveying paying customers. They endeavor to provide safe, fast, and reliable service at a reasonable price, but transit systems worldwide have struggled in a losing, century-long battle with private vehicles for market share in urban travel—especially in most U.S. cities. Thus, from the perspective of transit system planners and managers, safety and security are important, albeit intermediate, means to the end goal of carrying passengers. As one transit industry official put it, "What's important to remember is that public transport companies are responsible for satisfying the mobility needs of citizens. They are not security agencies."

With respect to the sometimes competing objectives of maximizing security versus maximizing ridership, one London interviewee noted,

> Our primary function is to get loads of people to use trains. Security, I would suggest, is still seen as a secondary but integral function. So you won't have the world's most secure station built, but you'll have the world's most cost-effective station built with security enhancements.

Calls for increased attention to security have come in recent years from passengers, the media, local officials, and state and federal governments. With respect to the latter, mandates for regular and comprehensive security planning, more formalized safety and emergency response procedures, increased policing and surveillance, and so on were criticized by many of the transit officials we interviewed (both domestic and international) as unfunded mandates that strain already depleted transit system budgets. Indeed, the need for increased security funding was the central finding of the 2003 GAO study of transit security in the United States, and such calls for increased funding were echoed in this research.

According to one transit official interviewed, transit terrorism is a tremendous burden for agencies because they "have to be lucky all the time, while the terrorists only have to be lucky once." Regarding the need for public subsidies to support security expenditures, another interviewee noted, "In the end, public transport is a business…There comes a point at which the businessman will say that the security measures will cost him more than the revenues. The key issue for addressing risk is to get things down to 'ALARP' as we call it, 'as low as reasonably practical.'"

In addition to concerns over the costs of security programs, many of the transit officials also expressed concerns over the uncertain nature of the risks and the uncertain effectiveness of increased security expenditures. "How," several of those interviewed asked, "should systems evaluate costs and benefits in such uncertain environments?" Further, what techniques or approaches offer systems the most security bang for the buck? In response to such questions, the transit systems examined for this study have pursued an array of ways to prioritize expenditures on security:

- customizing security measures based on a detailed evaluation of risk for each site (Paris).
- assessing risks based on station location, socio-demographics of the region, and delinquency rates of surrounding population (Madrid).[††]
- focusing efforts on terminal stations, the most heavily patronized stations, and stations near government buildings (Tokyo).
- giving top priority to securing sites with concentrations of hazardous materials (Paris).
- conducting public surveys of riders' perceptions and concerns to help prioritize needs (Madrid).

5. **Given the varying roles and mandates of agencies of the central government (ministries, federal agencies, and so on), intelligence services, police agencies, and transit operators on matters of security, close coordination and cooperation are critical to effective transit security planning.**

Many of our interviewees spoke of the need for a multilayered and multipronged system of security in which various agencies play very different roles. Many transit officials with whom we spoke suggested that interagency cooperation is common to the industry, which bodes well for increased coordination with police and security agencies in the years ahead. One U.S. transit industry representative put it this way:

[††] Said one Spanish official we interviewed: "…a station in the Basque country is not the same as a station in Andalusia in South Spain."

> The transit industry, because it's public, is very mutually supportive. Transit agencies aren't in competition with each other. In fact, we have a long history of aiding one another with training programs. Even if you've hired a consultant to help you with a program, we've seen people really sharing that program or that information. One of the roles that [the American Public Transportation Association plays is that] we're a conduit for the sharing of a lot of that information.

Many of those interviewed emphasized the importance of clearly defining roles and responsibilities among actors. Several also stressed the need for frequent and regular interaction among agencies to share information and agree on common strategies and tactics. Concluded one London interviewee,

> Partnership is not easy. You have to invest time, and emergencies are not the time to meet your counterpart in different agencies.... Resilience is about coordinating and facilitating efforts of all the disparate, separate agencies to ensure better quality of performance, aiding and leading to a more effective prevention or recovery than might otherwise be the case.

Finally, several of the transit officials interviewed noted that APTA, the leading U.S. transit industry organization, has come to play an increasingly central security coordinating and information-brokering role, and, in doing so, has come to more closely resemble the activities of the International Union of Public Transport (UITP) outside of the United States.

6. **An important benefit of improved coordination is standardization of emergency training, security audits, and disaster preparedness procedures, and the issuance of common guidelines about security.**

While the airline industry has adopted common international security standards and procedures, many other modes—and in particular public transit—have not done so. For example, several of our European interviewees noted that while many European Union (EU) member countries have developed highly integrated international passenger rail service, similarly integrated systems of rail security have been slow in coming.

Likewise, while the many transit agencies typically operating in larger metropolitan areas have developed reciprocal integrated fare and passenger information protocols, efforts to integrate and standardize security practices and procedures among transit systems within metropolitan areas and between them are relatively new.

Such standardization can be particularly helpful to smaller transit operators that do not have the resources to independently develop security standards and procedures. For example, standardizing safety guidelines and signage, the structure and content of security announcements, and the marking of emergency exits on trains and in stations can all help passengers avoid confusion in times of emergency. Likewise, standardizing security training of personnel—drivers, supervisors, and managers—can improve coordination with police, fire, and intelligence officials in times of emergency. Many of the respondents from U.S. transit agencies surveyed for this research noted that, under the guidance of the federal government, standardized security plans and training programs were being integrated into already established emergency response training programs traditionally aimed at responding to personal and property crime and smaller-scale emergencies.

7. Despite significant progress in increasing coordination between transit and police/ intelligence agencies, much work remains.

Despite significant and ongoing efforts to improve the coordination and cooperation between the many, largely independent transit agencies operating in large U.S. metropolitan areas, seamless integration of routes, schedules, and fares has long proven elusive. Given the widely divergent goals and objectives of public transit and police/intelligence agencies, the challenges to increased coordination and cooperation are even greater.

Perhaps the greatest challenge to improved coordination identified in this study concerns ambiguity and uncertainty over lines of authority and responsibility. Put simply, it is not always clear who is responsible for what. Said one European transit industry representative we interviewed,

> The public authorities are responsible for security. If there is a terrorist incident or attack, the transit authorities are responsible for restoring traffic as soon as possible. They [the transit agencies] should also help the public authorities to organize first aid and emergency response, but they are not responsible to follow up the threat or to investigate the threat.

Despite the many challenges, nearly everyone queried agreed that increased coordination was needed. Such coordination can take many forms: (1) coordination between neighboring transit agencies; (2) coordination among local, state, and federal law enforcement officials; (3) information sharing with the media and the public; (4) the improved dissemination of best practices in security planning; (5) consistent emergency response procedures and protocols;

(6) improved integration of different security-related technologies; and (7) increased international cooperation in sharing information and best practices. With regard to the latter, one official interviewed noted, "The threat is international and the way you need to deal with it is an international effort," although several other interviewees cautioned that while international threats call for international collaboration, security measures should not be applied equally in all places; they should be customized according to local organizational/governmental structures, transit system size, age, and characteristics, and the specifics of local cultures and norms.

8. Passenger education and outreach is a challenge; informed passengers can increase surveillance and safety, but fearful passengers may stop using public transit.

Although most of the officials surveyed and interviewed agreed that public education and outreach had become an important part of transit security planning, respondents were in general more ambivalent about education and outreach than about policing, technologies, or CPTED. In particular, many cited the challenge of raising awareness without raising fear. One of the officials we interviewed in Madrid said that their goal following the March 11, 2004, attacks was to augment feelings of security and diminish feelings of insecurity: "The methods we chose and implemented after the March attack were not so much about combating terrorism; rather they were used to help riders recover a feeling of security."

While our interviews suggest that passenger outreach efforts on security have been more common outside the United States, nearly all those to whom we spoke agreed that it is a delicate balance between creating a perception of excessive, pervasive security (which is both costly and can incite fear among passengers) and too little security (which can promote a sense of danger and unchecked lawlessness). Said one transit industry official, "You have to reassure but not scare off passengers, because if you exceed a certain level [of police activity] it might be considered that you are in a very insecure place."

Enlisting the public's help in security surveillance can be effective, but entails risks. Excessive marketing of vigilance can create an environment of paranoia, where everything and everyone can be viewed as potential threats. Such paranoia can suppress ridership while overwhelming transit officials with security tips, and panicked passengers can compound damage after an attack.

Further, a strong emphasis on police and public surveillance can lead to social profiling, and with it losses of privacy and civil rights. Said one interviewee,

> Here [in Spain] there would be a lot of problems and it wouldn't be convenient to start screening passengers. People will not accept being identified, profiled, and searched, even if it is a random manner, because when you select, you elect and you have to do this with a certain objective and clear parameters. You will be accused of discrimination because this is labeling, marking people with certain physical features.

9. The role of crime prevention through environmental design in security planning is waxing.

Most of our survey and interview respondents were familiar with the concept of CPTED, and most viewed CPTED—which considers how the physical design of spaces can affect both the likelihood and impact of criminal or terrorist activity—as an important longer-term strategy to address both crime and terrorism on transit systems. According to the respondents to our survey, CPTED was given much less weight in security planning prior to 9/11. Since 9/11, however, over 80 percent of the respondents now believe that CPTED is a somewhat or very effective strategy in preventing terrorist attacks. This ranking of effectiveness is similar to both policing and security hardware and technology strategies, and well ahead of public education and outreach.

According to one of our interviewees in Madrid, "Security is based on prevention, and prevention begins with design. A station designed without security criteria would be much more insecure and expensive to protect."

While the potential effectiveness of CPTED was widely touted by those queried, many also noted that design is a longer-term strategy. CPTED strategies can be cost-effectively incorporated into new stations and terminals, such as in the new Météor and Eole Lines in Paris, the new Line 11 in Madrid, and the new Bilbao subway in Spain. On the other hand, most interviewees thought retrofitting old stations to be extremely costly for the most part. Concluded one interviewee regarding the retrofit of older stations, "The best you can do is to use some passive methods such as mirrors, cameras, and increased lighting."

Even among officials interviewed who work primarily in policing and security, knowledge of and enthusiasm for CPTED principles was widespread. For example, one London transit police official said,

> If you take a station like Baker Street, it's very dark {and listed as a historically significant} building so there are limitations on what can be done to change the appearance and structure. Not very much can be done at all. We'd like better lighting, more CCTV {closed-circuit television}. We'd like cleaner lines. Any vending machines that are brought in, we'd like them to have sloping tops so nothing can be put on top of them. We'd like them to be totally accessible or totally enclosed so they're easy to search or impossible to put something in. We look at tamper-evident seals {on entryways to areas closed to the public}, which can't be physically locked. When it comes to new stations, bigger, brighter areas, clear sight lines, certainly those are the kinds of things that we would seek to influence.

10. Since 9/11, transit agencies are more likely to adopt comprehensive, multipronged approaches to security planning than in years past.

Our survey and interviews focused in detail on four types of security strategies—policing, technology, education and outreach, and CPTED. We found that attention to all these strategies has increased since 9/11, and over half of the respondents now view all four strategies as central or significant parts of security planning efforts.

Prior to 9/11, most of the respondents to our national survey of large transit operators said they had emphasized policing and hardware/technology in security planning, and placed far less stock in either public education or CPTED. While the survey respondents believed that the importance of policing and hardware/technology increased after 9/11, their assessments of the importance of public education and, especially, CPTED increased even more.

This broad support for all four security strategies reflects a consensus among those surveyed and interviewed regarding the need for a comprehensive, multipronged approach to transit security planning. Several interviewees cautioned against becoming too reliant on just one or two strategies. As one of our London interviewees noted,

> Each one (strategy) on its own can't work in isolation. I don't think that one of them sits out on its own. You've got to do each one. And you've got to have an element of each one in terms of being able to combat terrorism or crime in general.

11. The public transit industry is vulnerable to security policies or programs that reduce the speed, comfort, or convenience of transit, and may benefit significantly from policies that increase the attractiveness of transit.

Despite significant public investments over the past three decades, public transit systems around the United States continue to lose market share to private vehicles. Many transit systems have made important strides in increasing the comfort, safety, and convenience of using transit, but matching the speed and flexibility of private autos remains a challenge. Transit security policies and programs that increase the hassle of, or delays in, riding buses and trains may significantly undermine an already vulnerable and distressed industry. For example, the random bag and parcel inspections instituted on the New York transit system following the July 2005 attacks on the London public transit systems will add stress and delays on the United States' most heavily patronized transit system—stress and delays that inevitably make traveling by other modes relatively more attractive.

Many transit system managers said that new security measures should enhance the perceived safety and attractiveness of their systems, and not add to delays, inconvenience, or perceptions of heightened risk. The importance of creating safe, attractive systems for passengers, report some transit officials, is sometimes lost on security officials; as one interviewee from London said prior to the July 2005 attacks,

> It's trying to balance providing maximum security while still providing the kind of service people expect. People still want to go from point A to point B as fast as possible. They don't want to be delayed, even for security reasons. So that's the balance…it's still a struggle… I think that is something that in the future has to evolve, to where you have that perfect balance where you can say, "I think we're providing as much security as we can," but it's also seamless to the customer so you don't have an operational slowdown.

12. Given the uncertain effectiveness of antitransit terrorism efforts, the most tangible benefits of increased attention to and spending on transit security may be a reduction in transit-related personal and property crimes.

Terrorist attacks on transit systems in the United States and abroad have increased in recent years in both frequency and severity. Likewise, public and political concern over the issue has skyrocketed since 9/11. The fact remains, however, that transit patrons remain far more likely to be victimized by personal crime than a terrorist act.

According to Federal Transit Administration data, an average of 279 people have been killed on or by public transit each year over the past decade. In addition, an annual average of 18,748 people have been injured on or by public transit over the same period. Crimes ostensibly unrelated to transit use—such as being robbed or killed while waiting at a bus stop—would push these figures far higher. This means that, between September 11, 2001, and August 11, 2005, more than 1,100 people have been killed on or by public transit, and more than 75,000 have been injured on or by transit in the United States[‡‡]

Further, studies have repeatedly shown that fear of crime is a significant deterrent to transit use for many people.[***] So while political attention and public resources are currently focused on transit terrorism, reductions of personal and property crimes on public transit systems could prove to be a significant collateral benefit of safer, more secure public transit systems.

In both our review of the research literature and in several of our interviews were repeated suggestions for a "dual-use strategy," whereby antiterrorism measures may be effective in reducing transit crime. Coincident with new security measures on the Tokyo Metro, both robberies and thefts are down substantially. Likewise, fewer crimes were reported in the period following the implementation of random parcel inspections in Madrid.

Such complementary benefits, however, are not assured without careful attention to congruency between anticrime and antiterrorism measures. Some of those interviewed suggested that anticrime and antiterrorism efforts are not always reciprocal and complementary. "By preparing your system to react to terrorist attacks, you also prepare it to react to different types of crime…But the other way around is not always true" (Madrid transit official).

‡‡ Federal Transit Administration, "Transit Safety and Security Statistics," accessed http://transit-safety.volpe.dot.gov/Data/Samis.asp.

*** David Hartgen, Gerald Ingalls and Timothy Owens, *Public Fear of Crime and Its Role in Public Transit Use,* Raleigh, NC: University of North Carolina, Center for Interdisciplinary Transportation Studies, 1993; and G. Lynch and S. Atkins, "The Influence of Personal Security Fears on Women's Travel Patterns," *Transportation 15*, 2001.

However, others argued that anticrime and antiterrorism efforts worked very much hand in hand. Said one London transit official:

> It's easier for a terrorist to operate in an environment that is disorderly, that does not give the appearance that someone is in charge; the area does not look secure. Actually taking care of the little things, and insuring that there is order and maintenance, sends a signal that it's hard to operate illegally or carry out an attack in this environment. There's a deterrent effect.

Postscript

Whether these findings are discouraging or heartening depends on one's perspective. The stakes are high, the risks uncertain, and the solutions unclear. The July 7 and 21, 2005, subway and bus attacks in London offer a sobering reminder that transit systems remain inherently vulnerable to terrorist actions, even on systems where security and vigilance have been the modus operandi for decades. While public transit systems are likely to remain attractive and vulnerable targets for terrorists, U.S. transit systems are today better coordinated, policed, monitored, and designed, and staff and passengers are better informed and prepared than just a few years ago. How effective these efforts will be (or have already been) in deterring or minimizing a terrorist attack is unclear. What is clear, however, is that crimes of all types—political, personal, and property—drive riders away from transit systems. So if the recent rise in transit security planning deters a major terrorist attack, or simply the activities of a lone pickpocket, the transit industry will be better off as a result.

INTRODUCTION

For those determined to kill in quantity and willing to kill indiscriminately, public transportation offers an ideal target.

—Jenkins and Gerston, 2001

The events of September 11, 2001, brought the issue of transportation security and terrorism to the forefront of civil society. While transportation security officials had been aware of the possible threat of terrorist attacks on transportation networks for some time, these tragic events revealed both vulnerabilities in security systems and the previously unimaginable consequences of such breaches. Public surface transportation systems are especially attractive targets for would-be terrorists wanting to cause the maximum amount of disruption and harm.[1] Such systems serve very large numbers of people over extensive networks of stations, stops, and facilities. In the United States, 74 rail transit systems operate 18,000 vehicles in 38 cities; collectively, these systems carry 3.4 billion passenger trips annually. The wide use of rail transit systems by many segments of the public makes them especially attractive targets for terrorists wanting to maximize disruption and harm. Accordingly, concerns about transit security rank high among transportation officials and transit riders.

The vulnerability of railway systems lies in the fact that they are very open and accessible, with fixed, predictable routes and access points. Their openness and anonymity make it easy for potential terrorists to hide in crowds without arousing suspicion. Securing such open and public systems presents a series of problems. The volume of passengers makes it impossible for transit operators to employ many of the security tactics used by commercial aviation.[2] Preventive security measures on public transit, such as the screening of passengers and luggage with X-ray machines and metal detectors, hand searches, passenger profiling, chemical- and bomb-sniffing dogs, and armed guards, would lead to intolerable delays and costs. The need for transit agencies to offer transit systems that are accessible, convenient, and affordable for daily users thus conflicts with many security goals. In cities around the globe, people choose between public transit and private automobiles for many trips. Private vehicle use is growing in most cities, resulting in worsening congestion and air pollution. Attractive, convenient public transit systems help to mitigate many of the problems of widespread auto use, and provide mobility for those who do not have access to automobiles, including the young, elderly, disabled, and poor. Security measures that cause inconvenience, delay, or added cost to travel by public transit are likely to shift travelers and cities toward greater dependence on private vehicles. Therefore, balancing transit riders' desire for convenience, accessibility, and affordability with security measures presents a challenge to transit operators.[3]

A 1997 survey sponsored by the Transportation Research Board assessed both the perceptions of transit system managers regarding terrorism and security as well as the status of agencies' existing emergency preparedness, planning, and response procedures. Over 40 U.S. transportation agencies participated in the survey, including agencies that provide rail service and coordinate bus systems. Urban and commuter rail systems ranked the highest in terms of the perceived risk as targets of terrorism. Detonation of explosive devices was perceived to pose the greatest threat to transit systems. A majority of the agencies surveyed had actually dealt with bomb threats in addition to a variety of other security threats.[4]

Transit Security in an International Context

Security on mass transit is a global issue. Indeed, many transit systems around the world have been victimized by terrorists, including the railway systems of New York, London, Paris, Tokyo, Madrid, and Moscow. An analysis of terrorist attack trends indicates that their lethality has increased over time. In addition, the number of attacks against transportation systems increased in the 1990s. In 1991, transportation systems were the target of 20 percent of all violent attacks. This rose to almost 40 percent by 1998. Jenkins' (1997, 2001) comprehensive chronology of 900 terrorist attacks involving surface transportation from 1920 to 2000 provides an analytical model useful in identifying the most salient patterns and trends. He finds that about two-thirds of the attacks were intended to kill people (as opposed to simply disrupting transit operations), while 37 percent of the attacks actually resulted in fatalities. Of the incidents with fatalities, about three-fourths caused more than one death, and 23 percent caused 10 or more deaths.

International case studies of surface transportation systems that have suffered terrorist attacks can offer examples of both vulnerabilities to terrorist threats, and effective measures for their prevention, mitigation, and response. Such case studies offer lessons on preparedness, response, and recovery that may apply to other transportation systems with similar physical and organizational characteristics, including those in the United States. While some case studies of transit terrorist attacks exist, such as Jenkins (1997) or Jenkins and Gerston (2001), they are almost exclusively descriptive narratives of the events or assessments of the police and emergency responses that followed them. The existing literature on transit terrorism does not identify and compare the social and environmental characteristics of the transit systems that have been hit by terrorism, or the strategies that transit agencies around the world are adopting to offer protection to their riders. While intelligence systems have globalized rapidly in response to recent terrorist attacks, planning to prevent and mitigate terrorist attacks on transit systems is far more insular. Additionally, most research on transit terrorism has centered on the role of policing and technology in mitigating terrorist attacks.[5] There has been far less investigation of how system design and public education may be employed to both reduce the likelihood of attacks and minimize the impact of attacks when they occur. Resources such as the public outreach tool kit for “Transit Watch” and the Volpe Center’s “Security Design Considerations for Transit Vehicles and Facilities” have more recently been funded by the Federal Transit Administration (FTA).

Conceptual Model of Transit Terrorist Events

Following the July 2005 bombings in London, concerns with transit security rank very high among transportation officials and transit riders. Deterring and minimizing terrorist attacks involves assessments of vulnerabilities, the mitigation of weaknesses in the system, and the development of effective response and emergency plans. Yet planning for transit security to date has largely been ad hoc and often ambiguous. For example, surface transportation security tends to focus less on deterrence and more on mitigation, quick response, and the rapid restoration of services after an incident.

In contrast, the study that follows examines and compares responses to transit terrorist incidents, conceptualizing a process that extends over a very long time frame, approximating the life of the transit system. The analysis of international terrorist incidents that follows has gathered information relevant to each of the four stages described below:

Stage One—Planning, Designing, and Building: It is important to incorporate into the planning and physical design of a transit system the best current knowledge of terrorist threats, thereby minimizing through system design the potential damage of incidents that could occur at any time, even decades later. The choice of materials for the construction of stations and vehicles, for example, should be made on the basis of full consideration of terrorist attacks; the provision of ventilation systems should include considerations of fire suppression, anthrax, and possible chemical attacks; the selection of computerized communications and control systems should be informed by their potential vulnerabilities; and the architecture of stops, stations, and vehicles should incorporate design principles that minimize their vulnerabilities, maximize their ability to continue functioning under difficult circumstances, and facilitate responses by emergency personnel.

Stage Two—Planning for Incident Response: The vulnerability of transit systems to terrorist attacks should be reviewed periodically throughout the operational life of a transit system so security officials can refine planning in response to evolving threats. For example, interagency cooperation should be encouraged and staff training should be updated. Sufficient information also must be provided to passengers so, in the event of an incident, they will know how to respond. In addition to the actions of transit operators and their funding agencies, law enforcement and intelligence efforts by agencies charged with counterterrorism should be ongoing.

Stage Three—Immediate Response to Incidents: If and when an incident occurs, the immediate response—including clearance, search, rescue, recovery, and the restoration of service—constitutes a critical stage. While the actions in this stage may last only a few weeks, they provide invaluable information for security planners as terrorist incidents are such infrequent events. With respect to this research, deconstructing the role of system design and operations in exacerbating or minimizing the effects of the attack can be used to help plan and operate safer public transit systems in the future and provide for continuity of operations in emergency situations.

Stage Four—Long-Term Recovery: The final stage in responding to a terrorist incident may last for years, and constitutes the redesign, reconstruction, and operation of the system under new rules and procedures that are influenced by the incident and what has been learned during the planning and rebuilding process. This stage also involves restoring public trust in the security of the transit system.

Scope of the Problem, This Research, and Policy Responses

The goal of this study, which uses transit authorities and transportation agencies as units of analysis, is to research global responses to the threat of transit terrorism by:

- comparing policies and strategies employed by transit agencies in the United States and around the world.
- contrasting the larger policy framework of transit security funding as exercised by different transit authorities and ministries of transport.

- evaluating the importance of transit station design for transit security.
- assessing the lessons learned from the different contexts for a more effective future response and prevention of terrorist attacks.

Implicit in our research design—and indeed in nearly all policy discussions surrounding the issue of transit security—is that public transit systems, or transportation and infrastructure systems more broadly, are the right way to think about the problem, the appropriate unit of analysis for study, and the correct venue for policymaking. At the very least, such assumptions warrant reflection.

We can think about three ways that acts of terrorism intersect with transportation systems:

- when transportation is the *means* by which a terrorist attack is executed.
- when transportation is the *end*, or target, of a terrorist attack.
- when the *crowds* that many transportation modes generate are the focus of a terrorist attack.

Examples of transportation as the means of a terrorist attack include the use of cars, buses, or trains to convey explosives, or when cars, buses, or planes are used as weapons. Examples of transportation as the end of a terrorist attack include attacks on bridges or tunnels to disrupt transit, railroad, or highway operations, exact economic costs, and attract attention. In each of these cases, the unique characteristics of transportation (and other infrastructure) networks define many aspects of the attacks, emergency response, and system protection. As such, the logic of defining both the problem and proposed policy solutions in terms of transportation, or in our case public transit, is clear.

But when crowds are the target, which is the case in many recent suicide bomb attacks, the logic of defining the problem and its solutions in terms of transportation is less clear. Airports, rail stations, and bus and ferry terminals all congregate large numbers of people in small, often enclosed, spaces. But such crowding is in no way unique to transportation stations and terminals. Skyscrapers, shopping malls, and major shows, concerts, and sporting events likewise congregate large numbers of people in small spaces—as do major celebrations (such as the 4th of July on the Mall in Washington, D.C.) and parades (such as the Tournament of Roses on New Year's Day). In such cases, even if it were possible to completely close and secure public transit systems, the potential venues for tragic and devastating attacks on large crowds of people would hardly be dented. Thus, while public transit systems may currently be a favored venue of terrorists in search of crowds to attack, one cannot assume that securing or eliminating crowds on public transit would in any way end or mitigate such attacks. Public assembly is a defining characteristic of free and open civil societies, and the consequences of closing, securing, or eliminating large gatherings of people reach well beyond the scope of this study or of the transportation sector.

Methodology

The study has gathered research data from numerous sources, including the following:

- primary and secondary documents and archival information relating to terrorist incidents.
- visits to sites of terrorist attacks in New York, London, Paris, Tokyo, and Madrid.
- interviews with officials of transit agencies in these same cities.
- interviews with officials from ministries of transport and federal transportation authorities in five countries (United States, England, France, Japan, Spain).
- interviews with officials from two nongovernmental public interest groups, the American Public Transportation Association (APTA), based in Washington, D.C., and the International Union of Public Transport (UITP), based in Brussels.
- a survey of 120 transit agencies in cities throughout the United States.

Layout of the Study

The study is composed of six sections. Following the introduction, the second section presents a comprehensive look at “Securing Urban Rail Transit Systems against Terrorism: A Review of the Literature.” This research-literature review gives particular emphasis to design strategies. Drawing from two Mineta Transportation Institute reports, this section includes an overview of the history and chronology of terrorist attacks on railway systems, extending the inventory of terrorist attacks to 2004, and providing basic information about the medium of attack, the type of transit system attacked (heavy rail, commuter rail, light rail), and the impact of the attack (number of casualties).

The next section, “Securing Transit Systems in the Post-9/11 Era: A Survey of U.S. Transit Operators,” presents the results of a Web-based survey administered to 120 transit agencies in 108 cities in the United States. The survey assesses (1) how the threat of terrorism affects the transportation security decisions of agencies; (2) how such decisions have changed after the events of September 11, 2001; (3) how agencies effectively identify and assess vulnerabilities in their transportation systems; (4) what measures they are taking to increase transit security; and (5) the relative importance they place on different security strategies such as crime prevention through environmental design (CPTED), public education and user outreach, policing, and security hardware and technology.

Transit agencies do not operate in a policy vacuum. Their planning efforts against terrorism are determined largely by policies and funding allocations at the state and federal levels. The fourth section, "Institutional Responses to Increasing Transit Security Threats: Interviews with Key U.S. Stakeholders," assesses the federal government's role in the security of urban rail transit in the United States. Drawing from interviews with officials in a number of federal agencies, this section discusses and analyzes initiatives taken by the Department of Homeland Security (DHS), the Federal Transit Administration (FTA), and the Federal Railroad Administration (FRA). The section also reports on interviews with officials from the American Public Transportation Association (APTA) and security personnel from Amtrak, the New York Metropolitan Transportation Authority (MTA), and the Port Authority of New York and New Jersey (PATH).

"Case Studies of Contemporary Terrorist Incidents," the next section, draws from the literature and first-hand interviews with transit officials in five cities—London, New York, Tokyo, Paris, and Madrid—to present five case studies of contemporary terrorist incidents: (1) the terrorist attacks waged by the Irish Republican Army against the London Underground; (2) the Fulton Street Station fire bombing in New York; (3) the sarin chemical agent release by members of the Aum Shinrikyo cult on the Tokyo subway system; (4) the bombings on the Paris rail system by Algerian terrorists, and (5) the Al Qaeda attack on the Madrid subway. The case studies detail the incidents and discuss the emergency and long-term design and policy responses to them.

The last section, "Transit Security Strategies of International Agencies," reports on interviews with transit officials from Paris, Tokyo, London, Madrid, and Brussels to better assess the role of transit system design and operation in both exacerbating and minimizing terrorist attacks. This section also compares transit security policies in different countries and elaborates the goals of the different international transit agencies, their security measures and strategies, and the challenges they face in securing their systems.

From the hundreds of pages of interview transcripts, survey results, and fieldwork notes, we distill twelve important lessons, which are summarized in the concluding section of this report.

SECURING URBAN RAIL TRANSIT SYSTEMS AGAINST TERRORISM: A REVIEW OF THE LITERATURE

This section examines the current research literature on design and planning for terrorist attacks on urban rail systems. There is little dispute that urban rail transportation systems are uniquely attractive to those seeking to cause maximum disruption and harm. The Federal Bureau of Investigation (FBI) issues regular threat assessments that place transit, particularly rail transit, at the top of their list of likely targets.[6] These systems are made vulnerable by the very qualities that make them invaluable to the functioning of our most populous and economically critical metropolitan cores: their ability to move large volumes of people predictably and reliably to a large number of locations in the heart of the metropolitan region.

Efficient transit systems require an openness that prevents agencies and governments from adopting many of the terrorism prevention strategies used in aviation.[7] Additionally, those charged with protecting transit systems from terrorist attack are often challenged by the scale and interdependency of many of these systems, which can include miles and miles of track in addition to stations and rolling stock. Finally, while the threat of terror has loomed large in the public mind since the 2001 attacks on New York and Washington, D.C., attacks on transit occur rather rarely. This makes it difficult to justify cost or gauge the effectiveness of any particular strategy.[8] Nevertheless, some very recent major terrorist attacks on railways in Madrid, Moscow, and London have raised major concerns about the vulnerability of mass transit systems.

In light of these complicating factors, it is not surprising that strategies to protect transit from terrorist attack historically have been reactive and ad hoc. Research in this area, consequently, has focused on policing, response, and rapid restoration of service. Only recently have researchers and transit systems turned their attention to long-range security planning that incorporates the terrorist threat.[9] The focus on guidelines to help management and develop procedures gives agencies tools to assess their needs and develop solutions in the context of their transit systems' unique configurations of threat, risk, and function. However, for information on specific measures and strategies, transit agencies must turn to other literatures provided by the building trades, the Federal Emergency Management Agency (FEMA), and the General Services Administration (GSA). Certainly, the diversity of transit systems and the uniqueness of each transit environment have frustrated efforts to develop comprehensive guidelines on specific security strategies and individual measures.

An ad hoc, reactive approach may have served urban rail transit in an era when the threat of terror was more diffuse and remote. Indeed, further research may reveal that a solid response and recovery program is transit's best defense. However, such research has not yet been done. Additionally, there has been far less investigation of how design may be employed to reduce the likelihood of attack and minimize the impact of attacks when they occur. Therefore, this review will pay particular attention to these longer-term design countermeasures.

Scope of the Literature

Research relevant to urban rail transit security consists of work in a number of disparate disciplines: risk assessment, transit safety planning, emergency response, crime prevention, urban design, and architecture. Materials include government guidelines, specifications and briefings from various federal and state agencies, best practice compendia, academic research, and industry and academic journals. With some notable exceptions, only very recently have researchers examined the threat of rail transit terrorism.[10] Late in 2003, the Federal Transit Administration (FTA) unveiled a Website devoted to transit security (http://transit-safety.volpe.dot.gov/Security/Default.asp), which assembles many of these varied threads. The Website is a valuable resource that makes available the FTA's publications on the subjects of safety, security, and emergency preparedness, but it also reveals gaps in the literature. Another task of this review will be to examine the utility and potential pitfalls of adapting strategies for addressing the problem of transit terrorism from nonterrorism and nontransit situations.

Case Studies and the History of Transit Terrorism

Curiously, much of the national policy literature that discusses terrorism generally does not dwell on transit terrorism.[11] In fact, most of the literature on transportation terrorism tends to focus on aviation and cargo, despite the fact that mass transit is clearly a target and carries more passengers annually than air transport. A 2000 article in *Transportation Research News* with the auspicious title "Transportation Security: Agenda for the 21st Century" made no mention of rail transit security issues.[12]

However, recent deadly attacks on subways in Moscow and Madrid, the impact of the events of September 11, 2001, on the transit systems of New York and Washington D.C., and the memory of terrorist attacks on subways in London, Tokyo, and Paris have heightened awareness of rail transit operators of the threat of terrorism. While the magnitude of the threat is the subject of some debate, there is no longer a question that terrorism poses a challenge to urban rail transit systems. Jenkins' research for the Mineta Transportation Institute, which presents a chronology of terrorist attacks on surface transportation systems from 1920 through 2000, concludes that terrorist attacks on transit targets worldwide have increased in frequency and lethality over the past 25 years.[13] Nontransit events such as the Oklahoma City attack, the Olympic Park bombing in Atlanta, and the September 11, 2001, attack on the World Trade Center and the Pentagon, reveal that the United States is vulnerable to both domestic and international terrorism. Further, while transit systems in the United States have not been the targets of sustained terrorist campaigns, a majority of the agencies surveyed in a 1997 Transportation Research Board study had actually dealt with bomb threats in addition to a variety of other security threats.[14]

For transit operators, the consequences of large-scale violence, or even the threat of such violence, is too dire to allow us to justify debates over the strict definitions of terrorism. The FBI's official definition of terrorism is laid out in the Code of Federal Regulations as "a violent act or an act dangerous to human life, in violation of the criminal laws of the United States or of any state, to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social goals."[15] The terrorist threat to transit is not limited to plots by international organizations. In fact, even in the United States, the vast majority of terrorist acts are carried out by domestic terrorists such as neo-Nazis, antiabortion extremists, right-wing antigovernment militants, and far-left environmentalists.[16] Although urban rail transit has not been a primary target of such terrorists, the 1995 derailment of Amtrak's Sunset Limited by right-wing militants drew awareness to the possibility of such an attack. Because transit agencies are more concerned with effect, rather than motivation, they also analyze acts of "quasiterrorism," such as the 1994 Fulton Street firebombing in the New York City subway.[17] Bomb threats and acts of mass violence not intended to further political goals are no less crippling to a transit system than nominal terrorist acts.

Chronology

Jenkins and Gerston's research sheds light on the nature of the terrorist threat facing transit systems.[18] Their work—which examines both rail and bus transit—comprises three volumes presenting case studies, an extensive chronology, and an executive overview. The chronology includes more than 800 separate incidents of terrorist attacks and other "significant criminal incidents" involving public transportation, culled from news accounts, books, and databases compiled by the U.S government, the RAND Corporation, and the Kroll-O'Gara Company (see Appendix A). Roughly half of these incidents involved rail and half bus transit. Bombings are the most common mode of attack. Other tactics include ambushes and armed assaults, sabotage, hostage taking, and standoff attacks in which terrorists fire guns from a distance. The 1995 sarin attack on the Tokyo subway was the only incident of chemical or biological attack. However, the attack, which killed twelve people and injured thousands of others, has prompted many transit systems in the industrialized world to include such a scenario in their security planning.

Jenkins discerned a number of important trends in transit, which is thought to make up a third of all terrorist targets worldwide. The findings on the lethality of transit terrorism are disturbing. While only 20 percent of all terrorist incidents involve fatalities, 35 percent of the attacks reported in the 1997 document resulted in one or more deaths. In the 2001 document, the percent of fatal attacks rose to 43 percent. While Jenkins cautions that the data are difficult to compile comprehensively, the combined chronology results in a rate of lethality of 37 percent. Of the 641 incidents reported in the 1997 report, 80 percent involved more than one fatality and 30 percent more than ten. While transit terrorism has increased in the past 25 years, it remained stable during the 42 months between the 1997 and 2001 reports. Jenkins noted that changes in the reporting of terrorist acts may have been a factor.[19]

The implications for the United States and comparable developed nations are less dire, however, than the numbers above would suggest. Two-thirds of attacks occur in countries with ongoing civil wars or terrorist campaigns. India, Pakistan, Cambodia, Angola, and Israel have suffered the greatest number of fatal attacks. Consideration of total attacks changes the rankings somewhat: Israel, India, the United Kingdom, Pakistan, and Egypt. As a reference to the magnitude, 493 people were killed in 54 incidents in India that occurred from 1920 to 1997. The median fatal incident involved four deaths, and the maximum was more than one hundred. In some sense, it would appear that terrorism on transit is analogous to crime on transit, in that transit crime generally reflects the level of crime of the larger urban area in which it is situated. Jenkins concluded that if such countries were left out of the analysis, the threat would look quite different. Attacks would be less lethal and predictable, and Japan and Germany would move to the top of the list.

Case Studies

Jenkins' 1997 *Protecting Surface Transportation Systems and Patrons from Terrorist Activities* details the experience of four transit systems that were targets of terrorism: the New York City Transit Authority (NYCTA), the Metropolitan Atlanta Rapid Transit Authority (MARTA), the Réseau Express Régional (RER) in Paris, and Amtrak's Sunset Limited. Jenkins' follow-up report, *Protecting Public Surface Transportation Against Terrorism and Serious Crime: Continuing Research on Best Security Practices*, documents London's experience with the IRA's seven-year bombing campaign, and the sarin attack on a Tokyo subway in March of 1995.[20] It also reviews the security strategies of greater San Francisco's Bay Area Rapid Transit District (BART) and the Valley Transportation Authority (VTA) in Silicon Valley. While these last two systems have not been the target of any terrorist threat, the authors hoped to shed light on levels of preparedness that may be more useful to the majority of transit agencies outside the largest urban areas. All the research was conducted prior to the 9/11 attacks of 2001.

To make comparison and future analysis easier, Jenkins and Gerston applied a consistent format to all eight of the case studies. The format included a description of the system, existing security elements, crisis management planning, liaisons with authorities, and an account of the immediate response to the threat or attack. Existing security elements described are threat assessment, organization and personnel, environmental design, technology, emergency communications, response, recovery, and the role of the public. Response elements included additional security measures put in place after the communication of threat or attack, emergency response, restoration of services, lessons learned, and problem areas. The applicability of these categories to each of the case studies varies, as does the depth to which they are discussed. However, the format allows the researchers to distill from them a number of "desirable attributes of security." Coordination with authorities is deemed to be most important, followed by dedicated security personnel, security technology, advanced planning, environmental design, communications, training, and public involvement.

In addition to Jenkins and Gerston's work, case studies are also available from other sources. The Federal Highway Administration offers a series of reports, *Effects of Catastrophic Events on Transportation System Management*, two of which deal with New York's and Washington's transportation response to the events of September 11, 2001.[21] The New York report notes that, despite the significant damage to the PATH World Trade Center Station and the Cortland Street subway station, there were no transit-related injuries or deaths. Credit is given to the immediate activation of rehearsed emergency procedures by the transit agencies.

Finally, Whent's presentation, "Control of Public Space," to the American Public Transportation Association's 1999 annual conference, provides a particularly insightful case study of London's antiterror transit strategy.[22] The safety and security strategy employed by railway networks in England, Scotland, Wales, and throughout the London Underground, called "Control of Public Space," was developed in response to the seven-year bombing campaign carried out by the IRA from 1991 to 1998.

Over the course of the seven-year campaign, three people were killed and sixty-seven were injured. The system received 7,000 bomb threats, forty-nine of which resulted in actual detonations. In spite of this, the system was able to operate effectively, which Whent directly credits to the safety and security strategy. By 1994, three years after the initiation of the Control of Public Space strategy, no bombs were placed in railways stations. Although the IRA continued to issue bomb threats, service was disrupted for less than 1.8 percent of the called-in threats. Whent's rough estimate of the saving in economic damage was millions of pounds. He describes the concept of Control of Public Space as "one station stop before zero tolerance." Under this theory, data collection, as well as coordination among agencies and the public, helped to pinpoint concentrations of antisocial behavior where resources could be concentrated before the commission of any crime or bombing.

This is similar to New York's crime tracking and accountability CompStat program. Measurable performance indicators were developed at the outset and reviewed throughout the campaign. The first three of these goals were increasing passenger satisfaction, revenue, and the number of rail users. This is in line with the CPTED principle that security should first support the function of an environment, rather than be an end unto itself. Separating security from an environment's primary function increases the danger, particularly relevant to transit, that security measures themselves will exact too high a cost on the environment that the security strategy is attempting to protect. The next three goals were increasing arrests and the number of detected offenses, and decreasing the number of offenses reported. Among the other strategies that the scheme employed were removal of trash cans from stations, immediate removal of unsupervised packages, announcements and public notices on trains and stations, computer-assisted analysis of threats and bombings, contingency planning, regular searching of facilities, and extensive use of computer-assisted closed-circuit television (CCTV) systems.

Framework for Addressing Rail Transit Terrorism

The overall framework for conceptualizing rail transit security against terrorism has traditionally drawn on agencies' experience with safety, crime prevention, and emergency response.[23] However, the threat of terrorism is differentiated from all these prior concerns. The type of security concerns transit agencies have confronted in the past, largely personal and property crimes, typically did not result in the need to mobilize a coordinated emergency response effort by the system as a whole. Natural disasters and safety failures were more likely to trigger such a response, but are not deliberate crimes. As the threat of terrorism increases, agencies are charged with incorporating elements of all three—safety, crime prevention, and emergency preparedness—into a comprehensive planning effort.

The transit industry began to formally address issues of emergency preparedness and security in the early 1990s with the development and implementation of the APTA Rail Safety Audit Program. Within the prescribed elements set out for system safety programs plans, were elements specifically noted for emergency preparedness and response and security. This standardized approach to system safety became imbedded in regulation by the FTA (49CFR/ Part 659). Subsequently, in a partnership between APTA, commuter railroads, and the FRA, a similar program, the Commuter Rail Safety Management Program (including elements pertaining to emergency response and preparedness and security) was implemented in 1996. An additional program for bus operations, known as the APTA Bus Safety Management Program, was introduced in 1997.

Initially, the process of planning for terrorist threats against transit targets involved three broad categories of consideration: **prevention**, **response**, and **recovery**.[24]

Prevention includes design, technology, policing, and public education. In the open environment of a transit system, prevention may be too optimistic an expectation when faced with a determined attacker. In this case, a more accurate way to conceive of the security function of prevention is to consider strategies to detect the threat and deter or delay its realization. Policing, technology, and design strategies are all geared to these two functions. The **response** effort comprises planning for disaster, conducting drills, and designing to facilitate evacuation and minimize damage. **Recovery** planning focuses on rapid service restoration. By getting the system up and running to minimize disruption, transit agencies reduce the reward of the terrorist act. Within these three broad categories, the literature has given the most attention to response and policing strategies. They are logical first steps that are easily folded into existing programs that have long been in place to address more common incidences of crime and natural disasters. Given the cost of planning, design, and construction, system design responses tend to be or are limited in scale and ad hoc in nature. Often such strategies are sought in the immediate aftermath of an attack or in response to an immediate threat. For example, immediately following the 9/11 attacks, the Metropolitan Transportation Authority placed New Jersey barriers around the perimeter of Grand Central Station, and many systems removed trash bins from stations.

With a longer time horizon, transit operators must now identify what strategies are likely to be most useful given varying levels of threat, vulnerability, and value associated with a system and its components. The literature has begun to reflect this shift with a number of studies that seek to apply risk assessment methodologies used by the military, government agencies, and industry to the context of urban rail transit terrorism.[25] These frameworks come under the titles of "hazard analysis," "risk and threat assessment," and "systems approach." Given the diversity of transit systems' designs and needs for security, these frameworks give only general guidance on individual strategies. Rather, they provide procedures to support agency decision making around security.

The FTA first began to comprehensively address transit security related to crime with its 1983 publication, *Transit Security: A Description of Problems and Countermeasures*, by Mauri, Cooney, and Prowe.[26] The report's findings are based on a literature review, site visits and interviews at thirteen transit systems, and contact with nontransit organizations with knowledge of security. The report uses the framework of the Federal Bureau of Investigation's Uniform Crime Reporting (UCR) Program, which provides categories and classifications for criminal acts. Terrorism and sabotage had not yet appeared on transit agencies' radar screens as a serious concern. Instead, the focus was on protecting passengers from individual violence and theft, and on protecting the system from vandalism and theft. When asked about situations involving bomb threats and terrorism, the agencies said they would rely on the police.

The most comprehensive of these frameworks applicable to urban rail transit is listed in the FTA's 2003 publication, *Public Transportation System Security and Emergency Preparedness Planning Guide*.[27] The guide deals explicitly, but not exclusively, with terrorist threats against rail and bus transit. However, more frequently occurring crime and emergency responses to natural disasters are the basic justifications of these preparations. This is the FTA's main guidance on transit security and the first to marry crime prevention with emergency response. It advocates a systems approach that combines the practices of emergency response planning and criminal security planning. System security has been defined in previous documents as “the application of operating, technical, and management techniques and principles to the security aspects of a system throughout its life to reduce threats and vulnerabilities to the most practical level possible through the most effective use of resources.”[28]

The current framework has refined the broad three-phase approach mentioned earlier to include five “Elements of Protection.”[29] These elements include security planning, security management, emergency response, physical security and procedures, and threat and vulnerability resolution. The guide provides step-by-step procedures for threat and vulnerability resolution and security planning, necessary for implementation of the other three elements. While transit agencies must turn to other sources for more comprehensive guidance for the implementation of specific strategies, the guide does introduce available techniques for implementing security management, emergency response, and physical security measures.

The main component chapters provide detailed methods for developing a Security and Emergency Preparedness Program (SEPP). Under the federal State Safety Oversight Rule, thirty-two transit systems in nineteen states and the District of Columbia must have a SEPP in place. The directive that required the FTA to establish these rules was codified into the Federal Transit Act in 49 U.S. Code, section 5330. The final rule is codified in 49 CFR Part 659, and is referred to as the State Safety Oversight Rule or Part 659. The information on SEPP programs details how agencies develop internal management systems and external coordination systems with local law enforcement as well as state and federal agencies.

To support the development of a SEPP, the guide covers procedures for conducting capability assessments as well as threat and vulnerability assessments. A major goal of these assessments is to rationalize the process of providing security, making it more cost effective and sustainable. They are designed to enable transit operators to strike a balance between security needs and practices and available resources. A capabilities assessment is proposed as a way for transit operators to assess their current procedures and resources to reduce the threat of crime and terror; respond to incidents that do occur; protect passengers, personnel, and the system itself during emergencies; and assist the community in emergency response. A threat and vulnerability assessment is used to analyze the likelihood that a specific threat will occur. The five elements to be included in a threat and vulnerability assessment are asset analysis, target and threat identification, vulnerability assessment, consequence analysis, and countermeasure recommendation. The guide and the accompanying CD-ROM provide checklists to summarize the issues to be considered in all these assessments.

The final chapter of the guide offers an overview of available design and technology strategies to improve security, and briefly describes some of the crime prevention through environmental design (CPTED) and situational crime prevention (SCP) principles and design strategies commonly used in transportation environments: concentric security zones and spatial transitions, natural surveillance, access control, territorial behavior strategies, and good lighting. These principles will be discussed further in the next section.

The sequence of government publications leading up to the *Public Transportation System Security and Emergency Preparedness Planning Guide* illustrates just how recently terrorism has emerged as a major threat to the security of the U.S. transit environment. The 2003 guide builds on several previous government reports: *Transit System Security Program Planning Guide* by Balog, Schwarz, and Doyle, 1994; *Perspectives on Transit Security in the 1990s* by Boyd, Maier, and J. Kenney, 1996; *Emergency Preparedness for Transit Terrorism* by Boyd and Sullivan, 1997; and the *Transit Security Handbook* by Boyd, 1998. Terrorism is mentioned only in passing in both a 1994 guide by Balog, Schwartz, and Doyle, and in a 1996 survey by Boyd, Maier, and Kenny. However, by 1997, with Boyd and Sullivan's report, terrorism had become a serious enough concern to warrant its own *Transit Cooperative Research Program Synthesis* report.[30]

While the *Transportation System Security and Emergency Preparedness Planning Guide* and its predecessor documents are intended to assist established agencies in meeting state and federal requirements for system security and safety, the FTA also provides guidance for voluntary safety and security certification in the development of transit projects, both new starts and extensions. *Handbook for Transit Safety and Security Certification* was developed cooperatively by the FTA and the American Public Transportation Association.[31] Again, because of the diversity of transit systems, the role of this document is to provide agencies with an organizational and management framework that supports the decision making processes necessary to ensure that new projects are as safe, secure, and cost-effective as possible. Most systems engage in some form of self-certification procedure, but this document is intended to help them more fully integrate emerging safety and security considerations into those procedures. While the handbook does not include direct design guidance, it provides useful insight into the categories of design elements of transit projects for which safety and security are a major concern.

Designing for Security

Such frameworks provide useful tools for agencies seeking to define the overall scope of their antiterrorism efforts and enable them to begin to prioritize their approach. However, the strategies agencies choose will, by necessity, be specific to their situations and are beyond the scope of these guides. Designing for terrorism in transit has not received the same amount of attention as emergency management, response, and policing, and it can be difficult for a transit security manager to find comprehensive design guidance to suit his or her particular situation. It is incumbent on the security manager to seek out further guidance in other bodies of literature for these specific strategies, especially in the case of design. The lack of specific research and guidance for transit in this area is unfortunate. Security managers want to be assured that the design elements of their security strategy are effective and do not leave their passengers and personnel unnecessarily at risk. Additionally, as much as threats and acts of terrorism can have serious consequences for a transit system, security strategies themselves may also interfere with the operations of transit. This caution against unintended consequences has been raised numerous times in the general field of antiterrorism physical design.[32]

There are several reasons why design has not been given much attention in the literature of transit terrorism security. The first is temporal. While the threat of terrorism is not entirely new, the degree of consideration has been minimal compared to other transit issues, such as safety and crime prevention. As late as 1988, the U.S. General Accounting Office (GAO, today known as the United States Government Accountability Office) reported that among the agencies in the seven cities they studied, "transit officials had no direct experience of terrorist incidents, perceived the likelihood of incidents to be remote, and had no antiterrorism programs."[33] In the 1990s, the first order of business in addressing the emerging threat was to put systems into place to deal with the consequences of an attack, and only now do agencies have the dubious luxury of an indefinite time horizon that necessitates and facilitates design consideration.

Second, the most vulnerable systems are by far the largest; the task of retrofitting security design is a daunting one. Jenkins and Gerston were careful to include a security criterion category, called "environmental design and construction features," for each of the eight case studies, so that they could compare each system's efforts. However, Savage of the New York City Transit Authority (NYCTA), interviewed in one of the case studies, notes that,"NYC Transit suffers from a disadvantage due to the sheer size of the system because its 468 stations were constructed over a span of 120 years. Security was not previously a major consideration in design and construction and the cost of systemwide remedial construction would be enormous."[34]

Further reading on the NYCTA case does, in fact, show that the agency takes design into consideration. For example, a security task force from NYCTA visited England, Italy, France, and Japan, to study those systems' experiences with terrorism.[35] The agency implemented the task force's management suggestions, such as the establishment of ventilation procedures, but held off on the resulting design recommendations. Changes to station layout were considered infeasible, again, due to the scale of the system. Additionally, a recommendation to remove trash receptacles from stations was thought to be counterproductive. The heightened risk of track fires resulting from trash buildup was considered more dire than the perceived-as-remote risk of a bomb being placed in a trash can. Thus, the decision not to implement security measures can be as important as the decision to move forward with such measures.

A third reason for the limited attention design has received is that, as one author notes in a recent issue of *Passenger Transport*, "Preparedness is the best defense" against terrorism.[36] The expense of capital construction for physical security and the potential for such measures to be counterproductive in the transit environment may suggest that other alternatives take priority. This is coupled with the sense that in an era of suicide bombing, security is illusory and there is no defense against a determined terrorist.[37] In other words, the best hope for transit is to minimize disruption by having a very organized response and recovery strategy.

However, such a pragmatic, fatalist view ignores actual and potential roles that design plays in security planning for individual crimes and terrorism. Most terror experts call for "layering" protective strategies so that no single strategy is responsible for the entire system, and the failure of one layer does not necessarily jeopardize the security of the system overall.[38] Physical security and design dictate the location of system components and the layers of security encompassing them. Further, on a conceptual level, design is itself one of these many layers of security strategies, along with policing and response planning. Even if the consensus is that good policing is the best defense against terrorism and effective emergency response the best way to minimize the effect of terrorism, design serves the important function of ensuring that those primary resources are fully utilized.[39] In this light, the task of minimizing opportunities for crime and terrorism through design becomes critical.

Design Strategies

Security design involves two areas of facility design: the spatial layout of transit facilities, and the structural design of buildings, track, and rolling stock. Since very little has been written that is directly applicable to transit vehicles and stations, the most useful guidance in the area of designing for antiterror security comes mainly from the building trades. The GSA, in its capacity as the federal government's landlord, and FEMA provide excellent advice and specifications for building antiterror security in the areas of target hardening, fire safety, blast resistance, and situational crime prevention strategies (SCP) such as crime prevention through environmental design (CPTED).[40] The American Institute of Architects (AIA) offers guidance through its 2003 publication, *Security Planning and Design: A Guide for Architects and Building Design Professionals*.[41] Additionally, the latest edition of *Architectural Graphic Standards* includes a chapter on design criteria for security against terror.[42]

Academia has provided a number of case studies and best practice guidelines that list strategies employed by selected transit operators.[43] At least one state, Florida, through the work of the Center for Urban Transportation Research at the University of South Florida in 2001, has developed a list of recommended design measures in its own antiterror analysis.

Environmental Design

The important role that environmental design plays in reducing or supporting crime in the transit environment is well documented.[44] According to Felson and LaVigne, the Washington Metropolitan Area Transit Authority (WMATA or Metro) and the Port Authority Bus Terminal are classic examples of success stories of applied security design against crime in rail transit environments.[45] In each case, environmental design shares the credit for increased security with strategic policing, strict maintenance procedures, and "zero tolerance" policies in enforcing rules and regulations. However, the applicability of these successes to terrorist threat must be viewed cautiously. Effective design against crime will not necessarily provide sufficient protection against terrorist threats because there are significant differences between criminals' motivations and the effects of the crimes they seek to commit and those of terrorists.

CPTED and SCP are both aimed at reducing opportunities for specific types of crime, particularly in public or semiprivate environments. The goal of CPTED is to influence the social and physical use of space through environmental design that discourages antisocial and criminal behavior.[46]

The main CPTED principles are **natural surveillance, natural access control,** and **territorial reinforcement. Natural surveillance** refers to the use of building design and layout to increase the ability of legitimate users and security personnel to observe activity. Clear sight lines have the effect of increasing visibility of users and limiting opportunities for hidden activities.[47] **Natural access control** is achieved by using building elements to limit or channel access to the facility; for example, allowing for only one entrance into a facility and providing an extended "standoff distance" between the building and the street. **Territorial reinforcement** strategies encourage desired users to take "ownership" of certain spaces under the theory that people pay more attention to their surroundings if they are invested in that space. These strategies concentrate public uses and amenities to increase the likelihood that improper use of the space will not be tolerated by the critical mass of legitimate users. Situational crime prevention takes CPTED one further step by incorporating design strategies with strategic management policy and policing functions.[48]

LeVigne, Clarke, and Felson are each very careful to note that the successes recorded in their work are evidence of one of CPTED and SCP's fundamental principles: that management procedures and the environment be tailored to highly specific crime problems.[49] Balog, Boyd, and Caton also make note of this in their work.[50] The type of designs prescribed for individual crimes relies on well established theories of criminal behavior, motivation, and individual perceptions of risk and reward. However, criminals seeking personal gain will necessarily have very different motivations than those seeking to cause maximum destruction to further a social or political goal. Even on a purely theoretical level, the direct application of measures that have been successful in reducing the threat of crime will not necessarily prove successful against the terrorist threat. For example, LaVigne (1996) notes that CCTV cameras are mounted in very visible locations in the WMATA stations to alert would-be criminals that they are being watched.

The cameras alone appear to be enough to deter offenders, as LaVigne quotes former D.C. Metro Transit Police Chief Angus MacLean as saying, "The cameras mainly serve a psychological purpose because they read out at the station manager's kiosk and often no one is there."[51] It is easy to see where "dummy" cameras and similar devices might not be as effective in deterring a bomber with a different psychological relationship to the risk of being caught. For CPTED to work against the threat of terror, its strategies must be tailored to the motivations and behaviors of terrorists.

The applicability of crime prevention design strategies to the threat of terrorism has not been adequately addressed in the literature. Many sources simply extrapolate the CPTED approach from crime prevention to terrorism prevention. This makes sense where security tactics share common goals, such as in access control and surveillance. However, relying only on successful crime prevention strategies to address the terrorist threat ignores important distinctions in mode, motivation, and magnitude.

In its recent publications on designing buildings against terrorist attack, FEMA takes a more nuanced approach: "In cases where CPTED techniques conflict with security principles, designers should seek innovative solutions tailored to the unique situation."[52] The authors note that many antiterror design strategies are similar to those prescribed under CPTED principles. For example, using the principle of natural surveillance to limit opportunities to conceal illicit acts is similar to the common antiterror approach of eliminating spaces where an attacker could conceal an explosive. However, they also discuss the possibility that individual crime prevention strategies can conflict with the goals of designing for the threat of an explosive attack. They offer the example of the location of parking facilities. CPTED principles would suggest that a parking lot be located in a place that facilitates casual monitoring by the building's occupants and visitors. However, allowing vehicles too close to the building may increase its vulnerability to a car or truck bomb.[53] Some design elements credited with combating crime can, in fact, become liabilities in the event of an incendiary attack. Both LaVigne and Boyd note the role of trash cans on WMATA's station platforms in maintaining a clean environment in which crime is not tolerated.[54] This may be a good strategy in transit systems with low risk of terrorist attack as trash cans and recycling bins are important passenger amenities. However, Jenkins' chronology reveals trash cans to be a favorite delivery device for terrorist bombings in transit stations.[55] In response to this threat, the Metropolitan Atlanta Rapid Transit Authority (MARTA) switched from conventional to bomb-resistant trash cans at busy stations during the 1996 Olympics.[56] Other high-risk systems, especially those with underground stations, have removed or sealed their trash cans entirely. Such stations have maintained their standard of cleanliness by adopting a "pack it in/ pack it out" policy similar to many state parks, and increasing maintenance rounds.

The use of glass as a design element is particularly problematic in the event of a bombing, but it is cited in many documents dealing with designing out crime in the transit environment.[57] Glass serves an important security function when it enhances formal and informal surveillance by bringing in natural light, providing a sense of openness, and enhancing visibility. In

Felson's study of the Port Authority's efforts to bring crime under control in the mid-1990's, a glass-walled café in the Port Authority Bus terminal affords ample opportunity for casual surveillance of a once isolated area.[58] Glass is also featured extensively in the security strategies of a proposed subway station in Paris.[59] In this case, glass skylights bring in natural light and glass barriers along the platform prevent accidental falls and pushings.

However, when ruptured by a bomb blast, glass can be extremely hazardous. In its book, *Security Planning and Design*, the AIA offers this gentle caution: "Glass fragments generated during failure are extremely hazardous to building occupants and, if not properly designed, can cause mass casualties when propelled at high speeds into occupied spaces."[60]

This is not the end of glass, because there are several ways in which it can be made safer, including heat treating and laminating. The AIA book also notes that even if blast resistance is the only consideration (leaving aside aesthetics and building performance), decisions about glazing depend on many factors, from the level of the bomb threat to the integrity of the frame, and the blast load on the facility itself. This caution should serve not as a prohibition against the use of glass in transit station design. Rather, it is an illustration of the tensions among the design requirements of traditional crime security, antiterror security, and aesthetics.

In spite of the hazards inherent in applying crime prevention design strategies directly to the threat of terrorism, the many guiding principles and lessons of CPTED can inform antiterror security strategies. This is especially true in an environment as public and open as transit, where the theories of CPTED can be a valuable countervailing force against traditional target-hardening measures, which can interfere with an agency's mandate to provide efficient public transportation at minimal cost. A goal of CPTED is to provide security while emphasizing the objectives of the organization, rather than focusing solely on target hardening.[61] But for design to play a role in securing transit against terrorism, security planners and designers must first understand the nature of the threats posed by criminals who seek large-scale destruction of life and property. Then, they must select among the most effective strategies for each specific threat, according to an evaluation of each measure's tangible and intangible costs and benefits. At the very least, the effects of successful anticrime strategies must be decomposed to see what elements of these anticrime measures would work against the specific requirements of security under the threat of terrorism.

Understanding the Threat to the Physical Environment

To better understand the nature of the threat of terrorism in terms of modes of attack and effects of those attacks on transit's physical structures, planners can turn to the growing body of literature provided by the building trades, the military, and the federal government. Fortunately, the effects of manmade disasters, as well as their mitigations, are well documented and familiar to the emergency management community. One of the more accessible discussions of the current state of the practice is found in FEMA's 2003 publication, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*. A second 2003 FEMA publication, titled *Integrating Manmade Hazards into Mitigation Planning*, is part of a series of "how to" guides for communities and states.

In *Integrating Manmade Hazards into Mitigation Planning*, FEMA provides a set of "Event Profiles for Terrorism" that planners can use to familiarize themselves with the various modes of attack, the extent of their effects, and any mitigating or exacerbating conditions. The list includes attack modes relevant to the transit environment such as conventional bombs or improvised explosive devices, and chemical, biological, or radiological agents. In addition, the guide provides a list of "Terrorism and Technological Hazard Mitigation Actions," which they caution "is by no means exhaustive or definitive; rather, it is intended as a point of departure for identifying potential mitigation techniques and strategies in your community or state." With the foregoing caveat, the recommended actions range from "implement crime prevention through environmental design (CPTED)" and "eliminate potential site access through utility tunnels, corridors, manholes, etc." to "create blast-resistant exterior envelope."[62] Because the guide is intended for those without specific expertise in antiterrorism security, it does not discuss the degree of effectiveness of these measures in mitigating specific threats.

Even more specific guidance is provided by FEMA's *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*. Just as security design against terror builds on the detection and deterrence functions of anticrime security design measures, FEMA's reports build on its experience in mitigating against natural disasters. As an example of this synthesis, they note that their recommendations for hurricane window design also apply to bomb blasts. However, they are careful to note where a natural hazards approach may be deficient.[63] For example, mitigating natural hazards does not require the same attention to access control and surveillance.

The reference manual begins with a threat and hazard analysis methodology similar to those recently developed for transit. Part of this methodology includes an extensive "Building Vulnerability Assessment Checklist" borrowed from the Veterans Administration. The checklist is composed of questions designed to determine the vulnerability of specific elements of the building's design and operation. The questions relate to thirteen categories of building design and operations, many of which are applicable to the transit environment: site, architecture, structural systems, building envelope, utility systems, mechanical systems (heating, ventilation, and air conditioning), plumbing and gas systems, electrical systems, fire alarm systems, communications and information technology (IT) systems, equipment operations and maintenance, security systems, and security master plan. Similar assessment checklists are widely available, including one recently developed specifically for transit systems on behalf of the FTA.[64] FEMA's checklist is unique, however, in that each question is associated with specific guidance and a reference to another guide. For example, question 1.3 asks, "In dense, urban areas, does curb lane parking allow uncontrolled vehicles to park unacceptably close to a building in public rights-of-way?" In response, the guidance offers:

> Where distance from the building to the nearest curb provides insufficient setback, restrict parking in the curb lane. For typical city streets, this may require negotiating to close the curb lane. Setback is common terminology for the distance between a building and its associated roadway or parking. It is analogous to stand-off between a vehicle bomb and the building. The benefit per foot of increased stand-off between a potential vehicle bomb and a building is very high when close to a building and decreases rapidly as the distance increases.[65]

This is followed by a reference to a publication providing more detailed guidance: General Services Administration's *Facilities Standards for the Public Buildings Service*, published in 2003.[66]

Security is traditionally addressed from the outside in, from the building's site perimeter to the building envelope and, finally, the interior. FEMA's guide devotes a great deal of its report to site selection and site design criteria, which, they note, have limited applicability to dense urban settings. Nonetheless, FEMA does present the potential of urban design to negotiate the tensions among security, aesthetics, and primary use of space around the building's perimeter. Where similar guides have recommended against the use of bus shelters because they can hide illicit activity from view, FEMA simply suggests that they be designed to enhance surveillance. Also unique to this report is its explicit caution against the interference of security measures with pedestrian traffic flow and a reminder that "the design of bollards, fences, light posts, and other streetscape and landscape elements should form an urban ensemble that helps to create a sense of unity and character."[67] The guide's extensive discussion of considerations in the use and placement of bollards and planters is particularly useful to designing secure perimeters for urban rail transit stations. Parking presents a particular challenge to urban rail transit security because the danger of vehicle bombs demands more stand-off distance between parking and the station than is generally feasible. FEMA suggests that planners be creative and offers a sampling of design, operations, and engineering measures for parking near high-risk facilities.[68] Finally, the individual measures discussed throughout the site design chapter are listed and ranked according to their level of cost, effort, and protection. Those same measures are then correlated in a table with specific threats from vehicular bombs to airborne contamination.

Although bombs and other incendiary devices appear to pose the most likely threat to transit systems, there is no specific guidance for the design of rolling stock in relation to the terrorist threat.[69] However, there are two guides available that address fire safety: 1992's *Fire Safety Countermeasures for Urban Rail Vehicles* by Hathaway, Baker, and Moussa, and *Recommended Fire Safety Practices for Rail Transit Materials Selection*, from the Urban Mass Transportation Administration, 1984. Both reports assume only accidental ignition. The goal of the fire safety countermeasures prescribed in the reports is to prevent fires from starting, slow down or contain fires if they do start, and evacuate passengers as quickly as possible. The 1992 document focuses on all aspects of fire safety: fire prevention, early detection, fire hardening, and passenger evacuation. The shorter 1984 document recommends fire safety tests for materials used in rail transit—from undercarriage components to seat cushions. Similarly, *Fire Safety Countermeasures for Urban Rail Vehicles* focuses on replacement components and construction materials of rail cars, rather than the fundamental components such as motors and switches.[70] The 1992 report details the major characteristics of rail transit vehicle equipment, the types of fire problems that are likely to occur, and selected countermeasures against fire. In addition, potential research and development opportunities are highlighted. While certainly this is useful in suppressing the devastating secondary effects of fire from a blast, the guide provides no information on the specific effects and countermeasures for blast hazards on rail cars.

Bombs are not the only threat to transit, and terrorists have not historically limited themselves to one mode of attack. The sarin attack in Tokyo in 1995 alerted security managers to the threat of chemical and biological agents. There is a considerable body of research and literature on the behavior of chemical and biological agents in buildings, and mitigations including those by FEMA and Mead and Gressel. However, chemical and biological agents released in moving trains have a different impact from those released in buildings. Therefore, this literature may be of limited use in the transit environment. Fortunately, the potential of a chemical or biological attack on subways has been given serious attention since the Tokyo gas attacks.

Much of the guidance that arose out of that event relates to the emergency response and management functions necessary to reduce the harm done in the event of the release of a chemical or biological agent.[71] Policastro and Gordon have documented prospective technologies appropriate for the subway environment. Given the limitations of current automated detection technologies, they note that rapid containment and response are the keys to limiting casualties in the event of a chemical or biological release in a subway system. The need to contain or vent a released chemical or biological agent is determined by the properties of a specific agent. But without highly sensitive detection technologies, subway operators will not likely know the nature of the release in order to make the critical containment/vent decision. Therefore, Poliocastro and Gordon recommend a default policy of immediate containment of the “plume” by stopping the movement of the trains and delaying the activation of emergency fire and smoke fans.[72]

They also discuss the system design factors that act to spread or contain a release, noting that moving trains push contaminated air throughout the station, into adjacent stations, and out through any street level vents in a piston effect. Because subway system design factors are assumed to be fixed, they recommend that response strategies be tailored to the design of each track section (for example, single versus multiple tracks). Technologies that detect chemical or biological releases and automate part of the response are receiving an increasing amount of research and testing support because response time is so critical in reducing casualties from an attack. WMATA has plans to pilot test chemical detection equipment in twelve stations as part of the Department of Energy’s PROTECTS (Program for Response Options and Technology Enhancements for Chemical/Biological Terrorism in Subways) program.[73]

Challenges to the Security Paradigm

As noted in the introduction, transit presents several unique challenges to the security paradigm as it has historically been applied in other theaters such as aviation and federal buildings. In this section, three major challenges as they are presented throughout the literature of transit terrorism will be discussed.

Dual-Use

Given the existing demands placed on transit systems, and the limited resources with which transit operators execute their most basic functions, efficiency and effectiveness must play a large role in any comprehensive approach to security against terrorism. Several articles advocate for a dual-use approach to transportation security that would protect transportation systems against terrorism, while at the same time helping agencies meet their other transportation goals, that is, safety and efficiency.[74] In fact, this dual-use approach has been consistent throughout the literature. Transit security for terrorism is considered at once a new problem and an extrapolation of the general problem of transit crime and system safety.[75] Some, but not all, of the approaches for securing the system against terrorism will necessarily secure it against general crime and safety. Another reason for approaching transit security from this angle is that it has been historically difficult to justify the expenditures needed for securing a system against terrorism, given the low real incidence of terrorism and the variability of threat levels. Complementary strategies that address other transit goals, in addition to security against terrorist attack, are more likely to receive funding and support.[76]

The case studies have suggested that while preparation and planning for terrorism are key, it does not need to be all encompassing to be effective in the event of an attack. More limited efforts that focus on mundane crimes and smaller-scale emergencies such as power outages, technical failures, or natural occurrences have been shown to be as effective in the event of a major catastrophe:

> Advance emergency preparations were the backbone of New York City's response on September 11. Representatives of several transportation agencies noted that documented and practiced emergency response procedures could never have accommodated a catastrophic event with such widespread impacts. But it is clear that practicing and preparing for less-significant emergencies did, in fact, help transportation agencies manage and adapt on September 11.[77]

In other words, marathoners do not prepare for running a marathon by running 26.2 miles regularly. Doing so would be too taxing and leave them without the resources to perform effectively in daily life and in competition. On the day of the marathon, however, the months of shorter workouts carry them to the finish line.

The promise of dual-use strategies can easily be overstated. However, the consequences of an actual attack, rare as it is, may be too dire to risk ill-conceived measures. The fact that a strategy has a secondary benefit does not eliminate the need to question the assumptions about the applicability of nonterror strategies to the transit terror arena. Similarly, transit agencies must be aware of the danger of being swept up in the search for security so they do not waste resources on what some might call a solution looking for a problem.[78]

Evaluating Costs

The Federal Transit Administration asserts, "Security and emergency preparedness must be accountable for their return on their investment".[79] This is, however, easier said than done. Transit agencies have figured out how to quantify the economic impact of crime on their systems, both in terms of loss of life and property as well as revenue lost from passengers choosing other modes.

Transit crime has both financial and social costs. The financial costs, directly borne by the systems themselves, but indirectly passed on to patrons and taxpayers through higher fares and higher taxes, reductions in the frequency and quality of service, and higher government subsidies, can be divided into two categories: the increased financial burden of operating the system and the reduction of revenues collected. The social costs are borne by both patrons who suffer from reduced security in the system and nonpatrons who contend with congestion outside the system as potential passengers concerned about a lack of security turn to other forms of transportation.[80] There is no such economic measurement for the threat of rail transit terrorism. However, establishing such measurements will be a key task for the security and transit communities.

There is now a need to address the threat more critically and comprehensively so that transit security strategies themselves do not, in the long term, cripple transit agencies' ability to fulfill their critical role of providing mobility in urban centers. This alarm has been raised in terms of the mismatch between the level of preparedness that the Department of Homeland Security calls for and the funding available to local governments and transit agencies to meet these calls.[81] Peter Guerrero, director of physical infrastructure issues at the Government Accountability Office, notes, “Every time the administration raises the security threat level, the private sector and local governments are forced to divert resources from such things as maintenance and safety.”[82]

The diversion of funds from maintenance and safety is not the only concern transit agencies have in balancing the need for antiterrorism security with other transit goals. As transit security becomes more comprehensive and layered, there arises the potential that these security strategies conflict with agencies’ primary purpose: to provide accessible, convenient, and affordable transportation for daily users.[83] For example, one countermeasure for arson is the removal of shelters and benches.[84] Indeed, many transit operators have done just that. However, there is no analysis of the cost of such measures to riders and system ridership.

The effect of these dangers in approaching security extends beyond the transit system to our environment and the functioning of our economy. Transit agencies struggle to compete with the private automobile to alleviate the consequences of worsening congestion and air pollution. To meet these demands, they must provide convenience, attractiveness, and affordability above and beyond what is offered by private transport. If security measures add too much delay or cost, or make the trip unpleasant, the cost is borne by the transit operator, the economy, and the environment in the form of increased dependence on private vehicles. FEMA’s recent guidance on mitigating manmade disasters provides this cautionary note:

> While many benefits can be achieved through implementing mitigation actions, planners should be sensitive to potential negative impacts as well. For example, altering traffic patterns may increase commute times and distances, and reducing on-street parking may impact retail activity. Such considerations can be pivotal in determining the feasibility, viability, and potential for success of mitigation planning initiatives.[85]

In the past, transit agencies have addressed this challenge implicitly by showing a preference for dealing with transit terror in ways that do not affect operations, such as response planning and policing. However, in the post-9/11 era, the need to assure the public that more is being done has generated calls for a comprehensive approach, which ensures security but also preserves transit’s goals for ridership.

The goals of safety, security, and efficiency in transit operation are not fully compatible. Two documents discuss the impact of security measures on the functioning of transit. The first is transit specific, but does not consider terrorism, while the second deals with antiterror measures on urban design. In "Target Hardening at a New York City Subway Station: Decreased Fare Evasion—At What Price?" Weidner questions New York City Transit's (NYCTA) efforts to thwart fare evaders with high wheel turnstiles. He raises the issue of whether the benefits of reduced fare evasion outweighed the creation of a "prison-like" environment.[86] The NYCTA has since installed these turnstiles in hundreds of stations, with no negative effect on ridership or change in the rate of crime.[87] However, Weidner raises an important question about the nature of the costs security can impose on transit systems.

Similarly, the National Capital Planning Commission's (NCPC) 2001 publication, *Designing for Security in the Nation's Capital*, considers the effects of public security measures on the urban design goals of Washington's Monumental Core. "Even before the 1995 bombing in Oklahoma City, Washington's streets and public spaces had become an unsightly jumble of fences and barriers… The National Capital reflects the spirit of America, but today in Washington we look like a nation in fear."[88]

While urban design in this case has a much different function than the more workaday goal of transit to move people to their destinations, the NCPC report, like the Weidner article, can help practitioners frame some of the nonquantitative concerns and costs and compromises that arise when planning for security. The General Services Administration's symposium on security and the design of public buildings, "Balancing Security and Openness," carries these questions further by examining the effects of designing for security on the character of America's public buildings. The report provides insight into the tensions between the need of U.S. federal buildings for security and the need of the public for openness in government.[89] "Balancing Security and Openness" might as well be the title of a transit security symposium. However, in the case of transit, openness is a fixed condition of the system and not subject to questions of balance.

Evaluating Effectiveness

The available frameworks help systems assess their relative risk and vulnerability to terrorism in an effort to ensure that their security efforts match their financial and institutional capabilities. However, there has been no formal evaluation of the effectiveness or cost of individual security strategies in the transit environment. Much of what has been presented in the guidelines is extrapolated from best practices for dealing with nonterrorist threats. In part, this is due to the fact that concrete measures of effectiveness against incidents as rare as terrorist attacks are elusive, if not impossible. Jenkins notes:

> Because terrorist threats are not easily quantifiable, it is difficult to determine the "right" level of security. Using cost-benefit analysis as the sole criterion to determine the level of security is not very helpful. The risk of death to any individual citizen from terrorism is minuscule, making it difficult to argue for any security measure on the grounds that it will save lives. Since the threat of terrorism is murky and security measures are costly, it is hard to justify the expenditures before an attack.[90]

The fields of building science and disaster response have extensive experience in quantifying the physical effects of individual natural and manmade hazards on buildings, and designing to prevent catastrophic failure. In the case of natural hazards, researchers can draw on extensive historical data to quantify the economic risk and mitigate accordingly.[91] Likewise, crime prevention efforts have begun to rely extensively on historical data to target resources efficiently and analyze the effectiveness of their efforts. Thankfully, attacks on U.S. urban rail systems are rare enough that no equivalent databases are available for such analysis. Evaluation of the effectiveness of specific security measures in deterring terrorists must be more qualitative and theoretical.

At least one researcher has taken the time to ask the question, "Is there a difference between designing for crime and designing for terrorism?" Atlas contends that "attack from criminal behavior or attack from terrorist activity only reflect a change in the level and types of threats. The process and challenges are the same."[92] He provides a very thorough and informative list of established CPTED strategies that may address terrorist threats. A comparison of the current practices against crime with those of London's successful antiterror security strategies should give some confidence to security managers of the applicability of current crime control measures to the emerging terror threat. The integrated approach of London's antiterror strategy, "Control of Public Space," is very similar to the "systems approach" to traditional transit crime advocated by the FTA. Boyd, Maier, and Kenny present crime data and security practices of nine transit agencies around the country. They find that most agencies employ a combination of personnel deployment, system design and technology, data collection, and training, operating, and management practices. The study lists security measures used by these agencies in addressing twenty-eight different types of crime, including terrorism.

However, it was beyond the scope of the study to provide fine-grained analysis of the cost, consequences, and efficacy of the individual measures.

While a level of compatibility between strategies against crime and terrorism may exist, CPTED relies heavily on a thorough understanding of criminal motivation and behavior. Therefore, a change in the level and type of threat is a very significant alteration of practice for which some established CPTED strategies may not be entirely suited. Balog warns, “Solution for a particular crime in a particular situation, will not necessarily work for all types of crime.”[93] It certainly seems logical that many design strategies that reduce the opportunity for crime may also reduce the opportunity for terrorist activities. Still, the application of such strategies to terrorism in the transit environment deserves more critical analysis of the mode, motivation, and effect of terrorist actions against transit. It would be especially useful to think through the differences in motivation, evaluation of risk, and tactics between “ordinary” criminals who are out for their personal gain and terrorists whose goals are political.

Despite the lack of definitive evaluative research, an outline of best practices has emerged from the collective recent experience of rail transit terrorism, which suggests that coordination and response planning, assisted by technologies such as CCTV, are the best tools transit agencies have. Training police, transit employees, contractors, and the public to watch for suspicious activity supports a thorough response capability. Environmental design ensures that policing resources are used efficiently by making surveillance easier and reducing opportunities for terrorism (for example, eliminating places where bombs can be hidden, or erecting antiram bollards). Engineering blast resistance into existing transit facilities may be too costly for the level of threat faced by even the most vulnerable transit systems, but more modest structural improvements to glazing or light fixtures could be part of a system’s strategy. The threat of terrorism is no longer a political anomaly, but one of the challenges facing urban rail transit systems and public infrastructure as a whole. It is too grave a threat to pass up the possible protection that these strategies afford urban rail transit.

SECURING TRANSIT SYSTEMS IN THE POST-9/11 ERA: A SURVEY OF U.S. TRANSIT OPERATORS

Overview

When the September 11, 2001, attacks destroyed parts of the New York City transit system and the March 11, 2004, commuter rail bombings did the same in Madrid, Spain, the vulnerability of open, accessible public transit systems and their passengers to terrorist acts was cast in sharp relief. Well prior to these attacks, research on terrorism and public transit had shown public transit systems worldwide to be a principal venue for terrorist acts.

Most previous research on transit terrorism has consisted of single or groups of case studies of major terrorist acts and responses to them by police and transit managers. Case studies are especially useful when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context.[94] Despite these advantages, case studies are limited, in that they are not necessarily representative and thus may not reflect the conditions or trends facing the transit industry more broadly. Thus, one cannot generalize from the findings of case studies (though in practice, researchers often do). This is an especially relevant issue in the study of U.S. transit systems, because they vary so dramatically in size—from thousands of vehicles and millions of daily passengers, to just a handful of vehicles carrying dozens of daily passengers. As potential targets of terrorist acts, these systems, and their stations and vehicles, are likewise dissimilar.

In contrast to case studies, aggregated analyses of data drawn from a representative sample of the population (in this case, larger U.S. transit operators) are generalizable and allow researchers to draw conclusions about the population under study.[95] However, more generalized, aggregated studies of the security experiences and practices of transit systems have been much less common. In the United States, just two such aggregate studies of transit system security have been published in recent years.

In a 1997 Transit Cooperative Research Program report, Boyd and Sullivan reported on a survey of forty-two transit managers regarding experiences with terrorist acts, perceptions of risks, and interagency coordination in planning for transit security. They found that terrorist acts against transit systems were on the rise in the United States and worldwide, that transit agencies—particularly those operating rail service—were perceived by respondents to be at great risk for attack, and that coordinated efforts to both deter and respond to terrorist acts were on the rise but not yet commonplace.

Following the September 11, 2001, attacks, Congress asked the Government Accountability Office (GAO) to consider what role the federal government should play in helping public transit operators reduce both the likelihood and impacts of terrorist attacks on transit systems in the United States.[96] Part of this research included a mid-2002 survey of officials at 155 transit systems in the United States. The survey focused on security planning and preparation efforts, interagency and intergovernmental transit security coordination efforts, and perceptions of obstacles to more effective security planning. Perhaps not surprisingly, a principal finding of the 2002 GAO report was that transit system managers surveyed cited increased funding as the most important role the federal government could play in assisting transit systems with security planning.

The findings of these two surveys, which are discussed in more detail in the pages that follow, contributed significantly to our understanding of the experiences with, perceptions about, and preparation for terrorist threats to U.S. transit systems. While the 1997 Boyd and Sullivan survey was of a relatively small sample of transit systems (60 systems surveyed, 42 responded), it provides a snapshot of transit systems when concerns over terrorist threats were just beginning to wax for many transit managers. The 2002 GAO report surveyed many more transit systems (200 surveyed, 155 responded) about six months after the September 11, 2001, attacks, a time when transit managers (and, of course, their passengers) had a heightened awareness of terrorist threats, but before many new plans, programs, and procedures could be put into place. While both surveys devote considerable attention to bureaucratic, policing, and emergency response issues, they largely ignore the role of system design for transit security.

The survey reported on here complements and extends the findings of these two surveys in several ways. First, by surveying transit managers in the late spring and early summer of 2004, the survey findings provide a profile of experiences, perceptions, and actions nearly three years after the September 11, 2001, attacks that made security a top priority among U.S. transit operators, and just after the largest single terrorist attack directed toward transit (in Madrid, Spain), which further heightened concerns over transit security. This allows us to examine the degree to which post-9/11 attention, initiatives, and mandates have been integrated into transit planning practice.

Second, this research expands on these earlier studies by surveying respondents' attitudes toward, and efforts in, four distinct areas of transit security planning: (1) policing, (2) security hardware/technology, (3) public education/user outreach, and (4) environmental design strategies. The latter two of these approaches have received considerable attention in research on personal and property crime on transit systems, but far less in transit security research.

Finally, while previous research on transit system vulnerability has focused on transit systems operating one or more rail modes, less attention has been paid to systems that use or manage indoor bus and ferry terminals. Like rail transit stations, terminals—such as the Port Authority Bus Terminal in Manhattan, or the TransBay Bus Terminal in downtown San Francisco—host tens of thousands of weekday passengers in enclosed spaces vulnerable to terrorist attacks. While we separately evaluate rail and nonrail transit systems, we include data on the experiences and perceptions of transit system managers responsible for enclosed bus and ferry terminals as well.

Description of Survey

During the spring of 2004, hard copy and electronic letters describing our research and soliciting participation in a survey were sent to the general managers of all 259 U.S. transit agencies that, according to the National Transit Database maintained by the Federal Transit Administration, operate at least 50 vehicles in peak period service. This ranged from a high of 9,136 vehicles at MTA-New York City Transit, to a low of 50 vehicles at South Bend Public Transportation Corporation in South Bend, Indiana; Bay Metropolitan Transportation Authority in Bay City, Michigan; and Escambia County Area Transit in Pensacola, Florida. The letter asked each general manager to designate the appropriate person or persons to complete an on-line survey. In the case of smaller systems, this was often the general manager himself or herself, and in larger systems this was most often (but not always) the director of policing or security. We assume in this analysis that the general manager was in the best position to determine who should complete the survey, so we do not parse our analysis to analyze responses by different types of respondents. The survey instrument was designed to allow respondents the flexibility to complete the survey over the course of several interactive sessions before submitting a completed survey. Respondents from 113 transit agencies completed some or all of the survey questions (44 percent of the 259 agencies contacted).[97] Figure 1 on page 56 compares the resulting sample to the population with respect to the number of vehicles operated during peak period service. The sample is somewhat underrepresented with respect to smaller systems.

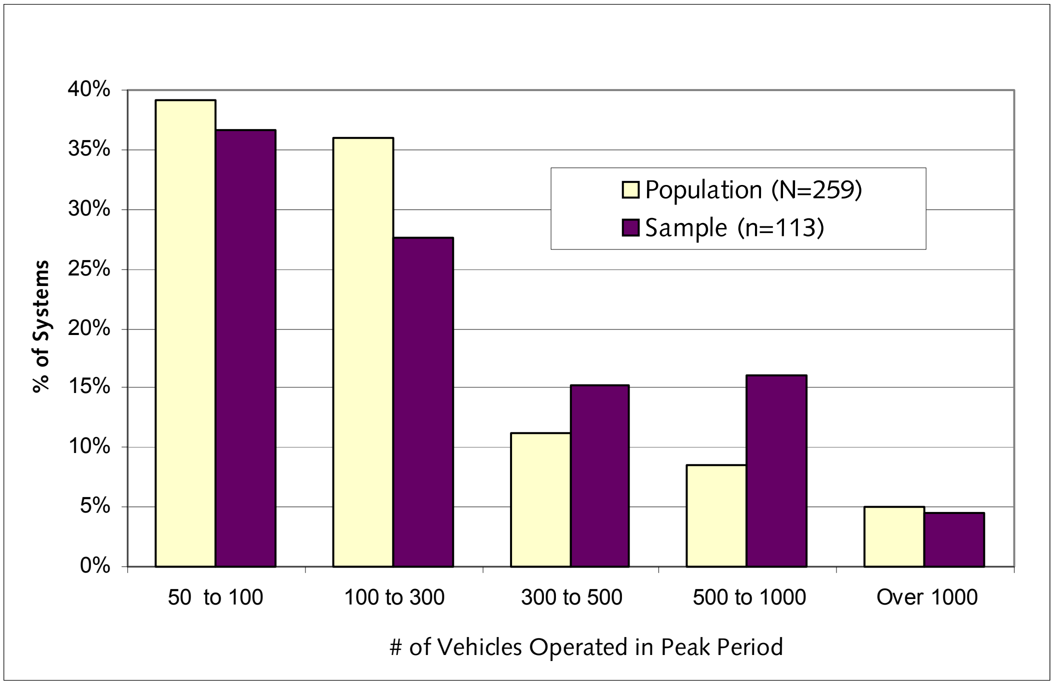

Figure 1 System Size Comparison

Transportation systems from 108 cities in 40 different states are represented in the sample. California has the highest number of responses with 22, followed by Florida (8), and Washington (7). Almost half (45 percent) of the respondents identified their title as something associated with security; 28 percent had titles associated with management; 13 percent were associated with operations or maintenance; and 14 percent reported various other titles (a complete categorization of titles is presented in Appendix B).

Most (80 percent) of the systems analyzed here operate more than one transit mode. Fifty-nine systems (or about half—52 percent—of the entire sample) operate bus and paratransit only. One-fourth (twenty-eight) of the systems operate rail service;[98] twenty-three of these systems are multimodal operations, while five systems operate rail service only. Fifty-two of the fifty-nine nonrail systems (which were drawn from the largest such systems in the country) report that they operate service out of at least one enclosed bus terminal or multimodal transfer facility; these fifty-two systems represent 46 percent of all respondents. Systems operating rail service or that operate out of an enclosed bus terminal or multimodal facility (n = 80) responded to a more extensive set of questions than did the nonrail, nonenclosed terminal systems. Table 1 shows the percent of systems analyzed operating each of the specified transit modes.

Table 1 System Travel Modes

Mode	# of Systems	% of Systems
Commuter Rail	9	8%
Heavy Rail	7	6%
Light Rail	18	16%
Bus	104	92%
Ferry	10	9%
Paratransit	91	80%
Other[a]	13	11%

a. Includes vanpool, carpool, cable car, trolley, streetcar, incline, automated guideway, airports

The range of responding agencies' services is broad. For example, the Massachusetts Bay Transportation Authority reported operating all modes of transit listed in Table 1, while the Dallas Area Rapid Transit, New Jersey Transit, and the Southeastern Pennsylvania Transportation Authority operate commuter and light rail as well as bus and paratransit service. The Greater Cleveland Regional Transit Authority (GCRTA) system in Cleveland operates heavy and light rail plus bus and paratransit, while the King County Metro Transit system offers light rail, bus, ferry, and paratransit.

Three-fourths of the twenty-eight systems with rail service modes operate out of multiple types of stations. All but two systems have some or all at-grade stations, and about 60 percent have elevated and/or below-ground/subway type stations (see Table 2 on page 58). Respondents were asked to identify the busiest station in the system and the year it was built. The oldest station in the sample is South Station Rapid in Boston, which was built in 1899. Most of the stations for which year-of-construction data were provided were built since 1970. Table 3 on page 58 lists the twenty rail transit systems that provided information on the age of their busiest station.

Table 2 Rail Station Types

Type	# of Systems	% of Systems
Elevated	16	57%
Below-ground/subway	16	57%
At grade	26	93%
Don't know	1	4%
More than one type	21	75%

Table 3 Busiest U.S. Rail Systems

Agency	Headquarters	Station	Year Built
Massachusetts Bay Transportation Authority	Boston	South Station Rapid	1899
Southeastern Pennsylvania Transportation Authority	Philadelphia	Suburban Station	1920
Metrolink	Los Angeles	Union Station	1939
New Jersey Transit	Newark	Penn Station, New York	1965
San Francisco Bay Area Rapid Transit District	Oakland	Embarcadero	1971
Washington Metropolitan Area Transit Authority	Washington, D.C.	Metro Center	1976
San Diego Trolley Inc.	San Diego	San Ysidro	1980
Metro. Atlanta Rapid Transit Authority	Atlanta	Five Points	1980
Niagara Frontier Transportation Authority	Buffalo	University Station	1984
Tri-County Metropolitan Transit District	Portland	Rose Quarter	1985
Sacramento Regional Transit	Sacramento	St. Rose of Lima Station	1987
Santa Clara Valley Transportation Authority	San Jose	Tamien	1987
GCRTA	Cleveland	Tower City	1987
Virginia Railway Express	Alexandria	L'Enfant	1991

Table 3 Busiest U.S. Rail Systems (Continued)

Agency	Headquarters	Station	Year Built
Regional Transportation District	Denver	I-25/Broadway	1994
Dallas Area Rapid Transit	Dallas	West End	1996
Montebello Bus Lines	Montebello, CA	Montebello/Commerce	1998
Memphis Area Transit Authority	Memphis	North End Terminal	1998
Utah Transit Authority	Salt Lake	Sandy Civic	1999
Port Authority Trans-Hudson	Jersey City	World Trade Center Station	Reopened 2003

Incidents and Perceived Threats

Substantive security incidents on United States transit systems are rare, but not unprecedented. Respondents were asked about the occurrence of various types of security incidents and the frequency of such incidents over the past decade. The results of this query track very closely with those reported in 2002 by the United States Government Accountability Office (2002), suggesting some reliability in the results. Agencies with rail systems (n = 28, or 25 percent of respondents) or that operate out of an enclosed bus terminal or multimodal transfer station (n = 52, or 46 percent of respondents) were asked about possible terrorist incidents experienced on their systems. Of these eighty systems queried, there were sixty-eight valid responses. A total of twenty-eight agencies reported experiencing some sort of incident; twelve of these were rail transit systems, and sixteen were nonrail operators. Counts of different types of incidents experienced are shown in Figure 2 on page 60. Use of arson/incendiary devices on a system was the most common type of incident recorded. The "Other" category included reports by two systems of suspicious packages that were identified but turned out to be false alarms, a bomb threat, two knife attacks, a shooting with no victims, theft of a radio system, hazardous materials contamination on a bus, and a case of rail-track tampering. Details on these incidents are summarized in Table 4 on page 61 and Table 5 on page 64.

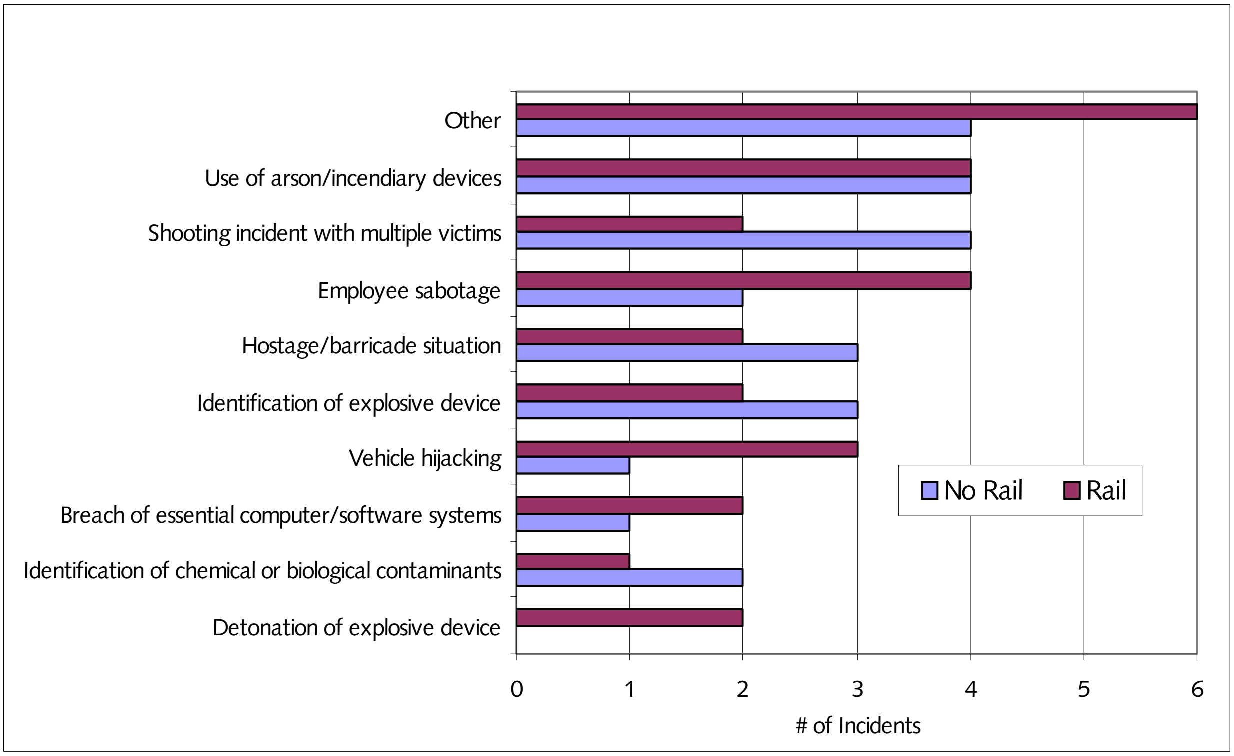

Figure 2 Incidents Experienced by Systems

Table 4 Description of Security Incidents

Type of Incident	System Has Rail	No. of Incidents in Last Decade	Year of Most Recent Incident	Location of Incident	Description of Incident
Identification of explosive device on system	No	1	2002	Bus Stop	Pipe bomb placed in trash can was located and destroyed.
	Yes	1	2002	Vehicle	Suspicious package on bus removed from vehicle.
	Yes	< 12		Station	Pipe bomb found on rail transit platform.
Detonation of explosive device on system	No	1	2003	Vehicle	Explosive device detonated by juveniles on a bus.
	No	1	2004	Station	Soda bottle bomb was detonated on a bus at main transfer point injuring one passenger.
Use of arson/incendiary devices on system	No	3-4	2003	Vehicle	Juveniles playing with matches ignited various things.
	No	Several	Yearly	Vehicle/Bus Stop	Arson vandalism by juveniles.
	No		2003	Bus Stop Shelter	Juvenile lit a bus stop shelter on fire.
	No	1-2		Station	Fire started in restroom trash container.
	Yes	120	2004	Station/ Vehicle	Intentional lighting of newspapers to make a fire.
	Yes	3	2002	Bus/Train	Five buses destroyed by fire and three more damaged.
					Rail car seat set on fire.
	Yes	1	2002	Vehicle	Fire intentionally started on floor of vehicle.
Chemical or biological contaminant	No	1	2003	Vehicle	Suspect sprayed pepper or mace on board.
	Yes	20	2002-03	Vehicle	White powder anthrax scare.

Table 4 Description of Security Incidents (Continued)

Type of Incident	System Has Rail	No. of Incidents in Last Decade	Year of Most Recent Incident	Location of Incident	Description of Incident
Vehicle hijacking	No		2002	Vehicle	Intoxicated male assaulted driver and attempted to leave using vehicle.
	No	1	1988	Vehicle	Passenger wanted to go to a city where the bus did not go. No other passengers were on board.
	No	1	1994	Vehicle	Passenger who said he had a gun demanded to be taken to the airport. He was arrested there.
	Yes	1	2004	Vehicle	Passenger took control of bus when it started back to the location where he boarded.
Hostage/barricade situation	No	1	2003	Vehicle	Armed suspect boarded a bus. Shots were exchanged with no injuries and suspect captured.
	No	1-2	2004	Vehicle	Passenger told driver he had a bomb strapped to his chest. Police were notified by silent alarm. There was no bomb.
	Yes			Station	Incident at rail station handled by local law enforcement.
	Yes	2	1999	Vehicle	Mentally disturbed persons threatening to harm others.
	Yes	1		Bus Terminal	Man barricaded in coffee shop threatening to kill himself. Surrendered after negotiations with police.

Table 4 Description of Security Incidents (Continued)

Type of Incident	System Has Rail	No. of Incidents in Last Decade	Year of Most Recent Incident	Location of Incident	Description of Incident
Employee Sabotage	No	several	2004	Vehicle/Bus Garage	Miscellaneous instances.
	No		2003	Maintenance Facility	Sabotaged oil on several revenue and support vehicles.
	No		2003	Vehicle/Bus Garage	Removal of microphones; damage to cameras.
	No			Station	Disabled buses.
	Yes	1	1985	Building	Employee drove stolen vehicle into administration building.
Breach of computer/ software systems	No	several dozen	2004	Vehicle	Sabotaging digital cameras and/or audio devices.
	No		2004	Other	Systems infected with computer viruses.
	Yes	1	2003	Computer	Accidental hacking caused brief shutdown of operations.
Shooting incident with multiple victims	No	1	2002	Vehicle	Male passenger boarded bus with shotgun and shot another passenger and himself.
	No	1		Other	North Hollywood shoot out.
	Yes	1	1996	Station	Gang members shot other gang members in stairwell at entrance to the station.
	Yes	1	1994	Station	Subject shot two or three passengers at station.
	Yes			Maintenance Facility	Disgruntled employee went to work and started shooting.

Table 5 Description of Other Security Incidents

Type of Incident	System Has Rail	No. of Incidents in Last Decade	Year of Most Recent Incident	Location of Incident	Description of Incident
Other	No	2-3	2002	Vehicle	Passenger told bus driver he had left a bomb on rear seat and ran away.
	No	2	2004	Outside Vehicle	Vehicle windows shot out while traveling on road.
	No	3	2004	Multi-Modal Transfer Center	Suspicious bag left on bench. Terminal evacuated until bomb squad determined it was not a bomb.
	No	2	2000	Vehicle	Chemicals for methamphetamine production released accidentally.
	No	1	2004	Vehicle	Radio stolen from service vehicle and vehicle set on fire.
	No	1	2004	Vehicle	One passenger stabbed another after verbal altercation.
	Yes	1	2003	Tracks	Track jacked up and boulder placed under track.
	Yes		2004	Vehicle	Operator shot by estranged husband.
	Yes	2	2001	Station	Two planes hit the WTC Towers causing a collapse onto station.
	Yes	< 10	2004	Vehicle	Male climbed through bus window and robbed driver.

Sixteen agencies indicated that they had received one or more of what respondents believed to be credible threats (for example, bomb, chemical, biological, fire attacks) in the last year. Most of these (fourteen of the sixteen) had received from one to four threats. Two other very large rail operators reported large numbers of threats; one cited thirty-one credible threats in the past year, and the other twelve.

In addition to providing information on actual threats and attacks, respondents were also asked about their perceptions of vulnerabilities. While one could argue that these survey respondents (who were designated by each system's general manager as the person at that agency who is most knowledgeable about transit security issues) are in perhaps the best position of anyone to offer vulnerability assessments, such perceptions should probably be treated more as informed speculation than concrete assessments of vulnerability. What is most clear from responses to these questions, however, is that transit systems are, by their very nature, perceived by system managers as very vulnerable to terrorist attacks. Of respondents who expressed opinions on vulnerability, only in the case of paratransit did fewer than 60 percent of the respondents rank a transit mode or system component as somewhat or very vulnerable. Overall, rail modes were perceived by respondents to be the most vulnerable (see Table 6), though these findings are based on relatively few responses.[99] Finally, respondents collectively did not assign much difference in vulnerability ratings of various system components (Table 7 on page 66).

Table 6 Vulnerability of System Modes to Attack

Mode	Don't Know	Not Vulnerable	Somewhat Vulnerable	Very Vulnerable	*n*
Heavy rail	-	-	20%	80%	5
Commuter rail	12%	-	25%	63%	8
Light rail	13%	-	27%	60%	15
Bus	6%	19%	29%	45%	97
Other	18%	18%	27%	36%	11
Paratransit	7%	41%	27%	26%	83
Ferry	22%	19%	44%	22%	9

Table 7 Vulnerability of System Components

Component	Don't Know	Not Vulnerable	Somewhat Vulnerable	Very Vulnerable	*n*
Tracks and rail lines	8%	15%	11%	66%	26
Rail stations	12%	14%	11%	63%	27
Bridges/tunnels	4%	8%	26%	62%	38
Multimodal terminals (bus and rail)	11%	10%	23%	56%	50
Vehicles	6%	10%	32%	52%	67

Given this overview of actual and perceived security threats on our sample of U.S. transit systems, our analysis now looks at the security planning efforts of these same systems.

Threat and Vulnerability Assessments

Of the 113 agencies represented in the sample, 85 percent indicated that they have conducted some level of threat and vulnerability assessment of key system infrastructure. Agencies with rail were much more likely to conduct a comprehensive assessment than other agencies. This is a significant increase over the 54 percent reported by respondents to the 2002 GAO survey. Almost half (46 percent) of the agencies with rail have conducted a comprehensive security assessment, compared to only about 13 percent of agencies without rail (see Table 8 on page 67).[100] Most transit agencies without rail have conducted security assessments, but they are more likely to be described by respondents as moderate or partial assessments, rather than comprehensive. Considering only transportation systems without rail, we find little difference with respect to assessment practices between those with a multimodal transfer or enclosed bus terminal and those without.

Table 8 Conducted Threat and Vulnerability Assessments

Level of Assessment	# of Systems	% of Systems	Cumulative%
ALL Systems			
YES, Comprehensive	24	21%	21%
YES, Moderate	38	34%	55%
YES, Partial	34	30%	85%
NO	11	10%	95%
Don't Know	6	5%	100%
TOTAL	113	100%	
Systems with Rail			
YES, Comprehensive	13	46%	46%
YES, Moderate	11	39%	86%
YES, Partial	1	4%	89%
NO	2	7%	96%
Don't Know	1	4%	100%
TOTAL	28	100%	
Systems without Rail			
Systems with Multimodal Transfer or Enclosed Bus Terminal			
YES, Comprehensive	7	13%	13%
YES, Moderate	15	29%	42%
YES, Partial	19	37%	79%
NO	7	13%	92%
Don't Know	4	8%	100%
TOTAL	52	100%	
Other Systems			
YES, Comprehensive	4	12%	12%
YES, Moderate	12	36%	48%
YES, Partial	14	42%	91%

Table 8 Conducted Threat and Vulnerability Assessments (Continued)

Level of Assessment	# of Systems	% of Systems	Cumulative%
NO	2	6%	97%
Don't Know	1	3%	100%
TOTAL	33	100%	

Among those systems that have not conducted security assessments, the primary reasons given for not doing so were lack of resources (*n* = 5) or the fact that services were contracted to an outside agency (*n* = 3). Four agencies indicated that they were in the process of planning an assessment at the time of the survey, while one respondent stated simply that his/her agency was not a "high-value target."

Thirty-five agencies report conducting assessments at least once a year, while twenty-eight agencies report conducting assessments every two or three years (see Table 9 on page 69). The remaining agencies report no regular policy regarding frequency, but rather conduct assessments as deemed necessary. Seventy percent of agencies conducting assessments had done so in the last two years (see Table 10 on page 69). In general, the reported frequency of such assessments is substantially higher than was reported in the GAO survey just two years earlier. There was not a significant difference in the timing of assessments between agencies that operate rail and those that do not.

Table 9 Frequency of Assessment

Frequency	# of Systems	% of Systems	Cumulative%
More than once a year	8	8%	8%
Once a year	27	28%	36%
Once every 2 years	19	20%	56%
Once every 3 years	9	9%	66%
Other	23	24%	90%
Don't Know	10	10%	100%
TOTAL	96	100%	

Table 10 Year of Most Recent Assessment

Year	# of Systems	% of Systems	Cumulative%
1999	2	2%	2%
2001	7	7%	9%
2002	16	17%	26%
2003	36	38%	64%
2004	32	33%	97%
Don't Know	3	3%	100%
TOTAL	96	100%	

The most common purposes reported for the most recent threat and vulnerability assessment conducted were to assess terrorism-related vulnerabilities (80 percent of systems) and crime-related vulnerabilities (70 percent of systems). Only 38 percent of the systems used the process to assess natural disaster-related vulnerabilities (see Table 11 on page 70), which contrasts significantly from the 85 percent reported in the 2002 GAO survey. Other purposes mentioned were to assist in developing a security plan and to help prioritize security enhancements for implementation. All but one of the systems with rail (96 percent) mentioned terrorism as a purpose of the assessment as compared to three-fourths of systems without rail.[101] Systems without rail were somewhat more likely to have conducted a crime or natural disaster assessment than systems with rail (though the observed differences were not statistically significant). Further, among systems without rail there were essentially no differences in the stated purposes of the assessments between systems that operated a multimodal transfer or enclosed bus terminal and those that did not.

Table 11 Purpose of Assessment

Purpose	All Systems		Systems with Rail		Systems without Rail	
	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems
Assess terrorism-related vulnerabilities	78	80%	24	92%	54	76%
Assess crime-related vulnerabilities	68	70%	16	62%	52	73%
Assess natural disaster-related vulnerabilities	37	38%	8	31%	29	41%
Other	4	4%	1	4%	3	4%
Don't Know	2	2%	0	0%	2	3%
More than one purpose	67	69%	17	65%	50	70%
Total systems conducting assessment	96		25		71	

Identifying effective security and technology procedures and supporting decision making at the executive level were the most prevalent uses of the threat and vulnerability assessment results reported (see Table 12 on page 71). Almost all systems with rail have multiple uses for the assessment results, and are much more likely to use the assessment for the specific uses listed in the survey than are systems without rail. For example, 58 percent of systems with rail use the assessment results to apply for Urban Area Security Initiative grants as compared to only 6 percent of systems without rail. In Figure 3 on page 72, we do see that there are some differences in use of assessment between systems operating an enclosed bus terminal/ multimodal transfer and those without.

Table 12 Use of Assessment

Use of Results	All Systems		Systems with Rail		Systems without Rail	
	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems
Identify effective security technology & procedures	79	81%	23	88%	56	79%
Support decision making at the executive level	67	69%	22	85%	45	63%
Support preparation of budgets	56	58%	17	65%	39	55%
Fulfill requirements of System Security Program Plan and/or State Safety Oversight Program	55	57%	18	69%	37	52%
Support FTA's security outreach & technical assistance program	37	38%	18	69%	19	27%
Apply for Urban Area Security Initiative grants	19	20%	15	58%	4	6%
Other	3	3%	2	8%	1	1%
Have not used results yet	4	4%	0	0%	4	6%
Don't know	1	1%	0	0%	1	1%
More than one use	82	85%	24	92%	58	82%
Total systems conducting assessment	96		25		71	

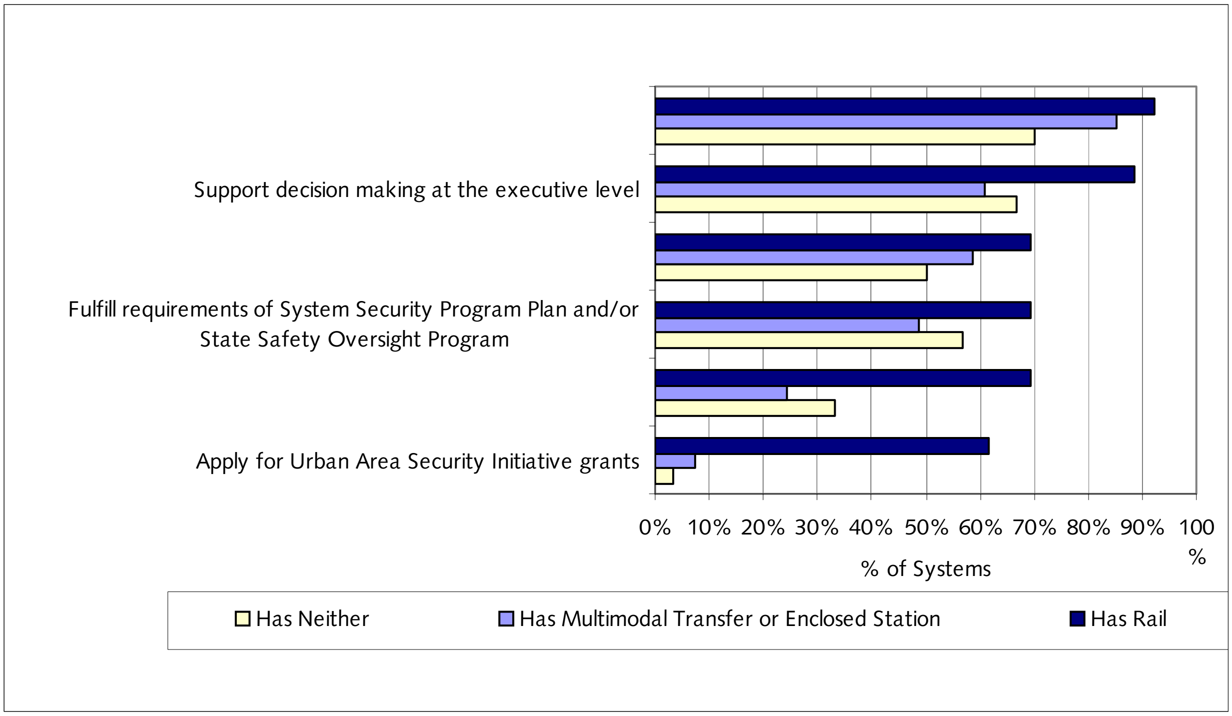

Figure 3 Use of Assessment

About one-third of the agencies without rail reported using an in-house team to conduct their threat and vulnerability assessments, while only 12 percent of systems with rail conducted such assessments in-house. Systems with rail were more likely to use a combination of groups to conduct the assessment, primarily made up of an in-house team along with contracted security consultants (see Table 13 on page 73). Systems without rail were twice as likely to use the sheriff's or police department (about one-third) than systems with rail (16 percent). The most common "other" group mentioned was assistance from the FTA (listed by nine agencies).

Table 13 Who Conducted Assessment?

Who Conducted Assessment?	All Systems		Systems with Rail		Systems with Multimodal Transfer or Enclosed Station		Systems with Neither	
	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems
In-house team	64	67%	15	60%	29	71%	20	67%
Contracted security consultants	28	29%	14	56%	7	17%	7	23%
Sheriff's or police department	26	27%	4	16%	13	32%	9	30%
Other	26	27%	8	32%	10	24%	8	27%
Contracted other consultants	5	5%	2	8%	2	5%	1	3%
Don't know								
More than one group	41	43%	13	52%	18	44%	10	33%
Total systems conducting assessment	96		25		41		30	

Security Strategies

Respondents were asked about their views on the importance of each of four distinct security strategies, and whether these views had changed since September 11, 2001. The four strategies are:

- policing.
- security hardware/technology.
- public education/user outreach.
- environmental design strategies.

The percentage of respondents who believe that all four of these strategies are central to security planning more than doubled after 9/11 (see Figure 4 on page 74 through Figure 7 on page 76). Both before and after 9/11, however, policing was considered the most central strategy, followed by security hardware and technology. Neither public education and user outreach, nor environmental design strategies, were given much importance by respondents before 9/11. Following 9/11, however, respondents from over half of the agencies said that these factors had become significant and even central parts of security planning. While attention to security increased for all types of transit agencies following 9/11, all four of the strategies analyzed here (policing, technology, outreach, and design) were considered more significant or central to security planning for agencies with rail than for agencies without.

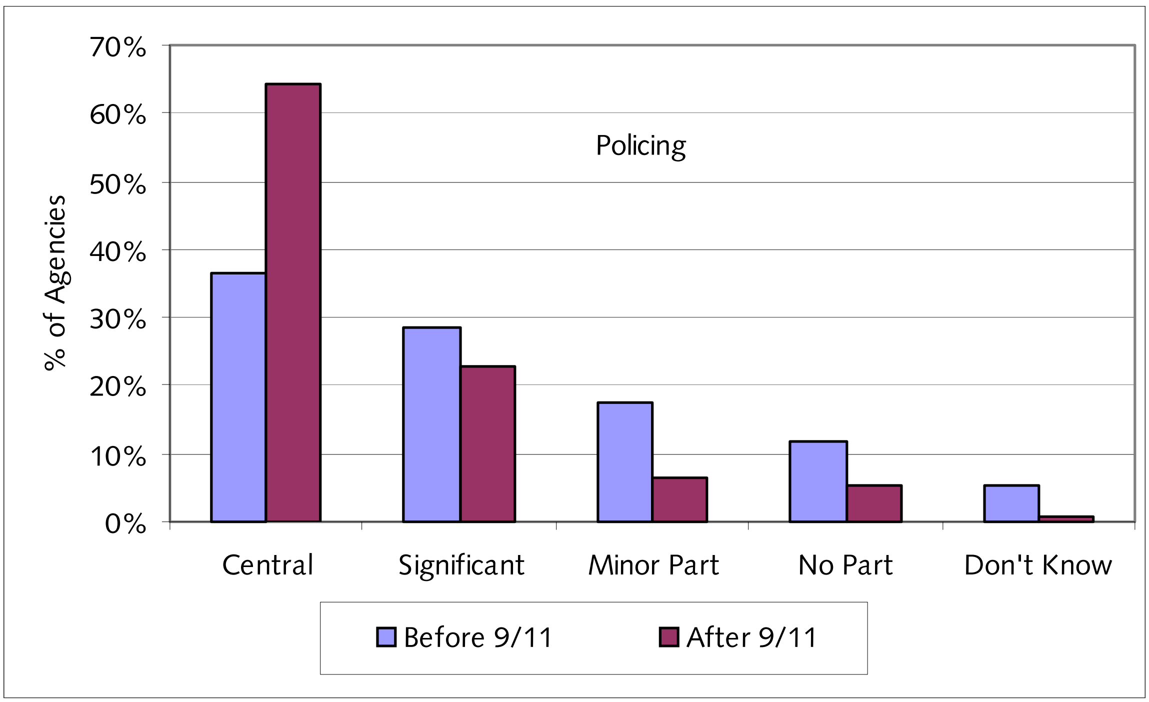

Figure 4 Importance of Strategies in Security Planning: Policing

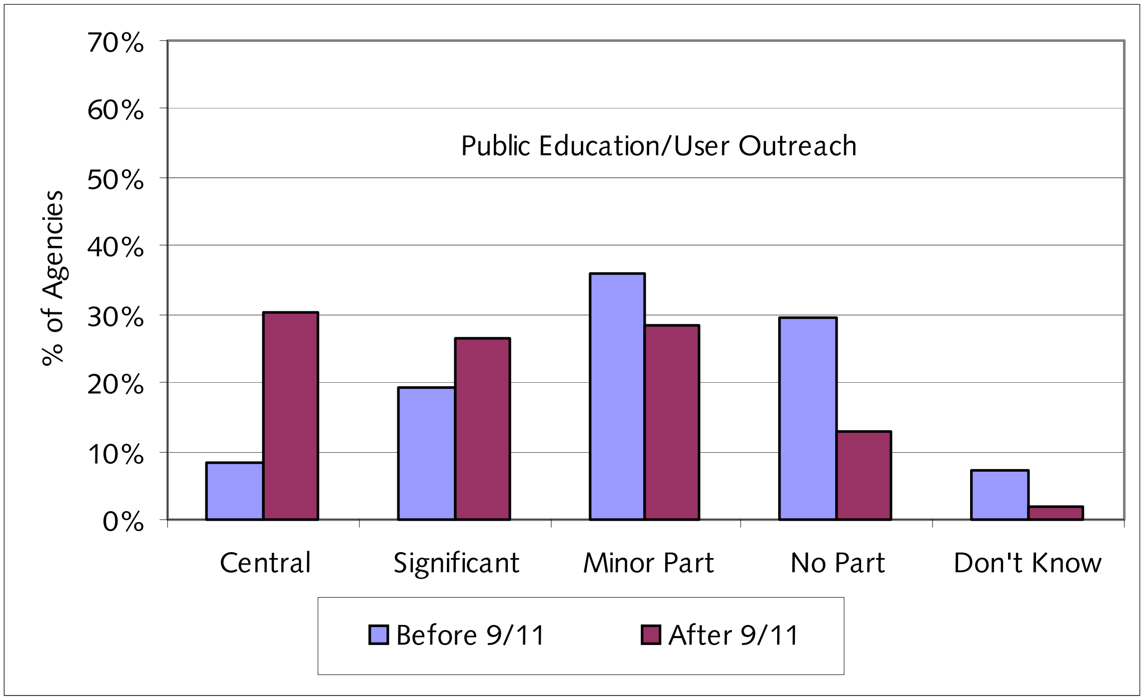

Figure 5 Importance of Strategies in Security Planning: Education & User Outreach

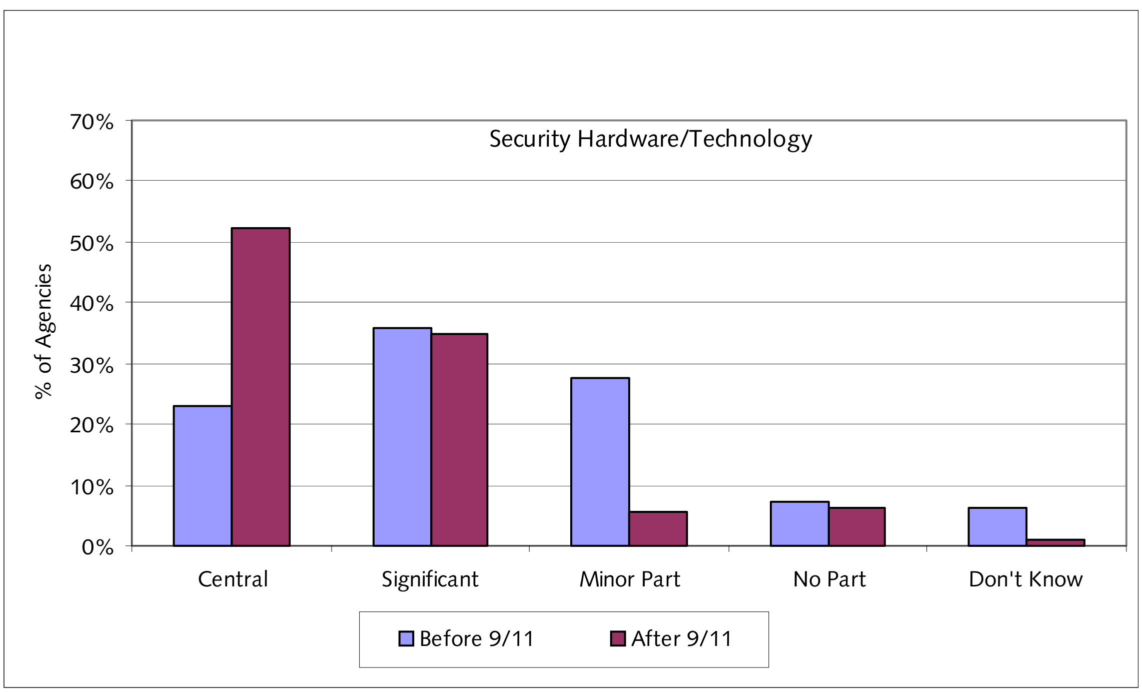

Figure 6 Importance of Strategies in Security Planning: Security Hardware/Technology

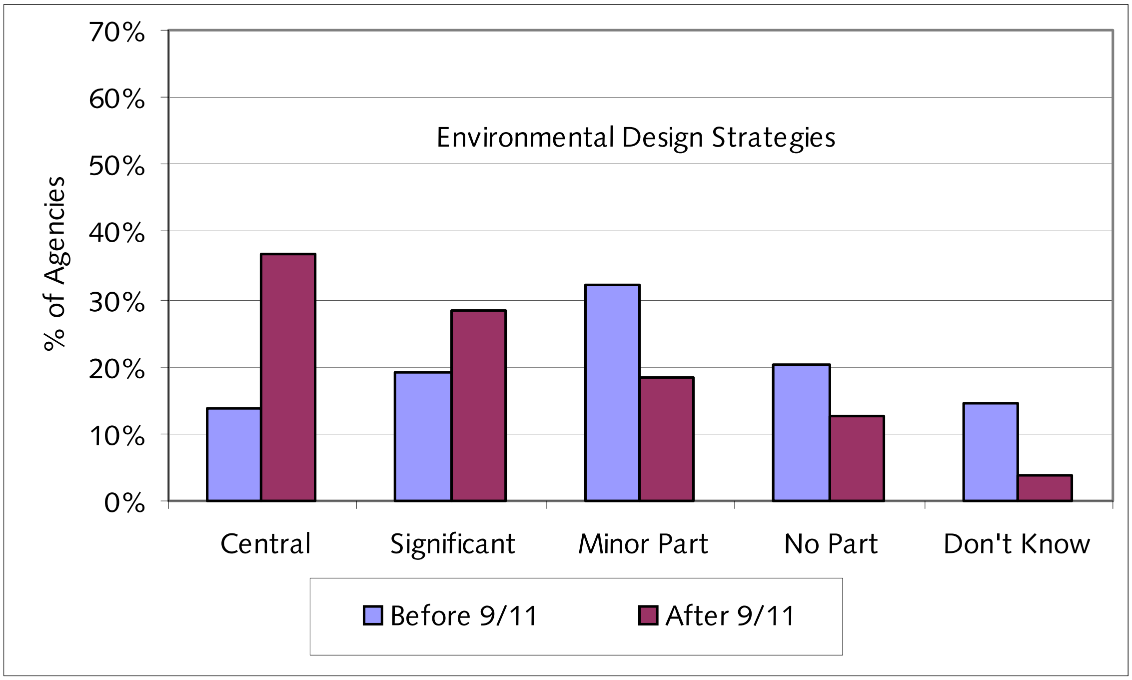

Figure 7 Importance of Strategies in Security Planning: Environmental Design

Before 9/11, respondents from agencies with rail were much more likely to have considered policing significant or central to security planning than were those from agencies without rail (see Figure 8 on page 77). Following 9/11, however, respondents from all types of agencies thought policing to be a significant or central strategy. Environmental design strategies were also considered by respondents from agencies with rail to be a more significant part of security planning, both before and after 9/11. Given that operators of rail systems are likely to be responsible for securing many rail stations and miles of rail rights-of-way, this result is not surprising. By contrast, nonrail operators of enclosed stations or terminals typically operate just one or few such stations and are not responsible for securing the streets and sea lanes on which their vehicles operate.

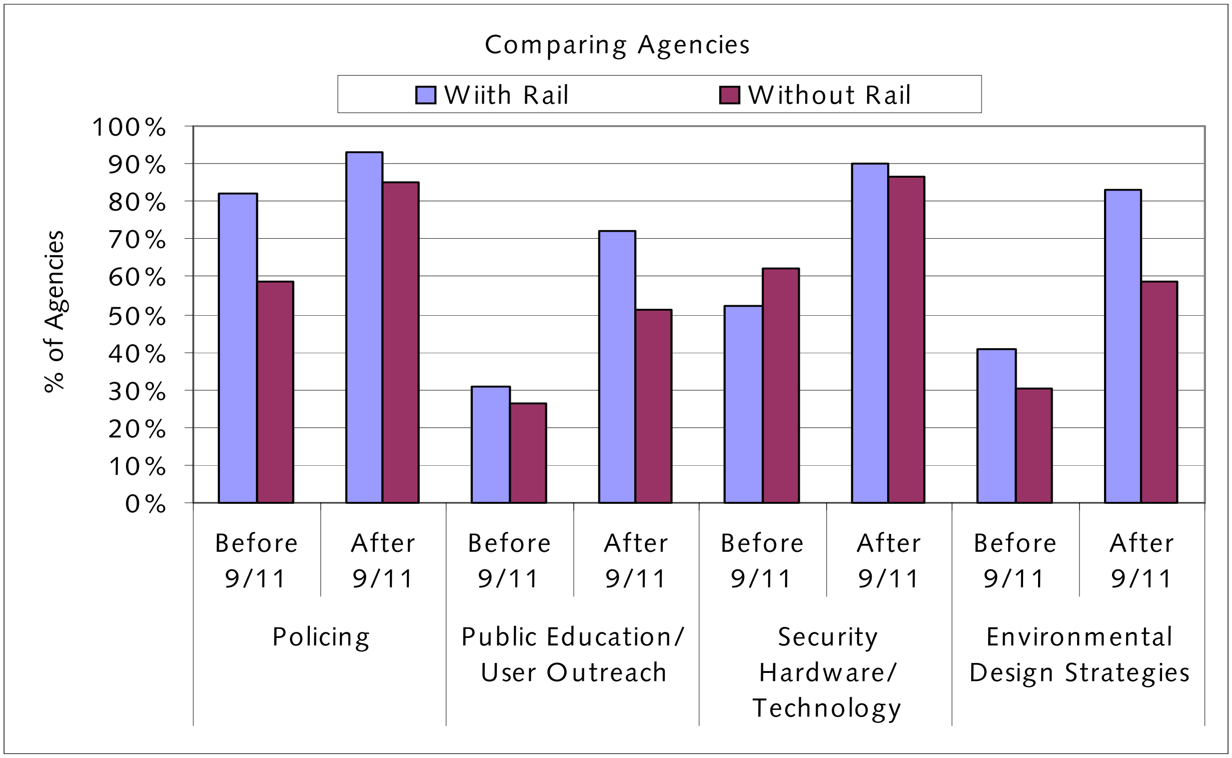

Figure 8 Strategies Considered Central or Significant in Security Planning

When asked about specific changes in security strategies after 9/11, many respondents reported that increased resources (for example, funding) were now devoted to policing strategies. For some agencies this entailed the development of a new in-house police or security force; in other cases, where police forces were already in place, the number of police or security officers increased. Specifically, many respondents reported having a greater public police presence with greater attention paid to increased public visibility of police officers and security guards. In addition, many respondents reported increased coordination with local law enforcement, as well as increased employee awareness training regarding the vulnerabilities of systems to terrorism.

Following 9/11, agencies have tended to look for new ways to engage passengers on security issues. A number of agencies have implemented a Transit Watch program, which engages the public as additional security "eyes" and "ears." Others have sought to increase public awareness of security issues through posters, pamphlets, Web pages, and regular newsletters.

The most common change in security hardware/technology strategies reported after 9/11 is the increased use of surveillance cameras both on vehicles and at stations. Also, more electronically controlled access points have been implemented.

Finally, respondents reported greater awareness of, and attention to, crime prevention through environmental design (CPTED) strategies after 9/11. While awareness of CPTED strategies was high, fewer agencies reported actually implementing CPTED strategies after 9/11. Such a result is not surprising, however, because while strategies like policing and public outreach are operational and amenable to short-term adjustments, changes in the design or rehabilitation of capital facilities to reflect security concerns is a longer-term and more incremental enterprise. Accordingly, most respondents report that their agencies intend to incorporate CPTED strategies into future facility designs.

Prior to 9/11, transit system security planning focused far more on personal and property crime than on acts of terrorism. While efforts to address crime and terrorism are frequently complementary, they are not always one and the same. When asked how they tend to consider antiterrorism and anticrime strategies, most respondents reported viewing the strategies as either hand in hand (46 percent) or partly overlapping (41 percent). Across all agency types, only a few respondents, however, reported that anticrime and antiterrorism strategies were largely separate from one another (see Table 14).

Table 14 Antiterrorism Versus Anticrime Strategies

Agency Opinion	All Systems		Systems with Rail		Systems with Multimodal Transfer or Enclosed Station		Systems with Neither	
	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems
Completely separate from one another	8	7%	1	4%	6	12%	1	3%
Partly overlap one another	44	41%	13	46%	20	41%	11	35%
Considered hand in hand	50	46%	13	46%	19	39%	18	58%

Table 14 Antiterrorism Versus Anticrime Strategies (Cont.)

Agency Opinion	All Systems		Systems with Rail		Systems with Multimodal Transfer or Enclosed Station		Systems with Neither	
Don't know	6	6%	1	4%	4	8%	1	3%
Total systems	108	100%	28	100%	49	100%	31	100%

Policing Strategies

Respondents were asked how policing is provided at their transit system. The survey instrument offered five possibilities, plus an "other" category:

- sworn transit law enforcement.
- nonsworn transit police (private security).
- contracted local police.
- dedicated bureau of local law enforcement.
- no formal security; rely exclusively on local law enforcement.

About half (47 percent) of the agencies use just one policing strategy; this total includes 19 percent that have no formal security and rely exclusively on local law enforcement (see Table 15). The remaining agencies use a combination of policing options, with nonsworn transit police the most common. Over half of the agencies use nonsworn police for all (10 percent) or part (43 percent) of their policing activities. The least-used policing option is a dedicated bureau of local law enforcement—only 7 percent of agencies rely completely or partially on this strategy.

Table 15 Agencies' Reliance on Policing Strategies

Policing Strategy	% of Agencies		
	Use Exclusively	Use as Part of Overall Strategy	Total
Sworn transit law enforcement	10%	19%	29%
Nonsworn transit police	10%	43%	53%

Table 15 Agencies' Reliance on Policing Strategies (Cont.)

Policing Strategy	% of Agencies		
Contracted local police	4%	24%	28%
Dedicated bureau of local law enforcement	4%	3%	7%
Rely exclusively on local law enforcement	19%	14%	33%
Other strategy	0%	19%	19%
Total	47%		

When comparing 2002 GAO survey results to our 2004 survey, we find the percentage of systems relying on regular local law enforcement (33 percent in 2002 and 33 percent in 2004) or with a contract or dedicated arrangement with local law enforcement (34 percent in 2002 and 35 percent in 2004) was essentially the same. However, our 2004 survey found significantly higher shares of transit operators with an in-house transit police department of sworn officers (8 percent in the 2002 GAO survey and 29 percent in our 2004 survey) and using contracted nonsworn transit security (35 percent in 2002 and 53 percent in 2004). While these differences might reflect random variation or bias in one or both of the two samples, the questions posed in these two surveys were similar enough to suggest that, in the three years since 9/11, the proportion of transit agencies with in-house police/security services has increased significantly.[102]

Systems with rail were more likely to rely on sworn transit police than systems without; 64 percent of agencies with rail used sworn transit police for at least half of policing, compared to only 10 percent of agencies without rail. In contrast, systems without rail service were twice as likely to rely heavily on nonsworn police than systems with rail; 37 percent of systems without rail use nonsworn police for over half of their policing, compared to 18 percent of systems with rail. These differences are statistically significant at the 0.05 level.

Eighty-one percent of the respondents provided us with information on the number of full-time equivalent security/police personnel contracted for or employed by the agency. The numbers ranged from zero to 1,500 (at the Port Authority Trans-Hudson headquartered in Jersey City, and with responsibilities for three airports and the New York seaports in addition to the PATH trains and stations). Just over one-fourth (27 percent) of the respondents were from agencies with no in-house or contract security personnel. Sixteen agencies—all of which have rail—employ or contract for over fifty security personnel, and seven of these agencies have over one hundred. Thirty-four percent of the agencies have between one and ten security personnel and 20 percent between ten and fifty (see Figure 9).

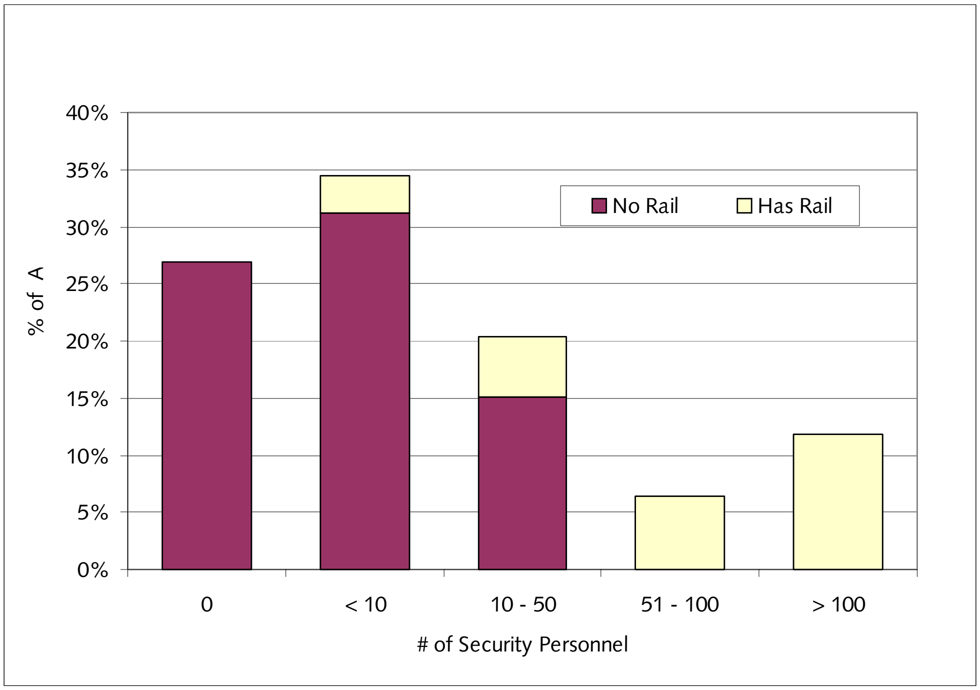

Figure 9 Full-Time Equivalent Security/Police Personnel

Regarding perceptions of effectiveness in addressing terrorist threats, policing strategies were ranked high by respondents. Policing was ranked by 84 percent of respondents as "very" or "somewhat" effective in preparing for terrorist attacks. This percentage is even higher (93 percent) for agencies with rail; 39 percent of respondents from agencies with rail consider policing strategies to be very effective, while 54 percent consider them to be somewhat effective. By comparison, only 24 percent of agencies without rail find policing strategies very effective and 57 percent find them somewhat effective—a total of 81 percent.

Security and Hardware Technology Strategies

In this era of rapidly evolving and extensively deploying information and communication technologies both inside and outside of the transit industry, it should come as no surprise that transit agencies are turning to technology to support increased security efforts. The most extensively used security hardware technologies in our sample were personnel radio communications systems, used extensively by over 90 percent of all agencies—both with rail and without. The only other technology hardware used extensively by over half the agencies is emergency alert/notification systems on transit vehicles, which are used extensively by almost 70 percent of agencies. Public address systems and closed-circuit cameras are used to some degree by most agencies (see Figure 10), while electronic access control, emergency telephones, and GPS locators are used to some degree by about half the agencies. There was little use of the other security-related hardware and technologies asked about in our survey, such as tunnel intruder detection systems, explosives detection equipment, and chemical/biological sensors.

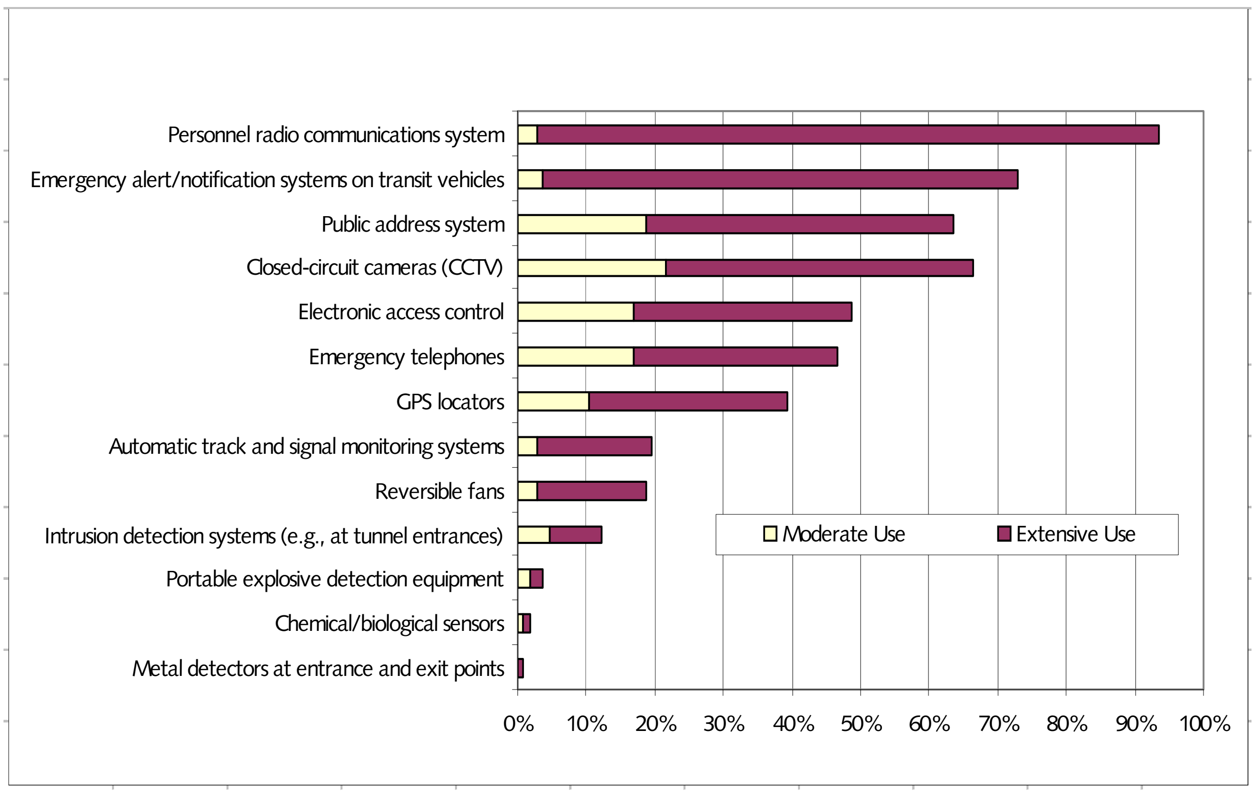

Figure 10 Security Hardware Technologies/Strategies Employed by Agencies

Systems with rail are more than twice as likely to make extensive use of electronic access control and emergency telephones than systems without rail, and are somewhat more likely to make extensive use of public address systems, closed-circuit cameras, and GPS locators than systems without rail (see Figure 11).

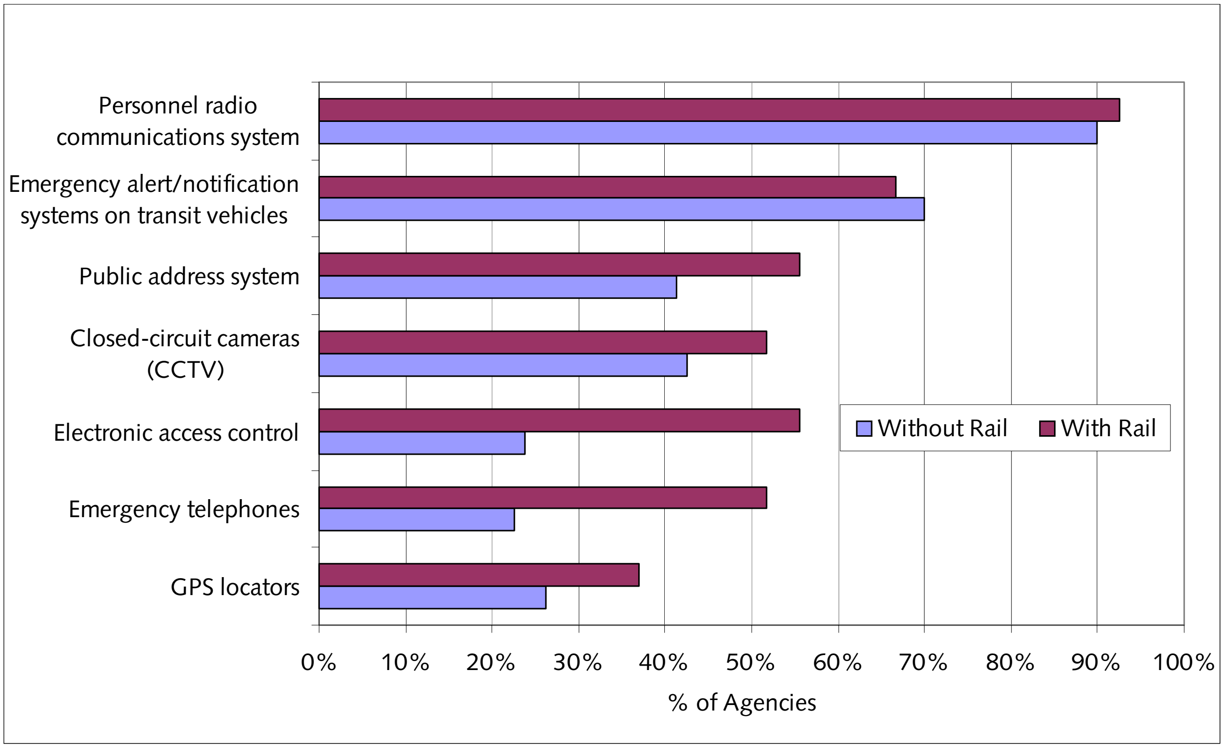

Figure 11 Extensive Use of Security Hardware and Technology Strategies

Just over one-fourth of the respondents consider security hardware strategies very effective in preparing for terrorist attacks and an additional 55 percent think these strategies are somewhat effective, for a total of 81 percent. There is little difference of opinion on this type of strategy between respondents from systems with rail and those without rail.

Information and Outreach Strategies

A stream of crime and public safety literature has for years suggested that public awareness of and involvement in crime reporting and prevention can greatly increase the watchful "eyes on the street" and help to reduce the acceptability of both petty and felonious criminal behavior.[103] Many transit systems abroad—such as the London Underground—have actively sought to enlist the help of patrons in watching for and reporting suspicious activity. When asked about information and outreach strategies to educate transit riders about general emergency and safety issues, three-quarters of those from rail systems report having such programs in place, and 86 percent of these include specific strategies to educate transit riders about dealing with terrorist attacks (see Table 16).

Table 16 Information and Outreach Strategies

Agency Has Transit-Rider Education Strategies	All Systems		Systems with Rail		Systems without Rail	
	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems
General Emergency and Safety Issues						
Yes, Extensive	16	15%	11	41%	5	6%
Yes, Modest	47	44%	10	37%	37	46%
No	36	34%	6	22%	30	38%
Don't Know	8	7%	0	0%	8	10%
TOTAL	107	100%	27	100%	80	100%
Dealing with Terrorist Attacks						
Yes, Extensive	8	7%	8	30%	0	0%
Yes, Modest	26	24%	10	37%	16	20%
No	64	60%	8	30%	56	70%
Don't Know	9	8%	1	4%	8	10%
TOTAL	107	100%	27	100%	80	100%

Efforts by transit agencies to educate passengers on safety and security issues appear to have increased dramatically since 9/11. In its 2002 survey, the GAO report found that just 18 percent of agencies surveyed had conducted transit safety/security campaigns prior to 9/11, while 23 percent had done so in the six months after 9/11. Two years later, our survey found a very different picture: 59 percent of agencies reported having a general safety/security public education program in place, and 32 percent reported having programs specifically devoted to educating passengers about terrorism.

The proportion of surveyed agencies without rail that have information and outreach strategies is (statistically at the 0.005 level) significantly lower than those with rail. Only 6 percent of the surveyed agencies without rail have "extensive" strategies in place to educate passengers on general emergency and safety issues, compared to 41 percent of agencies with rail. While nearly a third of respondents (30 percent) from agencies with rail report having extensive programs in place to educate passengers on what to do in case of a terrorist attack, none of the respondents from nonrail systems reported having an extensive education program in place.

We found no differences between rail and nonrail agencies in the specific information and outreach strategies employed to educate transit riders about general emergency and safety issues and strategies to educate riders about dealing with terrorist attacks. Transit Watch programs are popular, as well as posters and pamphlets that emphasize the message that security is everyone's responsibility. Respondents also report using passenger newsletters, Web pages, public forums on transportation issues, and neighborhood outreach to keep riders informed.

Information and outreach strategies are considered by over half the respondents to be very effective or effective in preparing for terrorist attacks. This percentage is even higher for agencies with rail. Twenty-one percent of respondents from agencies with rail consider information and outreach strategies to be very effective and 50 percent believe that they are somewhat effective—a total of 71 percent. In comparison, only 11 percent of respondents from agencies without rail find public education and outreach strategies to be very effective and 43 percent find them somewhat effective—a total of 54 percent.

Environmental Design Strategies

While system design for transit security received little attention in the two previous security surveys of U.S. transit systems,[104] this strategy was familiar to most respondents in our survey. More than two-thirds (69 percent) of the respondents in our survey reported that they were familiar with crime prevention through environmental design (CPTED) and could define the concept. Well over half (58 percent) of the respondents said that their systems employ CPTED strategies.

Given that rail transit systems tend to have many enclosed stations and miles of exclusive rights-of-way, it is not surprising that familiarity with, and employment of, CPTED strategies is higher at agencies operating rail transit service (see Table 17 on page 86). Almost all the respondents from agencies with rail (twenty-two out of twenty-five, or 88 percent) indicated that they are familiar with CPTED and could define the concept. Seven of these twenty-two respondents from rail systems are associated with agencies that make extensive use of CPTED strategies, and another fifteen agencies report having a moderate CPTED strategy program, for a total of 88 percent of rail transit agencies reporting use of CPTED. By contrast, about half (49 percent) of agencies without rail report making use of CPTED strategies, and about two-thirds (63 percent) of respondents from these agencies could define the term.

Table 17 Use of CPTED Strategies

CPTED Crime Prevention through Environmental Design	All Systems		Systems with Rail		Systems without Rail	
	# of Systems	% of Systems	# of Systems	% of Systems	# of Systems	% of Systems
Can you define CPTED?						
Yes, familiar with term	72	69%	22	88%	50	63%
Uncertain about meaning	18	17%	2	8%	16	20%
Don't Know/Not Sure	15	14%	1	4%	14	18%
TOTAL	105	100%	25	100%	80	100%
Agency makes use of CPTED?						
Yes, extensive use	14	13%	7	28%	7	9%
Yes, moderate use	47	45%	15	60%	32	40%
No	32	30%	2	8%	30	38%
Don't Know/Not Sure	12	11%	1	4%	11	14%
TOTAL	105	100%	25	100%	80	100%

Definitions of CPTED were reasonably consistent across respondents. Some of the definitions were rather broad, such as:

- "The proper design and effective use of the built environment that leads to a reduction in the fear and incidence of crime, and an improvement in a community's quality of life" (Manager, Special Projects, system with bus and paratransit only).

- "Design that eliminates or reduces criminal behavior and at the same time encourages people to be aware of each other and their environment" (Manager, Protective Services, system with bus only).
- "CPTED is a proactive strategy that builds security into the design with a focus on prevention through solid security design, e.g., adequate lighting, ease of patrol, perimeter protection and access control, minimizing landscaping and hiding places, etc." (Manager, Public Safety, regional system with light rail and bus).

Other definitions were quite specific, and often included specific design ideas:

- "Designing system and facilities with the intention of reducing potential criminal breaches, e.g.: lighting, open architecture limiting and/or eliminating alleyways and blind spots, reducing and/or eliminating use of or access to equipment and containers (such as enclosed trash cans) where IEDs (improvised explosive devices) or other potentially hazardous items can be left, etc." (Safety, Training Coordinator, system with bus only).
- "CPTED refers to the incorporation of anticrime design initiatives directly into the planning and construction of facilities and structures. This includes, but is not limited to, the reduction or elimination of 'blind' areas from the 'blueprint' phase through to aesthetic considerations (for example, landscaping, lighting). Both visual and psychological impacts are considered." (Government Relations Officer for Homeland Security, metropolitan transit authority with commuter, heavy, and light rail).

Two-thirds of the respondents from the sixty-one agencies that make use of CPTED strategies think that these strategies are very important in overall security planning, while the remaining third consider CPTED strategies to be somewhat important to transit security efforts. No respondents considered the strategies to be unimportant. These perceptions were similar among systems with and without rail.

Figure 12 on page 88 shows that agencies that use CPTED strategies are most likely to apply them to entrances and exits (82 percent), parking lots (75 percent), or gates (61 percent). By contrast, CPTED strategies are least likely to be applied to elevators, escalators, and vending machines. Comments listed under the "Other" category included landscaping and physical barriers around facilities. CPTED strategies employed for each component mentioned are summarized in Table 18 on page 89. When asked to rank CPTED strategies for cost-effectiveness (most "bang for the buck"), improved lighting and the addition of security cameras and/or closed circuit TV were the most commonly mentioned. Other strategies mentioned by multiple respondents were access control, open facility design with clear lines of sight, and landscaping.

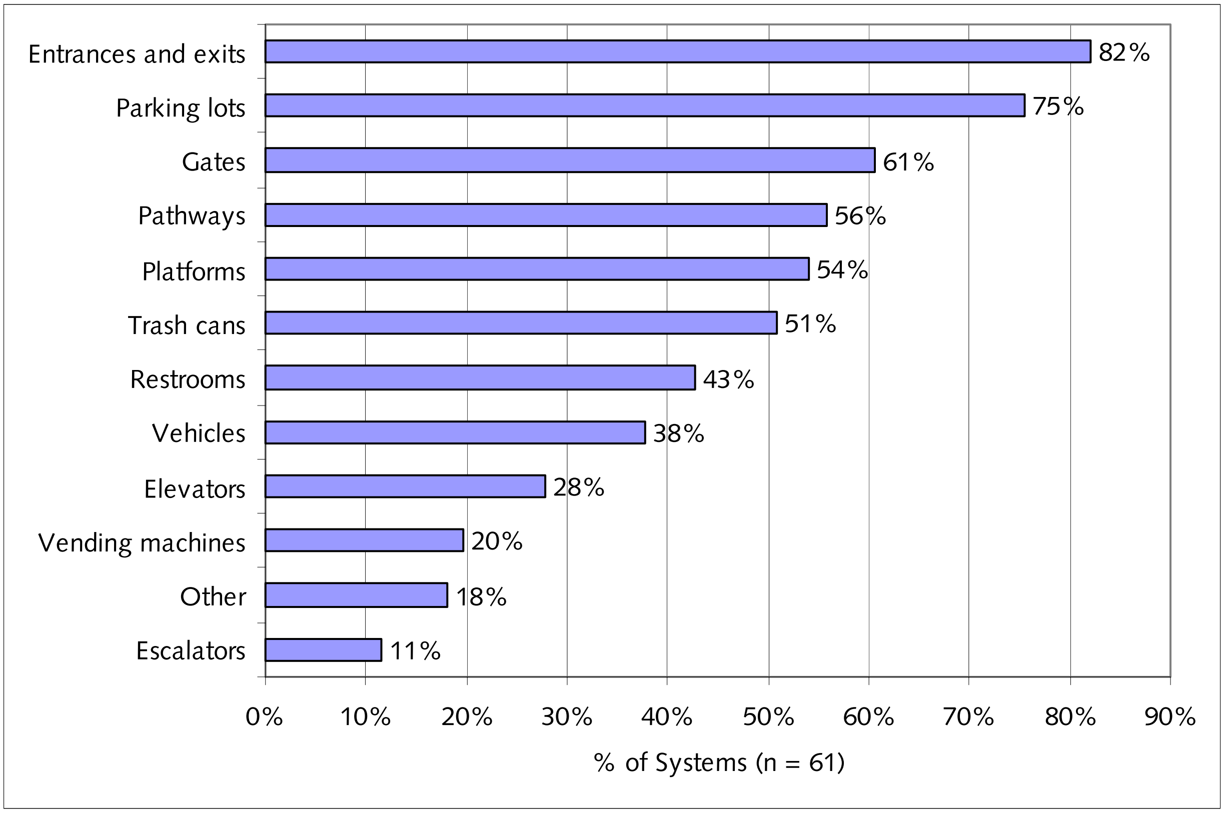

Figure 12 Components with CPTED Strategies

When asked specifically about application of CPTED concepts to rail systems, about half the agencies with rail use CPTED in the design of maintenance facilities and station tunnels (see Figure 13 on page 90). The other components listed—control centers, traction power stations and distribution, and tracks—were mentioned by between 20 percent and 40 percent of rail agency respondents.

Table 18 CPTED Strategies for System Components

TABLE 18: CPTED STRATEGIES FOR SYSTEM COMPONENTS

CPTED Strategy	System Component										
	Platforms	Entrances & Exits	Gates	Elevators	Escalators	Restrooms	Pathways	Parking Lots	Trash Cans	Vending Machines	Vehicles
Lighting	✓	✓	✓	✓	✓	✓	✓	✓			
Visibility (clear lines of sight)	✓	✓		✓	✓	✓	✓	✓			
Use of Glass & Natural Light		✓		✓							
Keep Clear of Obstacles	✓						✓				
No Hidden Corners/Dead Areas	✓	✓									
Limit Access Paths/Points	✓	✓					✓	✓			
Electronic Access Control		✓	✓								
Security Cameras	✓	✓	✓	✓		✓	✓	✓		✓	✓
Emergency Telephones				✓			✓	✓			
Emergency Alarms										✓	✓
Monitoring by Staff/Security			✓		✓	✓		✓			
Curved Entrance Wall without Doors						✓					
Explosive Resistant									✓		
See-through Containers									✓		
Location*			✓						✓	✓	
Minimal/Low Landscaping							✓	✓			
Fencing								✓			
Public Information Signage			✓								✓
Large Windows											✓
Secure Parking											✓
Vandal- and Graffiti-Proof											✓

* Configure location of gates to be able to close off sections of station. Locate vending machines

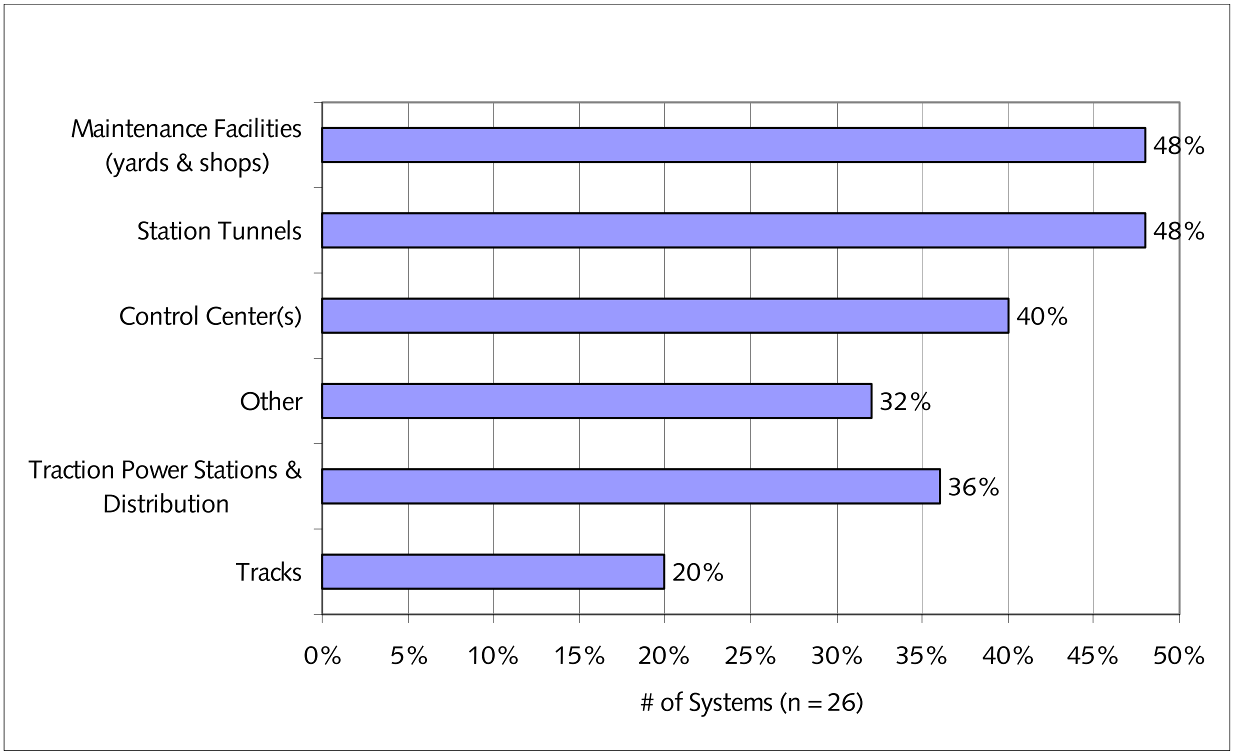

Figure 13 Rail System Components with CPTED Strategies

Respondents from just twenty-three agencies (22 percent) reported having CPTED guidelines in place (ten with rail and thirteen without).[105] Most (61 percent) of these guidelines were developed by an in-house team (fourteen of the twenty-three agencies with guidelines). Five contracted with consultants to prepare their CPTED guidelines, two used the sheriff's or police department, one adopted FTA guidelines, and one developed guidelines through CPTED training at a local technical college. The lead department for developing guidelines was most often associated with safety and security or operations. One respondent specified the district architect and another, capital development.

Conclusion

The findings of this survey in many ways reflect the asymmetry inherent in public transit in the United States. While hundreds of transit systems operate in dozens of cities, most of the stations, vehicles, and passengers are concentrated on a few, very large, high-profile systems—

systems that are the mostly likely targets for terrorist attacks. The ten largest U.S. transit systems (operating in nine metropolitan areas) carried 65 percent of all transit trips reported to the Federal Transit Administration for 2002, while the remaining transit systems carry the remaining 35 percent. Thirty-nine percent of all 2002 transit trips in the United States occurred in one metropolitan area, New York, and 31 percent of all United States transit trips were carried by just one system, the New York MTA.[106]

While significant attacks against U.S. transit systems remain rare, they are likewise asymmetric. Just sixteen of the eighty systems with rail service and/or enclosed bus/ferry terminals queried for this research reported receiving a credible threat (for example, bomb, chemical, biological, fire attacks) in the past year. While fourteen of these sixteen systems had received fewer than five threats, one agency reported receiving twelve credible threats, and another reported receiving thirty-one. These threats and incidents, combined with the tragic events of 9/11 and the recent, deadly transit attacks in London, have pushed security to the forefront of transit policy debates.

This survey of 113 U.S. transit systems finds that attention to transit system security increased significantly after 9/11, and this attention has been translated in the three years since into increased policing, use of security technologies, public information and outreach, and CPTED strategies. In its 2002 survey of U.S. transit systems, the GAO found that just over half (54 percent) of transit systems had conducted security threat assessments. Just two years later, we found in this survey that the proportion of large U.S. transit agencies that had conducted such assessments had increased to 85 percent.

Our survey asked in detail about four types of security strategies—policing, technology, education and outreach, and crime prevention through environmental design (CPTED). We found that attention to all these strategies has increased since 9/11, and over half the respondents now view all four strategies as central or significant parts of security planning efforts. Prior to 9/11, CPTED and, especially, information and outreach, were given much less weight in security planning by the respondents to our survey. Because they manage and operate large numbers of stations and rail rights-of-way, respondents from rail transit systems tended to exhibit higher levels of concern over, and attention to, security issues than did respondents from systems with no rail service.

With respect to system design, over 80 percent of the respondents to this portion of our survey now believe that CPTED is a somewhat or very effective strategy in preventing terrorist attacks (see Table 19). This ranking of effectiveness is similar to policing and security hardware and technology strategies (though we should note that half again as many respondents answered questions about policing and technology as those who answered questions about CPTED strategies). Among the four types of security strategies analyzed here, public education/user outreach strategies were generally viewed as less effective than the other three types of strategies; nonetheless, 58 percent of respondents rated these strategies as somewhat or very effective. In general, systems with rail were more likely to view most strategies as very effective compared to systems without rail.

Table 19 Perceived Effectiveness of Security Planning Strategies

Strategy	Agency Type	Very Effective	Somewhat Effective	Not Effective	Don't Know	*n*
Policing	Rail	40%	53%	7%	0%	27
	No Rail	24%	57%	9%	10%	79
	TOTAL	28%	56%	8%	8%	106
Security hardware/ technology	Rail	27%	62%	4%	7%	26
	No Rail	26%	53%	13%	9%	80
	TOTAL	26%	55%	10%	8%	106
CPTED	Rail	32%	50%	9%	9%	21
	No Rail	19%	62%	11%	8%	37
	TOTAL	24%	58%	10%	9%	58
Public education/user outreach	Rail	22%	49%	18%	11%	27
	No Rail	11%	43%	20%	26%	80
	TOTAL	14%	44%	19%	22%	107

Collectively, the findings of this survey reflect the fundamental dilemmas of transit security planning. Because transit systems are open, dynamic systems that congregate hundreds, and even thousands, of people together in stations and onto vehicles, most transit managers and security officials responding to our survey view transit systems (with the exception of paratransit services) as very vulnerable to terrorist attacks. On the other hand, the time, energy, and resources devoted to transit system security have increased dramatically over the past decade, particularly since 9/11, and a majority of respondents to this survey view four distinct security strategies as either somewhat or very effective in increasing the safety and security of these inherently open and vulnerable systems: policing (84 percent), technology (81 percent), public education (58 percent), and system design (82 percent).

INSTITUTIONAL RESPONSES TO INCREASING TRANSIT SECURITY THREATS: INTERVIEWS WITH KEY U.S. STAKEHOLDERS

Public transportation in the United States is traditionally a local responsibility, although assistance from the national government in the form of funding and technical expertise is a long-established practice. Much of that assistance historically has flowed from the U.S. Department of Transportation (DOT)—at one time from the Urban Mass Transit Administration and more recently from its descendent, the Federal Transit Administration (FTA). With the sudden apparent need for enhanced security of local transit systems, the events of 9/11 created the impetus for a significant reconstitution of national government security responsibilities. At the same time, local transit systems faced the challenges and burdens of enhancing the security of their systems while balancing security mandates and demands with operational and managerial concerns.

This section provides an overview and analysis of the initiatives taken by the various agencies and organizations involved in the transit security in the United States, including federal agencies, a national industry organization, and local operators. It necessarily omits any information about any classified or otherwise sensitive activities in which these agencies and organizations may be engaged. The information presented is based primarily on face-to-face and telephone interviews with representatives from these agencies and the nongovernmental organizations that work with them, along with publicly available documents and agency Websites.

The Role of Federal Agencies and Industry Interest Groups

With the creation of the Department of Homeland Security (DHS) and the concomitant placement of the Transportation Security Administration (TSA) therein, newly formed entities assumed the primary federal responsibility for domestic transportation security, including local rail transit. Other federal agencies play a significant collaborative role in what appears to be an evolving constellation of specific assignments in a rapidly developing component of transportation policy.

- The FTA, more specifically, the Office of Safety and Security (OSS), plays an "oversight role and an asset management role." Other offices within FTA, such as the Office of Research Management, also play significant roles.
- The Federal Railroad Administration (FRA) shares this oversight role with FTA with respect to local commuter rail systems only and also assists with the dissemination of security-related information to such systems.

Additionally, at least two nongovernmental public interest groups are active partners in the ongoing efforts to enhance the security of local transit systems:

- The American Public Transportation Association (APTA) serves as a liaison between federal security agencies and the local transit industry through several committees that focus on transit security issues. APTA interfaces with the various federal agencies listed earlier, as well as the General Accountability Office (GAO), and has helped create safety and security-related standards for the rail-transit industry.
- The Community Transportation Association of America (CTAA) similarly helps federal agencies validate their various policy initiatives, and relays technical assistance on security matters to its local transit agency membership.

In considering the present state of federal government efforts to enhance the security of local transit facility environments, perhaps the most noticeable consideration is their unsettled character. Clearly, the attacks of 9/11, coupled with the more recent spate of terrorist attacks on transit systems around the globe, have necessitated an almost improvisational response among the agencies charged with responsibility in this arena. The more conventional, carefully considered, and incremental approach to policy making has generally been supplanted by more direct responses. Therefore, three themes were particularly recurrent among those interviewed from these agencies: (1) a sense of urgency about the need to effect improvements in transit security from terrorist attacks, (2) the rapidly evolving set of roles and responsibilities of different entities, and (3) the significant amount of uncertainty that is attendant to these efforts. With these factors in mind, the following sections explore the roles and initiatives currently being pursued by the major institutions involved in these efforts.

Department of Homeland Security (DHS)

The Department of Homeland Security has the lead responsibility for federal efforts to maintain and enhance the security of public rail transit systems. More specifically, the

Passenger Safety division of the Transportation Security Administration (TSA) has responsibility for all nonaviation transit modes, including buses, school buses, passenger and commuter rail (including Amtrak), mass transit, and maritime transit. This responsibility overlaps to an extent with modal counterparts in the DOT, although DOT's responsibility is primarily transit safety, in contrast to TSA's charge to maintain security. The result, according to Brian O'Malley, Branch Chief, Mass Transit Infrastructure Security, is that responsibility for transit security-related functions is currently "oddly divided up."

According to Don Thompson, TSA Director of Passenger Safety, TSA's responsibilities are outlined in the Aviation Security Act, which tasks the agency with broad authority to maintain security of both aviation and "all other modes." TSA has used this broad legislative mandate to become active in the security of local rail transit. The extent of TSA's role in transit security has evolved rapidly with the creation of the agency in 2002 to build upon what the FTA, FRA, APTA, and other organizations have been doing from the standpoint of security. In the aftermath of 9/11, a great deal of "good work done in haste" was accomplished by these entities, according to Thompson. Meanwhile, some additional clarification of roles and responsibilities has developed, due in part to legislative mandates that have served to help define expectations for TSA.

The primary means by which TSA acts to enhance the security of local transit systems is to concentrate on the intermodal and interactive aspects of such systems, with the underlying principle being to avoid "hardening" one potential target at the expense of another by diverting potential threats to other target and modes. A key underlying principle in this endeavor is to balance the need for security with the viability of transit systems. The potential fiscal fragility of these systems is acknowledged in TSA's efforts to enhance security, therefore making it unlikely that costly security requirements will be foisted upon local systems absent the funding necessary to implement them. To date, despite its legislative authority to do so, TSA has eschewed the promulgation of transit-security regulations, but some may be forthcoming if it is apparent that the security of local agencies will benefit from them. TSA did recently issue a set of extremely generic regulations regarding local transit security directives. In fact, the FTA has been more active in this realm, as will be discussed below.

Although specific budgetary and manpower allocations were not available for this report, interviews with TSA officials strongly suggest that the vast majority of the agency's current efforts are on airline passenger safety. With respect to public transit, the TSA focus is on operational security initiatives rather than on facility design and environment. The DHS grant program for improving rail and transit security in urban areas has awarded or allocated over $115 million since May 2003, some of which may have been devoted to a transit environment focus. TSA has facilitated an analysis of the threats and vulnerabilities of transit systems, and has provided grant funds for sharing the costs of enhancing local transit security systems; these efforts might be construed as potentially useful in the area of transit design. Thompson suggested that the TSA-hosted "transit security roundtables" conducted at various regional settings across the nation might also provide a contribution.

The gradual historic shift from the old "pillar" style of transit station (for example, the New York subway system) to the more contemporary open style (for example, BART in the San Francisco Bay Area) is clearly superior from a safety standpoint, and perhaps from a security standpoint as well. According to Brian O'Malley, the 2004 Madrid attacks would have been much more deadly had they occurred within the confines of a more closed station. In this respect, the newer light rail transit stops (which tend to be above ground and open) may prove to be safer in the event of such an attack. The issue of design for security is new territory for the TSA and others endeavoring to envision a more secure transit environment.

More generally, TSA is struggling with the "entire panoply" of the terrorist threat to transportation, said O'Malley. Many aspects of transit design that were once taken for granted must now be reconsidered. For example, redundancies in transit systems were traditionally thought by many to be inefficient. Now they are being reconsidered as possibly useful for helping to maintain system operations in the wake of an attack.

Yet answers to the questions posed by the threat of terror attacks on transit systems are not readily quantified. If a system is to be redesigned, or a design improvement to be effected at significant cost, how can the costs and benefits be reconciled against the unknown likelihood and impact of a terror attack? The uncertainty inherent in the problems posed by such threats has forced TSA to take a relatively measured approach to policy making in this area. By contrast, enhancements to the security of transit system operations can be made relatively simply (although not necessarily cheaply).

Perhaps the activity most relevant to enhancement of transit security design is currently underway at TSA's Mass Transit Infrastructure Security office, and entails the study of the possible implementation of countermeasures to terrorist actions. Considerable efforts have been made with respect to planning and studying such measures, which would actually discourage the instigation and/or enhance the mitigation of terror attacks. However, according to O'Malley, sufficient resources have not yet been committed to implementing these measures. Evidently a critical mass of commitment to the idea of countermeasures does not yet exist at the policy making level. So, most of the effort is currently aimed at doing vulnerability assessments with relatively little being done to actively counteract the threats or weaknesses that are identified. More resources, therefore, are needed for mitigation measures to become a reality.

The countermeasures under consideration at TSA include a range of technologies that could mitigate and/or discourage terrorist attacks. According to TSA officials, it may be entirely possible to render bombs and chemical/biological attacks harmless. However, these measures need to be integrated into the design of transit facilities and cannot be readily retrofitted into them. Such measures, however, would likely be more effective in the context of smaller, Madrid-style attacks than massive "doomsday" attacks. At least until recently, according to O'Malley, TSA's efforts have been more focused on the latter.

In sum, although the Madrid attacks appear to have spurred significant response in the local transit realm generally at TSA/DHS, interviews with TSA officials suggest that to date most of that activity has been directed at the security of local rail transit operations and consequently, relatively few concrete results have been achieved in the area of transit system design.

Federal Transit Administration (FTA)

Although it lacks the regulatory authority of the TSA, the FTA's role in transit security—and specifically the safety and security environment of public transit—is in some ways deeper and more direct. Perhaps due to its institutional focus on and experience with transit, the FTA is active in pursuing research into the design of transit facilities, promulgating possible regulations for the design of such facilities, providing local transit agencies with technical assistance, and interacting with TSA and other federal agencies in these efforts.

With respect to research, FTA's Office of Research Management is engaged in a study looking at the design of transit facilities in light of the potential for terrorism. This entails an analysis of the planning and design side of transit to see how different practices, procedures, and features could prevent incidents from occurring. Such efforts may also facilitate emergency responses to incidents as they do occur and facilitate the recovery of systems in the event of a terrorist attack.

Rhonda Crawley, Team Leader for the FTA's Safety and Security Research, said that the agency has partnered with the Washington Metropolitan Area Transit Authority (WMATA) and the Massachusetts Bay Transportation Authority (MBTA) to research a chemical agent detection program in a project titled "PROTECT" that has funded research at Drexel University's transportation center for bio-agent detection and filtration. Additionally, an intrusion detection project was underway at MBTA as of June 2004 to pilot a test system to prevent unauthorized access to bus tunnels. Congress has also earmarked $6.9 million in FTA funds for Florida Atlantic University (and a consortium of Florida universities) to use visual and virtual engineering techniques to test the design of transit facilities with respect to security. Florida transit properties will also participate. These techniques will enable visual simulation of transit facilities before they are built, rebuilt, or retrofitted.

The research being conducted at FTA has several components, including one that deals with transit infrastructure. It also touches on communications systems, including emergency communications systems and access management. FTA is looking at systems integration in terms of networking these things together to complement one another and to provide a higher level of security while at the same time facilitating the operations and efficiency of local transit systems.

FTA's assistance to local transit agencies is aimed at trying to standardize practices and provide support such that the agencies are prepared for a possible attack and can share information with one another, Crawley indicated. The goal is to identify best practices and their dissemination to other agencies in similar circumstances. More generically, FTA conducted threat and vulnerability assessments for the thirty-seven largest transit properties and provided on-site technical assistance to the fifty largest ones. In New York City, the rebuilding of PATH and MTA subway stations damaged or destroyed on 9/11 is being overseen by FTA to include design for security. This consists of hiring consultants who will review the work done by local operators and their contractors in rebuilding the stations.

However, the security needs of local transit agencies vary widely, and each agency needs to look at its circumstance and determine what efforts make the most sense. Some local agencies are undertaking major expansion programs, including building new facilities, new stations, and so on. Those agencies have a different set of opportunities (and challenges) than organizations with large, installed infrastructure that have been operational for decades. Agencies that have been operating for long periods of time on large, extensive networks have a whole different set of constraints and realities than do systems that are expanding anew.

Consequently, each agency has to develop its own security approach, again based on its current state, threats and vulnerabilities, and financial status. FTA recognizes that transit agencies are not equally capable from a financial standpoint, and as agencies develop their strategies, they have to base them around the resources that they have available. Lewis Clopton, Director of Research Management at the FTA Office of Research Management, said that "from a national standpoint the federal government can't define a solution and expect it to be incorporated by everybody. It's not a one-size-fits-all kind of issue…it's a matter of generating alternatives, processes, and approaches that agencies can apply to where they are."

Although TSA/DHS has primary regulatory authority, FTA is developing security-related guidelines for the construction of transit facilities, although these guidelines are not being developed as regulations. Several interviewees stated that the diversity of transit agencies and their milieus makes it impractical and undesirable to promulgate uniform regulations on a national scale. Said Clopton, "One agency may be able to look at hardening facilities; one agency may be able to look at how to locate and how to position things on site; whereas another agency may have to rely more upon softer measures in terms of security enforcement to achieve the same kinds of outcomes." So these guidelines—which were expected to be in draft form in late 2004—simply inform transit operators of design alternatives and allow local agencies to determine which alternatives fit their situation.

Comments from officials at TSA suggest that efforts to enhance security environments may at times conflict with the more traditional goal of crime prevention. Said Clopton, "Although the threat of terrorism is real, if you spend a lot of money and put in place a lot of practices which have no immediate utility, you've got a question of convincing an agency that it's worth doing those sorts of things when they have other more pressing needs up front. If we can show that these things have benefits that go beyond being prepared for what may be a very unfortunate occurrence but is by no means a certainty..." Thus, FTA officials hope to make security suggestions that can leverage at least some benefits relative to safety, improved operational efficiency, and attracting riders as a byproduct.

According to Clopton, the process of attempting to quantify these efforts to both heighten security and achieve efficiencies is highly challenging, given the number of different (and possibly conflicting) objectives:

> You have to look at each issue and the particulars. An emergency situation is not just a terrorist situation. An emergency situation can be a significant accident or

> another kind of emergency occurrence on a vehicle or in a transit system. From the security standpoint, these communication kinds of things do have a broad impact. On the other hand, we don't want to issue requirements for emergency communications that don't complement an agency that's getting ready to go out and acquire a new communications system. If an agency is getting ready to go out and acquire a new communications system, the emergency communication needs to be a driving requirement in the decision as to what to acquire. The same could be said for a number of other areas. In some cases, we're pointing to how to quantify some of these things, but it really depends on the particular situation that you're looking at.

Despite the fact that multiple agencies are working in this area, those interviewed from federal and national organizations were unanimous in their opinion that interagency coordination is occurring smoothly. Some commented that this was in part due to the fact that officials are working together on a personal, frequently face-to-face basis. Clopton cited the example of the effort to create secure credentials for transit workers:

> TSA is clearly going to be in the lead for establishing that requirement [for identity cards]. And the question is essentially going to be what are going to be the particulars of technology and the particulars of background checks and the particulars of application. We're addressing some of the issues relative to the particulars of application in terms of secured spaces versus nonsecured spaces and how that identity card will tie into permitting access to various privileges within the system. So we're addressing the operational side of the card assuming that TSA will eventually issue a requirement for such an instrument to be adopted by all transit agencies.

Similar cooperation has been achieved with the APTA and CTAA, as well as the FRA, according to Clopton:

> We're trying to make sure that anything that we do has a reality check such that the industry finds it useful and the industry finds it to have some utility. And any recommendations that we make we hope have gone through this kind of reality testing with various industry groups as we go ahead. We've also been working to some degree in keeping the FRA advised of the work that we're doing because on the commuter side they become very important there. We're going to be reaching

> out more to the engineering/design community…the people that actually design and plan these systems in the coming year to make sure that those communities review the work that we're doing before we adopt them as official FTA practices and so on… We've got to reach out to a fairly diverse and broad community to discuss these things before we issue any kind of recommendation about how it should be done.

Coordination is also proceeding at the local transit agency level, although funding for such agencies is clearly a hindrance as many recently have been scaling back operations as a result of the recent recession, trying to identify what are their core functions so they can keep those going in a time of fiscal challenge. Additionally, the assumption of vulnerability to a terrorist threat varies by locality. "Different agencies may have different perceptions about how vulnerable they may be," commented Clopton.

In sum, the FTA's effort to enhance the security of local transit environments is a work in progress. Technical assistance is perhaps the most tangible reflection of this effort, although draft guidelines for transit facility designs (at the time of the interviews) were due to appear sometime soon. FTA is attempting to provide helpful advice and guidelines that stand the test of the complicated reality of the diverse local rail transit environment. The FTA has also provided significant support, worked closely with the transit industry, and developed many resources, including funding programs through the National Transit Institute and the Volpe Center.

Federal Railroad Administration (FRA)

The FRA has regulatory authority over freight and commuter ("heavy") railroad systems. Its general safety and security role is to ensure public safety in commuter rail, with security being a significant component of that duty. More specifically, FRA is involved in ensuring transit security in the following ways:

- Fosters emergency planning for security among local rail systems, including a regulatory function over local rail systems—its regional offices conduct audits of local preparedness and security.
- Shares information with local rail systems, including participation in the National-Joint Terrorism Task Force (which also includes representatives from various federal, state, and local law enforcement officials).

- Participates in Surface Transportation Information Sharing and Analysis Center (ST-ISAC), a consortium of agencies that share information about terrorism threats, incidents, and other information.

The primary means by which the FRA acts to enhance the security of local rail systems is information sharing, a role similar to and shared with that of the FTA. This includes some of the activities listed above, as well as offering training in transit security to local transit law enforcement personnel. FRA also assists the FTA in ensuring that federal grants to transit agencies include appropriate provisions for security uses.

Some security policy initiatives originate from within the FRA, particularly those that are linked to some specific threat. The focus of such initiatives is almost exclusively on security operations (in contrast to environmental or system design considerations). According to Bill Fagan with FRA security, this is due to the fact that most facilities are privately owned and most consist of older infrastructure that cannot readily be modified to address emerging security threats. The FRA does offer guidance to the railroads on building design and is considering changing these guidelines to reflect the latest research and information. However, such changes must clear standard regulatory hurdles and are not immediately forthcoming. Rail systems are quite often easily accessible to the general public and the FRA has therefore focused much more on the operations side of security enhancement.

Fagan said that, to date, FRA officials are satisfied that the coordinated efforts of the FRA and other agencies comprise a "synchronized effort between industry, labor, government, and trade associations," resulting in effective information sharing and thereby enhancing the safety of commuter rail transit systems. Yet relatively little concrete progress has been achieved in the area of transit facility design and environments.

American Public Transportation Association (APTA)

APTA is a transit industry organization with a membership of over 1,500 transit agencies and business representatives from across the United States. The organization historically has served as an interface between operators and the federal government; this liaison role is even more significant with the issue of transit security. Greg Hull, APTA's director of operations, safety, and security programs, says that the agency has actively engaged individuals in various federal agencies working on security issues, particularly DHS and TSA, in order to educate them about public transit. According to Hull, APTA has used a *Transit 101* presentation with the message that their organization—not the federal government—has the real expertise in transit. APTA involves the transit industry in all important stages of planning:

> They [the federal government] may have the expertise in terms of security development for certain perspectives, and certainly they have the funds and the legislative mandate. But the bottom line is that if there are any directions or mandates to the transit industry…the only way that those things can be successful is by engaging us at a very early stage so that the industry can have proper buy-in and actually have a hand in the development of any such standards that might come forward.

One of APTA's strongest federal partnerships has been with the FTA, due in part to the funds available through the agency to develop a wide range of programs and support services. Just days after September 11, 2001, APTA sent the FTA a listing of key areas and immediate needs both within operations and capital programs. In the program development that followed, APTA populated working groups formed by the FTA. Hull described the relationship between the FTA and DHS, and in particular TSA, as evolving now that TSA has been given the lead role in addressing security-related issues in transportation modes of all types; the FTA will play more of a support role for TSA as opposed to taking the lead as they had in the past.

APTA also has worked with the FRA on various transit security issues. Hull cited the example of APTA's involvement in the development of standards for commuter rail systems. The organization had not participated in this aspect of transit safety and security management and operations until about six years ago. After a series of incidents in the commuter railroad industry, the FRA sought to develop standards through collaborative discussions. APTA worked with the FRA to establish what are known as "Passenger Rail Equipment Safety Standards," or PRESS Standards. APTA has now created approximately 100 standards for the rail-transit industry and recently became engaged in the development of standards for bus operations as well; last year APTA also became established as a standards development organization, a new role for the organization.

In addition, for the past several years APTA has assisted the Government Accountability Office (GAO) with a series of studies about the government's attention to security issues, particularly transit security. These include reports about the roles and activities of FTA and TSA relative to the needs of the transit industry, with recommendations put forth to provide better guidance to those administrations.

Hull says that there are “tools that enhance security and we certainly see more of the transit agencies moving towards introducing a variety of technologies,” but he emphasizes two particular security strategies: training and emergency preparedness drills. The first includes the formal training of transit staff and also outreach to transit customers—“the whole concept of having a broad network of eyes and ears and voices that will look for and let us know when they see something that just doesn’t seem right.”

In terms of understanding the threat of transit terrorism at the local level, Hull acknowledges that perspectives on the level of risk and threat vary widely. However, he argues, perhaps reflecting the breadth of his organization’s membership, that the threat is pervasive regardless of whether the transit system is located in a large metropolitan area or a small one:

> Some of us might argue that it doesn’t matter where you are. I mean, look at Oklahoma City. This isn’t just Al Qaeda we’re dealing with. There are domestic terrorists, there are people who have political missions, there are people who are wackos, there are people who are copycats, and so it doesn’t matter, from my perspective, it doesn’t matter where you are located, whether in Pocatello, Idaho, or Washington, D.C.…it doesn’t matter what city you live in or what town you live in, there is a need to address these issues.

Hull also argues that agencies need to address requirements in all modes—from subways to buses—and he says that transit terrorism is not confined to the largest population centers. However, he acknowledges that practically and realistically, when making decisions about security using a risk management approach, local agencies carrying the most passengers do pose the greatest vulnerabilities.

Agency coordination and the dissemination of information are also crucial, says Hull. Very few people in the transit industry, even among the police forces, have security clearances. He says that after 9/11, APTA realized that the transit industry and federal transportation agencies needed to access security intelligence information. Transit agencies in major cities usually had good working relationships with the FBI through established joint terrorism task forces. However, this was not the case across the board. The DOT designated APTA a sector coordinator for establishing a Public Transit Information Sharing Analysis Center (ISAC), part of the umbrella Surface Transportation ISAC, and APTA worked on this project through an FTA grant. Hull says that APTA used the grant to contract with a company based in Virginia:

> They have on staff, those people who have backgrounds, past careers with the FBI and Department of Defense. They have top-level security clearances. And they are able to glean through sources of information and package it in a manner that's meaningful to the transit industry. We are now in the process of connecting all transit agencies within this ISAC to be able to access this information.

Hull says the flow of information is from the ISAC out to transit agencies, but there is also a push to have agencies input their own information into the intelligence system:

> If an agency experiences a certain degree of trespassing, they might see that as kids getting into the train yards or something. But maybe it's part of something that's more of a trend in the industry and that becomes good information that needs to be analyzed and disseminated out to the industry.

The direct exchange of information among agencies is also a priority for APTA and something it helps facilitate:

> We get the permission of the transit agencies to share whatever the best practice might be. It might be something like preventive maintenance, it might be a design concept in a facility, it might the way that staff are utilized for safety and security. Our industry has historically and continues to be very supportive of one another. One of the things that has occurred is that, where prior to 9/11 we saw more agencies more willing to share their security plans, now that's a little more closely guarded. They may share those plans with one another, but it would be eye-to-eye and hand-to-hand as opposed to what we may have seen in prior years. But there's a very, very open sharing of information within the system.

Hull acknowledges that transit security is happening in an international context. As such, the organization has formal partnerships with other transit industry groups around the world: the Canadian Urban Transit Association, the International Union of Public Transport (based in Brussels), the Latin American Association of Underground Networks and Subways (ALAMYS), and the Cooperation for the Continuing Development of Urban and Suburban Transportation (CODATU), based in Paris and representing transit systems in developing nations. A couple of years ago, APTA invited these associations and some of their prime agency members to meet with them in Washington. The goal was to share information about program development and relationships with government agencies. Hull says that APTA representatives continue to share information with these other groups, and they invite each other to special conferences and workshops on security.

Transit Operators in the Northeastern United States

The New York metropolitan area is home to, by far, the largest network of public transit systems in the country. New York accounted for 39 percent of all transit trips taken in the entire United States in 2002, and 31 percent of all U.S. transit trips that same year were carried by just one system, the MTA-New York City Transit.[107]

While the venue of the 9/11 attacks was the air transport system, their effect on New York's public transit systems was dramatic and long-lasting and profoundly tested the ability of transit staff to respond to a major crisis. Given New York's dominant role in U.S. public transit and its recent experience with an extraordinary terrorist attack, it is the venue for one of our case studies. Accordingly, this section reports on findings from interviews with several transit security officials at major agencies in the northeastern United States, including the New York Metropolitan Transportation Authority (MTA), the Port Authority Trans-Hudson (PATH), and Amtrak.

Security staff remain extremely concerned about the possibility of transit terrorism on their systems. Chief John O'Connor at Amtrak believes that the threat of terrorism on transit systems is "very real and that it is a question of when rather than if." For O'Connor, 9/11 was a galvanizing force, but it had started to fade somewhat. The events in Madrid in March 2004 brought the issue of transportation security back to the forefront and "now for most transit agencies it's one of their top priorities, if not the top." Officials are concerned about the publicity as a terrorist target that transit is getting after the events of Moscow and Madrid. Attention is now focused on rail and stations such as Penn Station and Grand Central Station—large multimodal facilities and landmarks—that are considered targets of particular concern.

Passenger outreach and awareness is a strategy that many transit operators in the New York City area consider extremely important. At PATH, flyers about security are put out at stations and monitors flash messages that say, "Be Alert." The agency trains all employees and contractors about security awareness and "everyone knows what to look for, and if they do see something, how to respond." William Morange of the MTA believes that rider and employee awareness is the most effective transit security strategy. He notes that the executive director of

MTA had an "If you see something, say something" program in place before 9/11 "where if you see something that's not kosher—the way it should look—report it to the conductors, report it to the motormen… Now calls are going up, but it's worth it for us."

Policing strategies changed in some transit agencies in New York after the events in Madrid. At PATH, police started using patrol tactics that included scrutinizing the areas between parked cars and in station vestibules, as well as looking at unoccupied cars at terminal stations. In addition, the agency started using more undercover police and also began flooding different parts of the system with police at varying times of the day and night. After the Tokyo sarin incident, PATH police organized an elite group, the Emergency Services Unit. Half of this group was trained in chemical incident response at Fort McClellan in Alabama. Martha Gulick of PATH indicated that this was the first civilian or nonarmed forces group to be trained at Fort McClellan. This unit provides rapid response in the event of a Tokyo-type attack on the PATH system, whereas the response time of federal teams is seen by those interviewed as unacceptably long.

Transit operators in the New York metropolitan area are not strangers to environmental design as a security strategy. Security staff at the agencies feel that design elements are extremely important and ideally should be addressed during the actual building of facilities. Said one transit security official, "We've now incorporated security in the designs and boilerplates. Whereas at one time if you were going to construct a station, you would have only had to do safety: fire suppression, fire and life safety, ventilation, lighting, fire alarms. But now there's a security piece that gets incorporated." By including security as an integral part of the design process, agencies can avoid costly and sometimes impossible station retrofits and redesigns. At PATH, environmental design strategies have included, among other things, removing trash cans, locking down the seats in cars (which were not secured prior to 9/11), taking out recessed telephones, eliminating nooks and crannies, and installing access controls on all doors. Gulick notes security by design is an underlying philosophy at the new World Trade Center Terminal, and FTA expects this to be a model for new construction around the country.

Amtrak's O'Connor says that after 9/11, the agency took some steps to put environmental design features into place. At the major stations, barricades and CCTV systems were installed with no major renovations to the stations. In terms of design features for the future, O'Connor suggests that agencies will have to think about creating "secure zones" where people are screened and checked before they enter boarding areas, particularly for intercity trains. However, he acknowledges that this type of system is difficult to implement in the transit environment with people coming and going quickly. He also pointed to the Washington, D.C., Metro system as one of the best in terms of environmental design with its clear sight lines and few nooks and crannies. He adds that it is not extremely well lit, but it is bright enough that people feel comfortable in it.

One transit official points out that security decisions should involve more than just security staff because these procedures affect many facets of the system outside of security itself:

> …As the security people come up with ideas that may not fit, if you have operations people sitting there, that's better. We have to reach some sort of a balance, some sort of a medium. How do we stop trains, how do we do inspections, but weave it into the regular fabric of our operations so our customers hardly notice?

He goes on to describe an example of a situation where security impacts smooth system operations, which then leads to other potential safety and security problems:

> If we have a suspicious package, what is the procedure to deal with it? We try to minimize the delay to the train while still answering the concern... Because when you start delaying trains, you create another safety problem as more trains get backed up. Now you're creating a service disruption. In Penn Station or Grand Central, many of the subway stations where they have such volume, just delaying a train or two, you can lose a station. We end up having to shut down things. And then you get thousands and thousands of people in a panic situation wondering, 'What's going on? Why am I being evacuated?' Once you can't run trains, you can't let people into the station because you have a crush load.

This is a common tension transit security officials face—how to implement security strategies and maintain an effective level of security, while keeping the system running smoothly.

This discussion points to an ongoing issue faced by transit security officials: balancing the security of their systems with other operations and management objectives. Says Gulick, "Inspecting bags is not conducive to operating a rapid transit [system]. Explosive detection technology is out there, but to do it would increase the dwell time, taking the rapid out of transit. That's unacceptable in our business." However, O'Connor at Amtrak does not see security and effective system operations as mutually exclusive goals. Rather, he believes that they are intertwined, with secure environments bolstering ridership: "If people do not feel safe and secure, they won't use the system; they'll avoid it if possible… If you allow the system to fall into disorder and decay, it will definitely affect your ridership." Thus, operators are aware that weighing the costs and benefits of system security overall, as well as of particular measures, is a complex process and includes variables that can be difficult to quantify.

How do transit security officials in the New York area measure the effectiveness of security strategies? How do they decide which strategies to pursue, given the wide range of possible measures? Gulick says that at PATH there is an attempt to quantify reductions in risk and vulnerability as part of the mitigation project. They recently implemented a risk management and vulnerability assessment software package that evaluates terrorist threats for a particular site. It is a Department of Defense program modified for civilian use. Gulick says that as PATH and other Port Authority businesses put different security programs into action, they will be putting that information into this program. The software will actually document and demonstrate the effectiveness of mitigation measures. However, she points out that "from a cost-effectiveness standpoint, you don't necessarily go for the cheapest technology. You want to go for technology that is going to work on your system."

O'Connor says that all security strategies are important, and the distinction is between short-term and longer-term strategies: "On a day-to-day basis, your focus is on operations, police deployment, both prevention and response. Long-term, you need to set goals and design activities to help achieve those goals. You need to plan long term capital improvement that will help you achieve those goals. And you have to constantly—daily, weekly, quarterly, yearly—measure the effectiveness of your strategies and tactics to see if they are in fact achieving those goals."

Transit security officials in New York describe a significant amount of interagency cooperation, not just in the New York area but in the Northeast corridor generally. O'Connor of Amtrak says that his agency deals with the MBTA in Boston, the Connecticut Department of Transportation, the Long Island Railroad, New Jersey Transit, the Southeastern Pennsylvania Transportation Agency (SEPTA), and the Maryland Rail Commuter (MARC). Some of these agencies have their own police departments and others do not; some agencies provide security services for others. In a place such as Penn Station, there is a multijurisdictional structure where the station is owned by Amtrak and Amtrak patrols the majority of the facility. Long Island Railroad leases a portion and the MTA police patrol the lower level. Finally, the street level and subway entrances are policed by the New York Police Department (NYPD).

Gulick says that PATH has very good relationships with municipal fire services, police, and emergency medical service providers. Gulick described a large meeting that included PATH, the New Jersey State Police, New York Police, fire departments, Coast Guard, Office of Emergency Management staff, and chemical response teams "just to discuss the potential threats that were concerns for the last holiday season. It pays dividends because, if they have issues, they are very comfortable picking up the phone and saying, 'Have you considered…?' and vice versa if we need to reach out to them." PATH has also bridged the gap between transit agencies and intelligence agencies. The Port Authority Police sit on the Joint Terrorism Task Forces of both New York and New Jersey. These bodies serve to connect the FBI and local law enforcement so any intelligence from the FBI is accessible to security officials at PATH. In addition to these domestic collaborations, transit security officials mentioned meeting with their international counterparts in Tokyo, London, Moscow, Madrid, and Israel to learn about past incidents and to share best practices information.

Conclusions

This section has provided an overview of the efforts of organizations in the United States—federal agencies, industry organizations, and a sample of key transit operators in metropolitan areas of the northeastern United States—to maintain and enhance the security of local rail transit system design and environments. The bulk of federal efforts currently appear to be focused on the challenges with intelligence, policing, and emergency responses. Officials perceive that security operations produce the quickest and perhaps most noticeable results. As several officials who were interviewed commented, it is extremely difficult to quantify the costs and benefits of the various strategies for enhancing transit security. However, whereas the rush to increase security via policing and surveillance is probably warranted, it is possible that the longer-term potential benefits from changes in the design of local transit facilities may be shortchanged in the process. Additionally, the impact of the recent rash of terrorist attacks on foreign transit systems appears to have caused an increased shift in efforts to secure local transit, but the nature of this shift makes it difficult to forecast the evolving roles of federal agencies in this arena.

Those federal initiatives that are being directed toward the transit system design are either currently under development (such as FTA's guidelines for transit facility design) or in the planning and research stages (such as implementation of potential countermeasures at transit sites). Thus the implications of these efforts for the future design of transit facilities are difficult to predict. However, federal initiatives are being undertaken to address the diverse set of conditions under which local transit agencies operate and are managed.

One of the more positive developments in this regard is the amount of cooperation that appears to be occurring among federal and local agencies. Federal interviewees were unanimous in their view that relatively little in the way of "turf battles" was occurring as agencies juggle their evolving and, in some cases, newly acquired roles and responsibilities, although industry and local agencies' representatives also raised concerns over increasingly underfunded federal mandates. The contributions of nongovernmental industry organizations, particularly APTA, deserve special mention in this regard. APTA has assisted each of the agencies discussed in this section in a variety of ways, including cooperation in the development of the ISAC, which facilitates the sharing of security-related information among transit and government agencies. APTA and transit operators in the United States also appear eager to foster these relationships, both in the domestic and international contexts.

CASE STUDIES OF CONTEMPORARY TERRORIST INCIDENTS

Some of the security measures that we can apply to station design are the result of lessons learned by transit agencies that have experienced terrorist incidents. There have been hundreds of terrorist attacks on rail systems throughout the twentieth century.[108] These have ranged in severity from mere threats causing evacuation and service disruptions to sabotage resulting in property damage to large-scale attacks inflicting injuries and fatalities. A chronology of these incidents can be found in Appendix A. This section consists of case studies of five terrorist or quasiterrorist campaigns that inflicted serious property damage, injuries, or fatalities:

1. The IRA (Irish Republican Army) bombings against the London rail system—early 1970s to mid-1990s, London
2. The Fulton Street Station fire bombing—December 21, 1994, New York City
3. The sarin chemical agent release on the Tokyo subway—March 20, 1995, Tokyo
4. The GIA (Armed Islamic Group) bombings on the Paris rail system—July 1995 through December 1996
5. Al Qaeda's attack on the RENFE (La Red Nacional de los Ferrocarriles Españoles) subway system—March 11, 2004, Madrid

These case studies were chosen because of their severity and high visibility, and because they targeted five major transit systems of the world. Additionally, these incidents span a range of geographic areas, including Europe, North America, and Asia. The IRA attacks were a prolonged campaign that lasted from the early 1970s to the mid-1990s and terrorized British rail passengers. The Fulton Street Station bombing was the second bombing by the perpetrator and had unique characteristics in comparison to the other three case studies, because the bomb was an incendiary device. The sarin chemical agent release was the first time a chemical weapon of mass destruction was utilized by a terrorist group in a major attack. The Paris bombing campaign was similar in nature to the IRA campaign, but much shorter in duration, lasting a couple of years in the mid-1990s. Finally, the Madrid attack was the first time Al Qaeda's new brand of global terrorism hit a major railway system.

This section discusses each of the five case studies, describing the events and identifying the key design elements that had a significant impact on the response, recovery, and mitigation of the effects of the terrorist attack. Primary sources of information for this section were drawn from interviews with transit officials in London, New York, Tokyo, Paris, and Madrid.

Additionally, a full array of secondary sources was utilized that included books, reports, and newspaper articles written about the different incidents. We should note that the literature on each of these attacks is rather scarce when it comes to the role of design in mitigating or aggravating the impact of the terrorist incident. Therefore, much information had to be drawn from sources written for other purposes, such as news articles, medical journals, and historical narratives.

IRA Bombing Campaign: London

(For maps of London's Underground system, please see http://www.tfl.gov.uk/tube/maps.)

Incident Description

The Irish Republican Army conducted a bombing campaign in London and Ireland that lasted over twenty years; the London campaign in particular lasted from the early 1970s to the mid-1990s. Starting in Northern Ireland in 1969, their terrorist campaign moved to London in February 1973 with several coordinated car bombings. According to Coogan (1995) and Taylor (1997), the terrorists hoped to bring the reality of "the troubles" of the north to the British people. IRA members began targeting British rail facilities in September 1973. After that, they bombed or attempted to bomb stations and trains in London no less than twenty-two times. The following is a timeline of the attacks that occurred on London's underground rail network.

Chronology of IRA Bombings on London's Rail Network (Source: Jenkins 1997)

9/8/1973	Bomb explodes at Victoria Station (1 injury, 0 fatalities)
9/8/1973	Bomb explodes at King's Cross and Euston stations (13 injuries, 0 fatalities)
10/9/1975	Bomb explodes at entrance of Green Park Station (20 injuries, 1 fatality)
2/12/1976	Bomb defused at Oxford Circus Station
3/4/1976	Bomb explodes on commuter train minutes after Cannon Street Station stop
3/15/1976	West Ham Station explosion (1 injury, 2 fatalities)
3/18/1976	Wood Green Station bombing (1 injury, 0 fatalities)
2/18/1991	Victoria and Paddington stations bombed (43 injuries, 1 fatality)
8/29/1991	Incendiary devices found under seats of subway train

12/16/1991	Bombing near Clapham Junction Station (0 injuries, 0 fatalities)
12/23/1991	Incendiary devices found hidden on commuter train
1/30/1992	Firebomb found under seat of subway car
2/7/1992	Incendiary device ignited on the subway tracks at Barking (0 injuries, 0 fatalities)

Almost all attacks were preceded by a warning of some kind. The IRA's alleged primary strategy was to cause disruption and damage, not fatalities. Therefore, they claimed that the injuries and fatalities that occurred were the fault of the British Transport Police, who did not heed their warnings and evacuate the system. The relatively small number of injuries and fatalities was not, however, entirely a result of IRA's advanced warning. Many disasters were averted because of increased vigilance and systematic interpretation of bomb threats on the part of the transit police. Most of the time, the warnings were deliberately vague and often resulted in no bomb at all. Of 6,500 bomb threats between 1991 and 1997, fewer than one hundred were considered serious and of those, only forty-one required evacuation.[109]

The incidents that caused the greatest amount of injury were the Victoria Station bombing on February 18, 1991, which injured forty-three and killed one person, and the London Bridge Station bombing on February 28, 1992, which injured twenty-eight. The Victoria Station bombing was preceded by a bomb that exploded at Paddington Station at 4:20 a.m. This bomb exploded early enough that there were no injuries. It is likely that this bomb was some sort of warning for the explosions that followed. At 7:00 a.m., the IRA called and said that in 40 minutes, bombs would explode in all eleven of the mainline British Rail stations, but there was not adequate time for the police to check each of the stations. At 7:45 a.m., a bomb exploded in a metal trash can on the crowded main concourse of Victoria Station, sending shrapnel throughout the platform. The explosive used was one or two pounds of Semtex-H, with a 60-minute timer. The bomb had been hidden in a trash can near an automatic ticket machine close to phone booths, planters, and concession stands. Much of the shrapnel that injured the passengers was metal and glass from the facilities.[110] The survivors of the blast were taken out of the station through the main entrance, which was 150 feet away from the site of the blast.[111]

The London Bridge Station bomb attack was quite similar. At 8:20 a.m., a man called an Irish television station to state that a bomb had been left in a station. Within 10 minutes, the bomb exploded in the London Bridge Station men's restroom. Again, it was probably a two-pound charge of Semtex-H that was set on a timer. The bomb blew shards of metal and glass through the platform. Most of the injuries were a result of the flying debris.[112]

Both attacks demonstrate common tactics and results. They were preceded by a telephone warning indicating that bombs would explode. The time was perhaps sufficient to evacuate the system, but not to find the hidden bombs. Nevertheless, the railway authority did not proceed with evacuation, but took a calculated risk and lost. In fact, British Transport Police officers were searching Victoria Station when the bomb went off. After the Victoria Station bombing, all the stations' trash cans were removed. This forced the terrorists to place their bomb in the bathroom of the London Bridge Station, where it was potentially more visible. Both incidents caused major, albeit temporary, disruption in transit service. The Victoria Station bombing caused British Rail to close all its mainline rail stations in London for the first time in its history. The London Bridge bombing also resulted in a temporary closure of the system. In both cases, service resumed later in the afternoon, but thousands of commuters were stranded for hours during the morning rush hour.

Design and Policy Responses

The vulnerabilities of London's rail network were exploited by the IRA as long as possible. Jenkins argues that "a target was chosen simply because it was vulnerable, and once it was selected, the IRA would continue to attack it for as long as circumstances permitted. London's vulnerable Underground met these criteria."[113] The terrorists targeted the most vulnerable and concealed locations of the stations. In response to the IRA terrorist attacks, British Rail took a series of measures. Just weeks before the Victoria Station bombing, storage lockers were removed from all British Rail stations. In the absence of lockers, the most concealed location for a bombs became trash cans. When these were removed after the Victoria Station bombing, restrooms became the best place to conceal a bomb.[114] The stations were subsequently retrofitted so that there would be less opportunity for hiding bombs.

Most of the serious bomb threats by the IRA were successfully tackled by the police, who found the bombs before they were detonated or evacuated the system before bombs exploded. This is a result of careful planning, station retrofit, and execution of operational strategies to assess risk. Dwyer outlines some of the strategies that the British Transport Police took to effectively eliminate targeting of stations. Primarily, it put into place a comprehensive closed circuit television (CCTV) system that covered all stations. New stations or redesigned stations were developed so that all areas were visible to CCTV cameras. Because bombs were often left in poorly lit parts of the station, lighting improvements were made. Similarly, trash cans, which typically provided hiding places for bombs, were removed from stations. Those trash cans that were left in stations were replaced with blast-resistant cans in well-lit areas, constantly covered by CCTV cameras and located some distance away from secondary fragmentation sources such as windows.[115]

In addition, there were increased patrols of public spaces. To prevent attacks on trains, staff were trained to inspect the seats during cleaning. They fitted tamper-evident seals to the seats after they were checked to prevent someone from hiding something under seats. The new rolling stock was redesigned so that there were fewer places to hide objects.

Some of the strategies utilized by the British authorities in response to railway terrorism were summarized by Whent in 1999. They included (1) removal of trash cans; (2) use of a coordinated and centralized CCTV system; (3) announcements on trains and in stations; (4) the posting of notices such as "Bombs, be Alert"; (5) spatial analysis to identify possible terrorist targets; (6) contingency planning for evacuation and re-entry; (7) regular searching to prevent a bomb attack; and (8) a system to manage luggage left behind.

The large number of bomb threats made by the IRA made it difficult to make informed decisions on whether to evacuate a station or to disregard the threat. British Railway authorities employed roaming bomb response vehicles to quickly respond to bomb threats and determine whether they were serious or a hoax. The British Transport Police utilized a computer algorithm to analyze bomb threats and made judgments as to the credibility of those threats based on previous threats.

In 2002's *Transportation Risk Management: A New Paradigm,* Appleton reports on the risk of evacuating stations due to bomb threats. He demonstrates that the evacuation may at times be more dangerous to the passengers than the possibility of an explosion. There are many hazards associated with rapidly evacuating passengers, and evacuation should only be carried out when there is certainty of a bomb. Some guidelines that he suggests include:

1. Perform on-the-spot threat assessment of suspicious packages by train station personnel. They must make informed decisions and their criteria must be consistent among agencies.
2. Provide bomb detection equipment at high-risk stations: many times, the equipment or personnel take too long to arrive.

3. Provide public information: Rather than encouraging the public to report suspicious luggage, encourage them to be cautious not to leave their luggage behind.

The previously outlined measures and strategies effectively eliminated the targeting of stations in the urban core of London.[116] London's experience with the IRA is unique because it was a long bombing campaign that spanned three decades. It is clear that the IRA chose targets based on their vulnerability. The Underground stations and transit network were initially perfect examples of vulnerable systems. The IRA exploited this vulnerability with two devastating bombings and several other less severe attacks. By implementing several design strategies such as removal and reinforcement of trash cans, improved lighting, increased video surveillance, removal of sources of secondary fragmentation, and redesign of rolling stock, terrorism vulnerabilities were effectively eliminated in the subway network. However, these design strategies are not enough to deter terrorism. They must be coupled with inspection and policing to send the message to terrorists that bombs placed in a station will be found and that the risk associated with carrying out a terrorist attack is too great. The London experience illustrates the benefits of a coordinated response to terrorist threats that discouraged attacks on their system.

Fulton Street Station Firebombing: NYC

(For maps of the New York City (NYC) subway system, please see http://www.mta.nyc.ny.us/nyct/maps/submap.htm.)

The New York City subway system has had relatively less experience with terrorism compared to other railway systems, but it is considered a significant target. In 1916, union members detonated dynamite on a New York train. In 1927, bombs exploded in two subway stations. Another bomb exploded in the Times Square Station on October 30, 1960, injuring thirty-three people. A small bomb exploded on May 31, 1966, in a subway corridor, injuring two passengers. On May 2, 1971, a fire bomb was thrown on a train as it approached a station, injuring three people. On December 21, 1980, pipe bombs exploded in lockers at the Pennsylvania Station causing damage, but no injuries. The transit systems were also affected and partially destroyed by the World Trade Center attacks of 1993 and 2001, but these attacks did not specifically target the transit system. The most significant contemporary attack on the New York City system took place December 21, 1994, at the Fulton Street Station, when Edward Leary detonated two fire bombs that injured fifty-one passengers.

Incident Description

This attack is relatively minor compared to terrorist attacks on other systems and it is also, strictly speaking, not a terrorist attack but a quasiterrorist attack. Little has been written about it, but the details of the attack are best described in newspaper articles.[117] Although the attack is not representative of current terrorist threats, some interesting lessons can be learned. This incident was unique in the fact that the attacker was not a part of a larger group or movement, but was motivated by greed. Edward Leary attempted to extort money from the New York City Transit Authority through a terror campaign that included remote-controlled fire bombs and a rifle attack. Fortunately, he was captured before he could carry out many of his planned attacks.

Leary's strategy was to make fire bombs out of gasoline-filled jars rigged with timers and detonation devices. In order to inflict the maximum possible damage, he would rig those bombs to detonate in the tunnels below the East River. He successfully detonated two bombs on the system, but neither worked as planned. The first bomb was left on a Number 2 Interborough Rapid Transit (IRT) train on December 15, 1994. It was presumably timed to detonate when the train passed through the tunnel, but did not go off until about 30 minutes later. The fire bomb partially detonated at 3:15 p.m. as the train approached the 145th Street Station in Harlem. Two teenagers were severely burned; they were initially considered suspects in the explosion.

On December 21, Leary boarded the southbound Number 4 train of the Lexington Avenue IRT line. He carried a canvas bag with two jars filled with gasoline and an ignition device. As the train pulled into the Fulton Street Station at about 1:30 p.m., Leary reached into the bag and attempted to set the timer. The timer malfunctioned and the bomb exploded under the seat that Leary was sitting on. There were two explosions in rapid succession. The fireball filled the car and flames shot out of the doors as the doors opened and fed air to the flames. Many people were on fire and smoke filled the platform. An off-duty officer who was on the train ran to the token booth and got a fire extinguisher. He quickly put out the flames in the car. Because of the presence of this fire extinguisher and the quick thinking of the officer, the bomb was much less damaging than it could have been.

Emergency Response

In the end, forty-eight people were injured, seventeen were hospitalized with serious burns, and many others were treated for smoke inhalation. The emergency response was "close to miraculous" according to then-Mayor Rudolph Giuliani. Despite the fact that the Fulton Street Station is a very large and cavernous station, rescuers were quickly able to react and treat the wounded.

There was no structural damage to the station due to the explosion, but the operations of the subway were suspended for hours. Fulton Street Station is a major transfer point, so many lines were affected. The transit authority shut down power to some lines for a couple of hours. The charred train was left on the tracks for several hours after the attack. This power shutdown forced at least 100,000 passengers to use other forms of transportation in Manhattan. Fortunately, the bombs did not explode in the tunnels under the East River; otherwise, the impact of the explosion could have been much greater. Service resumed on all lines within three hours of the bombing.

Design and Policy Response

Apparently the Fulton Street Station bombing was considered an isolated incident and did not result in any major design or policy response on the part of the responsible transit authorities. According to an official in a 2004 interview, who wished not to be identified,

> Prior to 9/11, security on the New York subway system was very limited. Mostly the measures we took on security were through police, and were mostly crime-driven. New York had had terrorist attacks such as the first World Trade Center. There was also a threat of an attack on the Long Island Network in 1997. So we were aware of it, but we didn't really have much going on.

There were, however, some limited security drills in certain stations (particularly Penn Station) for emergency preparedness and security. Also, an emergency response committee for Penn Station was formed in 1995, which moved to consolidate three different emergency action plans for the station (by Amtrak, New York City Transit, and New Jersey Transit) into one cohesive document.

Sarin Chemical Agent Attack: Tokyo

(For maps of Tokyo's Metro system, please see http://www.tokyometro.jp/network/pdf/rosen_eng.pdf.)

Incident Description

The leaders of the Aum Shinrikyo cult decided to attack the Tokyo subway system by releasing the sarin agent on three Tokyo Metro subway lines, all converging on Kasumigaseki Station, which served as the Tokyo Metropolitan Police Headquarters. The attack took place on March 20, 1995, around 8:00 a.m., during a heavily congested commute time. The cult's original plan was to release the sarin on six different trains, two trains on each line approaching Kasumigaseki from different directions. The attack was planned with built-in redundancy to enable cult members to arrive from a variety of points in the system (on the Chiyoda, Hibiya, and Marunouchi Lines), lessening the chance of detection and enhancing the likelihood of successful release of at least some of the chemical agent. They were not able to develop enough of the sarin agent for all six trains, so one approach of the Chiyoda Line was eliminated. Figure 14 illustrates the relevant Tokyo Metro subway lines and stations targeted in this attack.

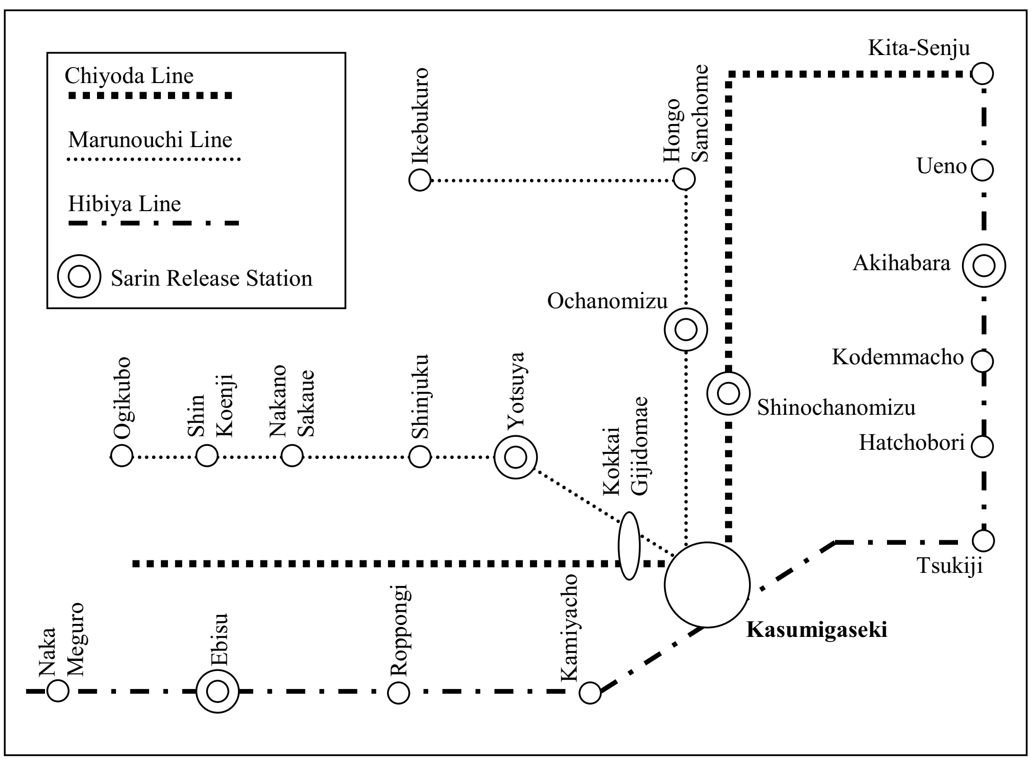

Figure 14 Tokyo Metro Subway Map Showing Sarin Release Sites

The dispersion tools were very crude, but effective. The sarin, in liquid form, was sealed into plastic bags, and terrorists were given two or three bags each. These bags, which contained about 900 milliliters of sarin each, were wrapped in newspaper and placed on the floor of five trains. The bags were punctured by perpetrators with sharpened umbrella tips when the doors opened at the designated station. The perpetrators then quickly exited, before being exposed to sarin. The liquid sarin evaporated quickly and almost instantaneously began attacking the nervous systems of those exposed. The sarin also spread to other stations on the line through the air current generated by the trains. A large number of passengers collapsed, fainted, or convulsed at nineteen stations. In all, twelve people (ten passengers and two Tokyo Metro employees) died and about 5,000 were injured. The two Metro employees had carried the sarin bag that was placed in the Chiyoda Line train car into the station office. The potential for loss of human life was much worse. The sarin used by the cult was only about 30 percent pure. If it had been 70 to 80 percent pure, thousands could have died and it would have taken days to decontaminate the system.

Even after this attack, Aum Shinrikyo members still attempted to exploit the weaknesses of the subway system. On May 5, 1995, and on July 5, 1995, members of the cult left devices used to release cyanide gas into the station in the restrooms of Shinjuku and Kayabacho Stations. These restrooms were chosen because they have ventilation ducts that go onto the platform. These devices, if they had not been found and disarmed, could have potentially caused thousands of deaths.

Emergency Response

After the attack, the entire system was shut down and evacuated. At 10:20 a.m., the National Japanese Self Defense Force and the Tokyo Metropolitan Police Department Laboratory identified the agent as sarin. This information was not shared with the other emergency agencies until 11:00 a.m., and the hospitals were never formally notified that the agent was sarin. Because of communication breakdowns, many of the station attendants thought they were dealing with an isolated incident. Confusion also resulted when the train driver in the Hibiya Line Train reported on his radio that there had been an explosion with white smoke, which led to misinformation and confusion regarding the required response. Cross-agency communication was a major problem in the response to this attack.[118]

The operation of the trains also helped to spread the sarin chemical agent. After the trains were evacuated, the drivers left them parked by the platform with the doors open. This allowed the spread of sarin into the stations. While the trains were traveling, most of the people opened the windows for ventilation and went through the doors between the cars to escape the gas.

This might have provided temporary relief, but it acted to circulate the air and spread the sarin throughout the train.

As much as 10 percent of the injuries were a result of secondary contamination of hospital and emergency personnel and police officers.[119] The emergency services were completely unprepared for such an incident. The first sign that something was wrong was the notification of an explosion at Tsukiji Station. As a result, all ambulances were sent to that station. It took ambulances over an hour-and-a-half to reach some of the other stations. Even when ambulances arrived, there were too many people in need of help. Some victims walked to hospitals; others were taken there by radio-dispatched taxis or by passing motorists.[120] Many victims lay on the ground in the cars or on the platform while they were treated. This made the symptoms worse because the concentrations of sarin were higher on the floor. The most seriously injured passengers were at Kasumigaseki, Tsukiji, Kamiyacho, and Kodemmacho stations. In addition, Kasumigaseki and Kodemmacho stations received little ambulance service.

After the evacuation, Japanese Self Defense Force soldiers in full chemical protection equipment began decontaminating the system, primarily by washing the cars and stations with a bleach and water mixture to neutralize the agent. Limited service was resumed later in the day and full service was resumed the following day. Overall, there was a very fast recovery, considering the magnitude of the attack.

Design and Policy Response

In response to this terrorist incident, the Tokyo Metro has initiated a series of preventive measures according to Makoto Himeda of the Tokyo Metro. In the station environment, these measures include:

- Installation at all stations of security cameras with a recording function, placed at strategic locations throughout the station. The system now has about 2,200 cameras, which were installed after the sarin attack.
- Initiation of new patrols of special security guards trained to watch for suspicious objects and activities. There were no security guards prior to the sarin attack, but employees patrolled the station during their down time. In the post-sarin and post-9/11 era, this type of ad hoc patrolling was considered inadequate, and private security guards were hired to patrol the system.

Measures taken by the Toei subway—Tokyo's other main subway system—initially included the removal of all trash cans from the station circulation areas and concourses.[121] The trash cans were removed after the sarin attack, but were moved back two years later and placed in locations easily surveyed by station masters. Eventually, all the trash cans once removed from the station were placed back in their original locations. However, as recently as February 2004, trash cans were again removed from the stations as a preventive response to the Japanese military involvement in Iraq.

Some design changes also have been introduced on the trains with the installation of windows that can open and close easily. Because of the importance of ventilation in a chemical attack, newly installed windows have wider portions that can open.[122] All train materials are now fireproof, and trains are equipped with emergency phones that enable the station master in the traffic control office to communicate with passengers in the train. Stickers placed on train doors ask passengers to report any suspicious persons or objects to the station staff.

To better increase the readiness and disaster response, the Tokyo Metro has a manual that instructs employees how to respond to disasters and communicate with other agencies. Employees are cautioned to immediately report to police and fire departments any suspicious incidents. According to Makoto Himeda, Tokyo Metro's assistant supervisor, Technology Section, the most important response activity in case of a terrorist event is to evacuate the passengers to a safe place without panicking them. In the case of terrorist events, rules established after the sarin attack require that all eight lines of the system are stopped immediately, even if the incident takes place on a single line.[123] After it is confirmed that all trains are safe, the Metro will resume the operation on each line.

Finally, Tokyo Metro has established a Disaster Prevention District Network, which has divided the system into fifteen districts. Each Metro employee is assigned to the district closest to his or her workplace. If an incident happens at one station, all employees of that district are supposed to report to the station.

The attack on the Tokyo subway system ushered in a new reality for terrorism planning. Since this attack, there has been some research in design, technology, and operational procedures to mitigate the effects of a chemical or biological attack. In "The Use of Technology in Preparing Subway Systems for Chemical/Biological Terrorism," which was read at the 1999 Commuter Rail/Rapid Transit Conference, Policastro and Gordon identify three ways that chemical and biological weapons can be dispersed on a subway system: released in the station; released in the train car; and released in the tunnel (possibly through a ventilation shaft).

As the trains travel through the tunnels, a large amount of air moves with them, being pushed and pulled by the movement of the train. This is known as the piston effect, and it stirs the air and spreads the agent throughout the station and system. The higher the proportion of the tunnel covered by a passing train, the larger the piston effect. Trains can be slowed down to reduce this effect.

A containment strategy to keep the agent from spreading is recommended for biological and chemical attacks. Swansiger's 1998 presentation, "Mitigation of Chemical Attacks in Enclosed Public Transportation Facilities," at the SPIE (International Society of Optical Engineering) Enforcement and Security Technology conference, as well as Policastro and Gordon's presentation, warn against using emergency ventilation that is designed for smoke. Venting the agent above ground could affect much larger numbers of people than those in the station. Additionally, many people can walk faster than the agent can spread, so by turning on ventilation fans, those who would have escaped will instead be affected by the more rapidly spreading agent. The recommended strategies include platform edge doors (Figure 15 and Figure 16) that reduce the piston effect of the trains within the station. Rapid detection through CCTV technology from a remote location with incident detection algorithms is essential to reducing the negative impacts of the attack and isolating the agent and the victims. Chemical detectors are error-prone, but can also be effective tools identifying a chemical attack.

Figure 15 Platform Edge Doors, Hong Kong

Figure 16 Another View of Platform Edge Doors, Hong Kong

Savage's 1996 presentation at the Terrorism in Surface Transportation Symposium, "Lessons Learned by the New York City Transit Authority from Recent Terrorist Attacks," discusses an investigation of the Tokyo case by the New York City Transit Authority. Some of the strategies and lessons learned include the following:

- Provide information and guidance about gas attacks to employees.

- Establish ventilation procedures for subway cars, stations, and facilities.
- Submit new gas attack procedures for coordination of effort between transit and other city agencies.
- Eliminate open and idle space behind token booths and concession stands.
- Remove trash cans in subway stations.

These lessons could have made the effects of the sarin attack less significant. Many of the casualties were subway personnel who did not know how to handle hazardous material. Even though sarin was released on the trains, 43 percent of the injuries occurred on the platforms, 32 percent on the trains, 15 percent in other parts of the station, and 10 percent in other places.[124] This indicates that sarin was effective in leaving the trains and spreading throughout the platforms and the station. Operational procedures and design elements that help contain the sarin and create an air-tight car and tunnel system relatively separate from the platform would have been effective in reducing the effects of the chemical attack. Additionally, procedures for speedy evacuation of the station, such as opening ticket barriers, would have speeded the evacuation.

Algerian Bombing Campaign on Paris' Rail Network

(For maps of the Paris Metro system, please see http://www.ratp.info/informer/anglais/index.php#, or for an interactive map, http://www.ratp.info/cv/cv_en/carteparis.php.)

Incident Description

The Algerians were in conflict with the French during the 1950s and the 1960s, and undertook several terror campaigns during that time. A 1991 civil war erupted in Algeria, raising the threat of continued terrorism in France. From July 1995 through December 1996, the Armed Islamic Group (GIA) conducted a bombing campaign on the Paris subway system in an attempt to reduce France's influence in the Algerian war.[125] The following is a timeline of the GIA bombing campaign on the Paris subway.

Chronology of GIA Bombings on Paris' Rail Network (Source: Jenkins 1997)

7/27/95	Bomb explodes in commuter rail line as it pulls into St. Michel Station (8 fatalities, 80 injuries)
8/18/95	Bomb explodes at Arc de Triomphe near the entrance of the Charles de Gaulle Metro Station (0 fatalities, 17 injuries)
8/26/95	Unexploded bomb found on train
10/9/95	Bomb found and detonated outside of Maison Blanche Station
10/17/95	Bomb explodes on subway line in the tunnel between Musée d'Orsay and St. Michel stations (0 fatalities, 24 injured)
12/4/96	Bomb explodes on train as it pulls into Port Royal Station (2 fatalities, 83 injuries)

This bombing campaign was very focused and severe, with the terrorists taking advantage of the vulnerabilities of the system. The first bombing, at St. Michel Station, had the most casualties, as it resulted in eight deaths and over eighty injuries. The following section draws from news articles and reports on the design issues that influenced this attack specifically and all of the other attacks in general.[126]

Two youths boarded the Réseau Express Régional (RER) train on July 25, 1995, during the evening rush hour. The terrorists left a bag under their seats and exited at Châtalet Station. The train arrived at the next stop, St. Michel Station, at 5:30 p.m., and the bomb detonated as the train doors opened. The bomb was a 28-pound camping canister that was filled with explosive powder, nails, and bolts, and set on a timer. An extremely hot fire started, but quickly went out due to the absence of flammable materials in the train and station. Most of the injuries were caused by the shrapnel from the bomb and flying glass from the train's windows. Several people were also burned by the ensuing fire. The train sustained heavy damage. Its sides bulged out so much that it would not fit through the tunnel. The station experienced minor damage, primarily to its communication cables.

Emergency Response

The response was rapid and efficient. While the police conducted their investigation, a "lifting team" removed the doors and pulled in the sides of the train car. The emergency workers set up first aid posts in the station according to an organized disaster plan. The station is many feet under ground, so many of the injured required immediate treatment and stabilization before being transported to the surface. Within three-and-a-half hours, all of the injured passengers were taken from the station. Within five hours, the communication cables were repaired and the train was removed from the station. During the night, the station was cleaned up and service resumed the next morning. Overall, considering the magnitude of the explosion and the deep underground location of the station, the response was very successful. The medical attention was sufficient and service was quickly restored.

There were some communication problems. For one, radio communication was poor due to the damaged communication cables, and there were difficulties getting information from the platform to the surface. Additionally, the evacuation broadcast was only in French, which undoubtedly confused non-French speaking passengers.[127]

Other Terrorist Attacks

This incident was the beginning of a series of bombings that occurred in underground subway stations of Paris. Three weeks after the bombing at St. Michel Station, another bomb exploded in a trash can outside of the Charles de Gaulle Station near the Arc de Triomphe, resulting in seventeen injuries. Two months later, another bomb exploded under the seat of a train in the tunnel between the St. Michel and Museé d'Orsay stations. This bomb injured twenty-nine passengers. Over a year later, a bomb exploded on the fourth car of a train as it pulled into Port Royal Station. The bomb was the same as all others: a 28-pound nail-packed canister was placed under a seat and detonated by a timer. There was a subsequent fire and a large amount of smoke, which caused many of the injuries. The bomb exploded immediately after the train exited the tunnel. If it had been inside of the tunnel, the damage would have been much worse. This was the last attack on the Paris subway system.

Design and Policy Response

Even before the first bombing incident in Paris, the Régie Autonome des Transports Parisiens (RATP), the rail agency in Paris, began instituting security measures to protect its system. These included the placement of physical barriers to protect vital systems, the installation of intrusion alarms, the development of an integrated CCTV system, and a vehicle and personnel location system. In an attempt to reduce fire hazards, the agency also removed combustible material and sources of toxic fumes from the stations and rolling stock. A smoke evacuation system was introduced to quickly clear smoke and hazardous fumes out of stations.

The bombings resulted in the institution of “Vigipirate,” a policy that mobilized 37,000 police and troops throughout the Paris metropolitan area. High-profile officers carrying automatic weapons started patrolling the subway stations, conducting searches of individuals who appeared to be North African. The policy was accompanied by public awareness campaigns urging vigilance. These policing efforts were, in many cases, extreme and politically unfavorable. The Vigipirate plan, which adds a high number of security agents to the stations, is mobilized during periods of high alert and during special occasions (for example, the D-Day anniversary in France).

After the bomb explosion in a trash can, the subway authority sealed 8,000 trash cans throughout the metropolitan area. They also installed devices to prevent bags being placed under the train seats. According to Patrick Dillenseger, Defense Assistant for RATP, during the Vigipirate periods, trash cans in the French stations are typically replaced by plastic bags. As very high temperatures, fires, and smoke were a part of all of the bombings, RATP redesigned train interiors using fireproof materials. More important, the French have integrated a series of design innovations in some new and state-of-the-art stations, such as Météor, which include more transparent materials in station areas, more natural lighting, and spaces with no curves. All these serve to facilitate surveillance from central command posts. These station design innovations for security will be discussed in a following section.

Some of the design changes that were initiated before and during the attacks had an effect on the mitigation and prevention of terrorist activities. Determined terrorists were successful in several bombings in Paris, but the effects were reduced considerably and the attractiveness of the target was eliminated due to design changes, advanced disaster planning, and policing.

Al Qaeda Attack on RENFE Subway System: Madrid

(For maps of the Madrid Metro, please go to http://www.metromadrid.es/default.asp?id=293.)

Incident Description

On March 11, 2004, Madrid suffered the most lethal terrorist attack by nonstate actors in contemporary Spain and the second deadliest incident in Western Europe. Terrorists detonated ten bombs on four suburban commuter trains of the national rail system, RENFE. Later the

Spanish police discovered and detonated three remaining bombs in the Atocha station, Spain's largest and busiest rail station and transportation hub. Based on the placement and timing of the bombs, we can assume the goal was to decimate the Atocha station, much like the World Trade Center in the September 11, 2001, attacks. The terrorist incident in Madrid resulted in the death of nearly 200 people and injury to another 1,800.

Spain has had a long history of terrorist attacks, but they had been an indigenous brand of terrorism. In the last four decades, the Basque group Euskadi Ta Askatasuna (ETA) had repeatedly detonated explosive devices in a number of public spaces in Spain. As Manuel Rodriguez Simons, Security Director for RENFE, explained:

> Unfortunately, we have a huge terrorist problem in Spain, and we've had it before March 11. ETA in its history has placed around 100 bombs in different places.[128] Normally they call when they place bombs to warn us, but anyway, we already have this experience. So, we've always had to prepare a security device to prevent terrorist attacks for each of our facilities. We had already considered the possibility of a terrorist attack. Well, we never imagined a terrorist attack so much bigger than anything else.

There were a number of things that took the Spanish authorities by surprise, including the scale of the attack. In addition, previous terrorist events by ETA typically targeted smaller areas or specific individuals. They were mostly preceded by telephone calls giving advance warning of the explosion. Finally, the bombs were placed on trains departing stations in working-class neighborhoods carrying mainly working-class commuters and students, and did not fit the profile of the common ETA targets. According to Jose Molina, Director of the Consorcio de Transportes de Madrid, even though RENFE employees were always vigilant about suspicious objects and suspicious people with backpacks, no particular antiterrorist system was in place for the Madrid commuter rail system.

> To have an antiterrorist system is super expensive. And the type of transportation that we provide is mass transportation where you cannot easily implement that kind of control. So, there weren't any antiterrorist methods in place before 3/11. There wasn't an assumption that something so major could occur. Always there was a possibility that somebody crazy could do something like start a fire in a station, but we never thought there was a capacity to do something like this.

Emergency Response

Immediately after the attack, RENFE alerted the emergency services in Madrid, and an emergency response team of police and fire department forces and medical emergency personnel rushed to the rescue of wounded passengers. According to RENFE officials, "everything went as well as it could and it was quite well coordinated." Throughout the day, the team managed to evacuate all the wounded people and send them to hospitals. RENFE also halted service on affected lines; this did not happen for all the Metro. Soon thereafter, police work started to identify the perpetrators and any evidence that would help the police investigation.

The next day, representatives from the police, RENFE, and Madrid Metro held a meeting to discuss security strategies. As described by Javier García Cadiñanos of the Madrid Metro,

> We had a meeting and we said, "What do we do?" Nobody knew; the world had no experts. We had to use common sense and experience. In criminology this is called "the biological maturity." What do we do to confront a situation about which nobody has any idea? The first conclusion we came up with was to have a campaign called "To See and to Be Seen." The elements of security, you have to make very clear to give a sense of security to the riders. As a consequence, we put bright orange vests on all the security agents. They already had it in London, so we used it here. This gave us a very important result because the security agents go through dark areas and with these bright colors, they were very obvious and we wanted people to think there was a lot of vigilance and security guards watching for their security.

Design and Policy Response

The March 11 attack led to the intensification of existing security measures and the adoption of new ones. RENFE intensified and redeployed its police forces and directed them to focus on attending to the needs of the passengers, but also intensifying their vigilance against suspicious persons. At the same time, security forces (the Spanish army) were asked to police the railroads. In Spain, the municipal police have oversight in large cities (such as Madrid), while the civil guard has oversight in the rest of the country (small towns and rural areas). For the first time, the army was asked to give a helping hand in policing railway facilities. RENFE officials describe as good the coordination between the army forces, the municipal police, and the RENFE security forces.

Additionally, RENFE is in the process of contracting security dog services and purchasing X-ray machines, as well as fixed and mobile scanners.[129] Mobile scanners will be installed on small vehicles operating in large and busy stations. Since the attack, the transit operator has expanded the existing CCTV network with the purchase of new cameras. It is also considering the purchase of special containers, "portabombas," in which security staff could put all suspicious objects. According to Metro Madrid and RENFE officials, the difficulty of sealing 150,000 trash cans and the inconvenience to passengers if these were removed prompted them not to take any action.

RENFE was concerned that the adopted measures might raise the already high levels of fear of the Spanish public. For this reason, they decided against posting messages, posters, and signs on trains and station facilities warning people to be vigilant. As explained by Rodriguez Simons,

> We didn't want to create more alarm and we thought that leaving this as it was would be better. There were occasions where people shouldn't have called, but they were calling anyway. Before, the things that were normal in stations, backpacks, mobile phone, things people lost, well in those moments after the attack, if somebody had left a mobile phone in the seat and exited the train in a hurry, this caused alarm even though before it was normal. So, in that moment, we decided not to create more alarm and psychosis and leave this technique for another time in the future. Now, we're rethinking it because the amount of calls has already decreased. If we think it makes sense, we'll implement this.

Today, the system seems to have recovered and to a great extent gained back its ridership. According to RENFE officials, "We have recovered after March 11; practically all the passengers are back, except in the line affected, which now has about two to three percent fewer passengers." Metro Madrid officials attribute people's return to the railways to the fact that the system was hit only once. Javier García Cadiñanos of the Madrid Metro says,

> If there had been an attack following this one, on whatever public transportation in Madrid, in all of Spain, in Paris or wherever, if there would have been another attack on public transportation, there would have been a lot more terror and we would have had a lot more problems. Fortunately this didn't happen, so practically, in 24 hours everything "returned to normal." The only thing that didn't return to normal right away, and took several months, and in cases still exists, is the

conscious fear that people have because about 200 people were killed and it could have happened to them. This is what later we had to combat immediately and to attempt as soon as possible to return a trust to the rider.

Conclusions

The experiences of rail agencies throughout the world can aid railway station designers in developing systems that are more difficult for terrorists to attack and, in the event of an attack, more inclined to rapid and efficient evacuation, emergency response, and recovery. Many of the attacks have common characteristics, resulting from persons who carried small devices onto trains or into stations. Mostly, the perpetrators relied on some sort of delayed effect or timer so that the terrorists could escape. Improved CCTV coverage can be an effective deterrent of transit terrorism when the perpetrator does not desire to be captured. However, it is ineffective in the cases of the recent suicide attacks.

Passenger and staff vigilance inside trains and in the station is an essential aspect of any antiterrorism strategy. Passengers, railway employees, and security personnel need to have clear lines of sight to all parts of the station and trains. Many terrorists utilized seating to hide bombs. Additionally, trash cans have been used as hiding places and should be removed, sealed, or reinforced.

Secondary fragmentation—shrapnel resulting from building materials, such as shattered glass—can became a "fragmentation bomb" and cause injuries and havoc. Facilities should be designed to reduce secondary fragmentation as much as possible. This applies to ground-level glass, vending machines, chairs and railings, and decorations. Facilities should also be fire resistant and not emit toxic fumes if exposed to extreme heat. Rapid extinguishing of the fires in these attacks resulted in limited injuries due to burns and smoke inhalation. Fire extinguishing devices should be readily available in stations and on trains.

In the case of chemical or biological weapons, early detection is essential. Unfortunately, many commercially available chemical detectors are costly and error prone. Incident identification might be best achieved through remote CCTV monitoring. It has been found that utilizing fans designed for smoke might only aggravate the situation and spread the agent faster than it would spread otherwise, but not fast enough to lower it to nonlethal levels. Additionally, there could be more exposure above ground than in the station. Hoods designed for chemical removal and deactivation would be more appropriate, but costly. Platform edge doors separate the airflow in the tunnels from the stations, reducing the piston effect of the trains. These are very expensive, but provide additional benefits besides terrorism mitigation. They provide a physical barrier between the platform and the railway, improving safety and comfort for passengers waiting on the platform. Rapid and informed responses can also greatly reduce damage caused by this type of attack.

Identifying vulnerabilities in rail car and station design and eliminating them can aid in securing transit systems from terrorist activity. Providing rapid response and recovery minimizes the damage. Removing places where bombs can be hidden, improving surveillance and lighting, removing sources of ground-level secondary fragmentation, controlling air currents in cars and stations, and providing on-site emergency response equipment and training are all design strategies that should be considered when encountering a terror threat. Designing stations, rolling stock, and systems that can withstand attacks and quickly recover reduces the attractiveness of targeting transit because the attack does not result in the desired disruption or alarm. Designing for terrorism has, and will, effectively reduce its threat.

TRANSIT SECURITY STRATEGIES OF INTERNATIONAL AGENCIES

How are transportation systems in different cities of the world handling issues of transit security? What are their concerns and challenges? What mix of strategies do they use? Do transit officials around the world perceive terrorism prevention through environmental design as a valid security strategy? What lessons can United States transit systems learn from the experiences of transit systems in other cities?

To respond to these questions, we undertook extensive fieldwork research in four cities—London, Madrid, Paris, and Tokyo—and their railway systems, and also interviewed representatives from the International Union of Public Transport (UITP), which has headquarters in Brussels, Belgium. Our fieldwork consisted of interviews with transit managers and transit officials responsible for the security of the systems, architects and engineers designing systems, and transit industry group officials. We also visited many stations in each system to see some of the design measures identified in the interviews. In some cities, we were shown the control and command centers of the transit systems. We also visited stations that had been recently designed or renovated to comply with state-of-the-art measures of security, such as the Alto del Arenal station on the Madrid Metro's Line 1, the Gare de Lyon Station on Line 14 in Paris, and the recently retrofitted St. Lazare station on the Eole line in the same city.

In Paris, we interviewed officials with the Regie Autonome des Transports Parisiens (RATP), a multimodal transit operator in Paris; with SNCF (French National Railways); and representatives from CERTU in Lyon, a think-tank technical agency of France's Ministry of Transportation. In Tokyo, we interviewed officials responsible for security at Tokyo Metro Co., Ltd., which operates the Tokyo Metro, and the Transportation Bureau of the Tokyo Metropolitan Government, which operates the Toei Subway system, also in Tokyo. In London, we interviewed transit officials from the London Underground, Transport for London, and Network Rail; a security chief with the British Transport Police; and a managing architect with Jefferson Sheard Architects, an architectural firm specializing in the design of transportation infrastructure. In Madrid, we interviewed officials from the Madrid Metro, RENFE, Spain's national train system, and Consorcio Regional de Transportes de Madrid (CRTM). Finally, in Brussels we interviewed officials from the UITP, an international association aimed at promoting public transport in Europe and around the world. This section discusses the major findings of our empirical research in each of the five cities.

Paris

The French perceive Paris as a "potential target for domestic or international terrorism." According to Patrick Dillenseger, Special Assistant for Defense at RATP, the transit infrastructure in Paris is an obvious target for terrorist attacks. In our interview, he admitted, however, that international terrorism may be aimed mostly at countries, like the United States, Great Britain, and Spain, that participated in the war against Iraq. Nevertheless, the French remain extremely vigilant against terrorist threats. According to Dillenseger, the domestic terrorist attacks against the French transit systems (described in the section "Case Studies of Contemporary Terrorist Incidents") have led to considerable reflection about how to better protect transit systems. At the same time, François Blasin of CERTU says the French recognize that "the threat has evolved and morphed from single modest man-made bombs, both limited in scope and capacity to harm, to multiple impact and large-scale paramilitary-style bomb attacks, such as those recently witnessed at the World Trade Center or in Madrid." Therefore, the French clearly recognize that security is today a global issue, says Michel Poulain of SNCF. According to the officials we talked to, "security, without forgetting daily vandalism and also safety, has become a 'hot' goal, regarding the reality of today and the high vulnerability of crowded public transport systems." Therefore, they perceive their primary goal to be to "create an efficient feeling of security rather than reduce the risk to zero, which is practically impossible," according to François Rambaud of CERTU.

The Role of Government and Centralized Planning

Prior to the mid-1990s different security measures were adopted by agencies with little, if any, coordination between them. Patrick Dillenseger of RATP says the terrorist attacks led the French transit agencies to realize that "it was time for a holistic approach to transit security with government support and guidelines and private sector backing." Consistent with the arguments we heard from transit operators in the other international cities of our survey, the French transit authorities also argued that the evaluation of and response to security threats go beyond the prerogatives and responsibilities of operators and transit agencies. The international situation has certain consequences to national security. Transit agencies simply have neither the capacity nor the financial resources to address such a dire threat in a comprehensive way. Therefore, in France, it is the Office of the Prime Minister, assisted by the Ministries of Defense, Interior, and Transport, that draws up comprehensive security plans and guidelines, and conducts and responds to threat assessments.

Regional authorities (generally the prefect or *prefet de zone de defense*) have locally approved general emergency plans for civil security such as *le plan rouge*, which is executed in response to major disasters with many victims, such as record floods or massive forest fires and explosions. These plans are coordinated by the prefect.[130] In each region, local security committees exist that coordinate operators, police, and local representatives of the government. According to Michel Persin of SNCF, the first transit security plan dates back to 1978, but was not adapted to today's threats of global terrorism. The French government did not produce any new security plans until 1990, when the First Gulf War started. Then the global situation, along with increases in public transit crime and incivilities, led the government to initiate global security plans, integrating forces of municipal and transit police and representatives of national governments and regional authorities, as a global answer to the growing insecurity in urban areas, including public transit. These plans are organized and implemented by the Ministry of Interior as well as transit operators. For Paris, in particular, after the attacks of Algerian terrorists against the French railway in 1995, the authorities elaborated the Vigipirate plan, which can mobilize a significant number of police forces during periods of high alert and during special occasions (such as the D-Day anniversary in France).

The early French security plans were simply a series of memos about security. The events of 1995, however, resulted in a push for the integration of the various security components into a comprehensive plan for transit security, which was adopted in 2000. According to Persin:

> ...early on there wasn't a real service in charge of transit security. The [terrorist] events pushed public authorities to move toward institutionalizing security management in public transit through existing measures and directives. This was rather hard as there wasn't a central authority within SNCF dealing with these issues. From four people we had to develop departments where 100 people are working today. And what triggered the new awareness of transit security were terrorist attacks; efforts accelerated after September 11.

CERTU, a technical agency of the French Ministry of Transport for infrastructure, transport, and spatial planning, is in charge of building up and sharing the knowledge available on a broad variety of urban issues. It deals with prioritizing transit safety needs and capitalizing security matters on sensitive sites. Evaluation of the potential danger of each site, based on the degree of hazard they represent to the population, highlights various security responses. These may range from preventing intrusions in sensitive areas to developing a safe zone perimeter around certain facilities or putting train cars under permanent surveillance, and finally even changing the route of cargo transit. SNCF's Persin said,

> The answer in many cases is identical whether it's a terrorist attack or equipment failure; we need to minimize casualties and environmental pollution among many other impacts. It is therefore crucial for us to map these industrial zones and hazard corridors which are not part of our network but whose proximity to the grid or stations could endanger our customers' lives.

An area that the Ministry of Transport and other French governmental agencies have emphasized after 9/11 is the protection of the transit system against a chemical or biological attack, because it was in this area the French felt they had the least experience, says SNCF's Persin. Today, both RATP and SNCF have agents trained by civil defense authorities, as well as firefighters who can respond to biological or chemical threat, in charge of decontamination in the case of attack and who are ready to intervene 24 hours a day, seven days a week in Paris and Ile-de-France. As a way to prepare for and anticipate risks from chemical and biological attacks, the French authorities staged a nerve agent attack simulation in Paris in October 2003. According to Persin, this simulation, which had been in the works for months, was designed to test a plan, "Piratox," put in place last year for dealing with chemical attacks. The agency also has similar plans for dealing with biological and radiological threats.

The Role of Transit Operators

Two major transit operators in Paris are RATP and SNCF. RATP, which is a regional and multimodal public transit operator, operates four mass transit systems or networks: the subway (Paris Metro), the Commuter Express Rail (RER), buses, and trams. In cooperation with SNCF, it also operates the Orly airport driverless rail shuttle, Orlyval. SNCF operates the French railway system. Representatives of these two operators believed that their facilities and systems are the primary targets of any transit attack in France. The budget dedicated to security clearly sets these two agencies apart from other national operators.[131]

Our interviewees from SNCF told us that their office of security (called "defense pole") evaluates risks in their service based on information coming from the French ministries. They also implement the general plans issued by the Ministry of Defense, Ministry of Transport, and Ministry of Interior. Additionally, some of their services respond to situational crime, and they employ about 2,300 officers throughout France. SNCF translates the general policies from the central authorities into concrete measures for each of the twenty-three regions of its jurisdiction. They also conduct research and gather data and statistics with respect to security.

Communication and coordination are essential for SNCF for crisis management and emergency response to attacks. The following excerpt from our interview with Michel Persin shows the extent and importance that the French operators place on coordination and integration of various security measures:

> There is a central center of coordination (dispatching center) which coordinates different regional centers that we could put in service within one hour. Here, in front of our offices, we have the crisis headquarters of national management of SNCF which is responsible for communication and emergency response. Here we answer to general guidelines and we work in cooperation with those in charge of immediate response to any crisis. SNCF has opted for a strong planning of security strategy. The result of these years of planning is that in case of a terrorist attack SNCF is capable of coordination with other actors. The main policy in the case of attack is to create a synergy between actors to maximize our capabilities to face a disaster. SNCF can organize a group of 2,000 to 3,000 people in response to any attack. This obviously is the result of a strong will to put forward the operational segment of railway transit security.
>
> At the same time, we do have an eye on long-term strategies, and how we should organize and build a new secure environment. The difference with Spain is that they had been used to fast response to crisis as the terrorists [ETA] traditionally had called a few minutes before an explosion and authorities need to be fast in their responses. The explosion in Madrid showed that this was clearly not enough. Of course today nothing in France can prevent a terrorist attack 100 percent. We have put in place a wide variety of policies such as detection portals, a canine group with dogs which are trained to detect explosives, as well as mobile de-mining equipments. But with 32,000 kilometers of railways we can obviously not have 100 percent security. As far as to what degree and where we prioritize which segment, it is rather case by case. On the operational side, it is mostly public health authorities who, in coordination with the governor and the government, establish priorities. On the systemic and long-term strategy side, we do work in cooperation with our European colleagues through inter-European programs. Nationally we are putting our efforts in synergy with RATP, firefighters, Municipality of Paris, Electricity of

> France, Aeroports de Paris, and Air France, among many other actors involved. We all have terrorism in mind but the way we perceive and answer to this risk may be different. For this reason we need to coordinate. In one word, our security strategy is rather systemic. We do integrate these segments in evaluating risks, anticipating threats, informing users, and in the case of a disaster, administer assistance and speed up decontamination if necessary.

Indeed, comprehensiveness, coordination, communication, and the adoption of a systemic approach were the keywords used repeatedly by the different French officials we interviewed. They identified as a "systemic approach to security" one that takes into account all the vulnerabilities of the transit system and responds to them in a comprehensive way, and argued that effectiveness cannot be achieved in terms of single actions, but is also about coordination with other agencies and integration of different strategies, without forgetting design matters of infrastructure and rolling stock.

Coordination with Other European Agencies

The importance of coordination with other European agencies and transit operators was also strongly emphasized by Patrick Dillenseger of RATP. According to him, "the future of public transit security (PTS) resides in pan-European cooperation, and the UITP has taken the lead in this respect." Such coordination is absolutely necessary, since many of the European transit operators (for example, Belgium, France, Germany, the Netherlands, and the United Kingdom) have highly integrated grids. Dillenseger pointed out that such cooperation is already underway and is based on sharing experiences, statistics and data, and to a lesser degree, the outcome of various simulations of terrorist attacks.

A European program with the objective to formulate policy recommendations for the future of public transport in Europe was the Voyager program. Voyager is an initiative of the European Union's Directorate General for Transport and Energy, Clean Urban Transport Unit.[132] Originally, the goals of promoting public transit and increasing ridership motivated the Voyager program. Today, the project is split into two phases. The preliminary phase examines state-of-the-art security practices and identifies key barriers and challenges to the implementation of competitive and attractive public transport systems. In its second phase, Voyager considers global trends likely to impact the future of public transport. This is to facilitate the drafting of policy and recommendations for all public transport stakeholders at local, regional, national, and European levels. As will be discussed later, the terrorist attacks in New York and Madrid brought the issue of security to the forefront of Voyager's concerns.

Security Strategies

The integration of different security strategies can be best seen in the design and implementation of a new line. In Paris, Météor (Métro Est-Ouest Rapide) is an excellent example of integrating security elements in the design of the railway network. Météor, which is now Line 14, was designed to ease the rush-hour traffic on the overcrowded east-west link of the Commuter Express Rail (Réseau Express Régional, RER), a long-distance heavy-rail Métro line serving the distant suburbs of Paris. Météor is 8 kilometers in length, and extends from the northwest suburbs, through the high-traffic areas in the center of Paris, down to the southeast suburbs. Its eight stations provide direct connections with eleven existing Paris Métro lines, five RER lines, numerous bus lines, and two railroad stations (Gare St. Lazare and Gare de Lyon).

The line's computerized and automatic trains are under constant surveillance by the command center (PCC) or traffic control center, which both operate the trains and monitor the station attendants. On the platforms, glass doors enable an unobstructed view of the other platform as well as trains which arrive at 1.5- to 2-minute intervals. Locks on train doors and platforms are adjusted and can be manually activated to prevent the escape of criminals. Traffic control oversees all operations including maintenance, technical support, and basic security. Staff and field agents are equipped with two-way radios. If a given situation gets out of hand or becomes life threatening, the matter is handed over to the RATP security control center (PC Securité or "SECURITY"). At PC SEC, uniformed staff, as well as attendants in civilian clothes, are constantly present and in communication with the Regional Transport Police (RTP). In the Metro and RER networks, remote-controlled closed-circuit cameras (CCTV) are linked to line PCCs and activated through intercoms, call buttons, and emergency alarms. These enable SECURITY to communicate to passengers through loudspeakers. Line 14 is equipped with both fixed cameras on the platforms and discreet CCTV located in the trains. Each of these cameras is easily selected for live or remote viewing from traffic control.

The environment and context of the stations of Line 14 is quite different from the rest of the network. Absent are the maze-like access ways and tunnels to the platforms and exit doors as well as the dead angles, which characterize pre-Météor classic design and slow down any intervention of police forces to prevent or respond to a terrorist attack. In place there is a very linear glass-enclosed track, the monotony of which is occasionally broken by soft curves, linking spotless and brightly lit stations sharing a homogeneous design. Spaces are wider, lending better opportunities for remote surveillance. Station materials are mostly transparent, reflective, and resistant to graffiti and vandalism. There is maximum use of direct natural or indirect artificial light. Overall the feeling for the user is that of high security, warmth, and cleanliness, which is quite different from the rest of the network. According to Patrick Dillenseger, the use of these materials and lighting complements and supports the surveillance technology and minimizes opportunities for situational crime and terrorist attacks.

Other environmental design innovations are implemented at the Eole Line, which is a 30-meter underground line connecting the stations of St. Lazare and Gare du Nord in Paris. To minimize the negative consequences of terrorist attacks and bomb explosions, architects used new materials such a shatterproof fiberglass. The construction of wooden access bridges is sufficiently strong to resist the blow impact of an explosion. At Gare du Nord, in case of fire, there is pressure or an air curtain that isolates the sector involved from the rest of the platform. It is hoped that such a feature will help in the case of a chemical attack as well. The station lighting is designed to enhance a feeling of security.

The retrofit of the old St. Lazare station has integrated design features to respond to concerns of crime and terrorism. The station now has limited entrances and exits, which are all well lit. Warm-colored materials, such as green panels above the access bridge and red plexiglass panels above the station platforms, reflect and redirect the light.

Figure 17 Red and Green Lighting at Retrofitted St. Lazare Station, Paris

Figure 18 Transparent Elevator, St. Lazare Station, Paris

Station entrances can be easily closed or blocked by police in the case of an attack, and the old and new parts of the station can be easily separated. The passages connecting the entrances to the platforms as well as the lobby areas are wide, which prevents overcrowding. Straight, wide passageways leave no room for corners, dead spaces, and blind spots, adding to the feeling of security. Arches, overhead passages, and bridges have an open view to the lower levels and give a feeling of spaciousness. Similarly, the platforms are wide and straight and have high arches. They are equipped with CCTV cameras, which can be activated by rapid movement or loud voices. Public telephones, ticket seller booths, and elevators are constructed with transparent and resistant materials. Transparent and reflective materials on the walls and light-colored floors are designed to reflect lighting.

While these examples represent good models of how to implement design strategies for transit security, the French officials do not believe that they can be easily applied to their whole railway network. As Patrick Dillenseger argued:

> While in new construction, we are taking lessons of past terrorist attacks such as at St. Germain and we are integrating design features to minimize risk, it is hard to consider any major changes to the environmental design of old segments of the network. It is indeed very costly to make major physical changes to cavernous and old access areas, platforms, and tunnels. To make these spaces more secure, there is a need to be creative but there is very limited margin for maneuver, as we can not break the old fabric and rebuild all the access areas or platforms. A trend which is increasingly followed by operators and agencies is, as in the case of Lille's metro, to create new structures and command centers dedicated solely to security. It is the case in Paris with the new lines. In the past it was the operator which had to regulate the line to take care of security and inform end-users. The result of that was a single structure which was constantly overloaded with work and had difficulties in prioritizing when there was a security concern coming up. The new trend is structures which are dedicated to security alone and which integrate different levels of security.

During Vigipirate periods, minor design measures were implemented at the stations which could have an impact on security. These included sealing off garbage cans in stations and on platforms, or replacing them with plastic bags, and closing or removing lockers and safe boxes.

In addition to design strategies, the French interviewees also talked about the importance of technology for security, referring to the development of new techniques, currently underway, that would greatly improve video surveillance and object detection by integrating smart programs.[133] They also referred to the importance of information and security awareness campaigns to educate transit riders about the different aspects of threat in public transit. As Francois Rambaud, from the French Ministry of Transport, claimed, “We have to combine and juxtapose environmental design, audio/video surveillance, rescuing, policing, prosecuting, and information campaigns in order to create an effective feeling of security for all passengers.” This is, after all, the major goal of transit authorities and operators.

Tokyo

The sarin attack of 1995 took the Japanese society in general, and the Tokyo transit operators in particular, by surprise. The Japanese were used to a safe society and were quite unprepared for such an incident. Shocked by the attack, Japanese transit operators took measures and initiated a protocol for emergency response (refer to the section “Case Studies of Contemporary Terrorist Incidents”), but they still perceived it as an isolated incident. The event was characterized by Japanese society at the time as an indiscriminate large-scale murder, not a terrorist incident, said an official in the Transportation Bureau of the Tokyo Metropolitan Government. According to another official in the Tokyo Metropolitan Government, it was not until the World Trade Center bombing, when the definition of terrorism started being discussed worldwide, that the Tokyo sarin attack came to be recognized by the Japanese as a terrorist incident.

The Role of Government

Unlike the situation in France, where the national government plays a major role in the issuance and enforcement of security plans, in the prioritization of security needs, and in conducting safety audits of transit facilities, the national government in Japan seems to have a much looser relationship with transit operators. Transit operators may receive, at times, guidance from the national government on security issues, but this comes in the form of suggestions rather than regulations. Ultimately, it falls upon the transit operators to decide what security measures should be employed. According to Yukio Takagaki, Assistant Section Chief in the Safety Section of the Tokyo Metro, transit operators

> ...are contacted in advance by the Ministry of Land, Infrastructure, and Transport and are asked about, for example, whether it is feasible to install English sentences on electronic schedule boards at platforms. When the Ministry sends an official guidance memo, usually, they contact transit operators to ask if their guidance is realistic enough to be implemented; otherwise, they would end up issuing directions that transit operators cannot follow. In this manner, we get to exchange information with the government. In some cases, the police also send their guidance through the Ministry.

Thus, for example, the Ministry of Land, Infrastructure, and Transport sent its most recent guidance to public transportation operators on April 27, 2004. This involved thirty-two sections covering aviation, railways, automobiles, buses, ships, ports, roads, rivers, and construction sites. For each of these categories, there were several suggestions as to what transportation agencies should do to improve security. Examples of such suggestions include the posting of signs in English on trains and platforms and the issuance of announcements from public speakers to passengers to raise their security awareness and cooperation. However, the suggestions issued by the national government typically are not accompanied by financial support for implementation. As one official of the Transportation Bureau exclaimed,

> Basically, the national government wants us to implement their guidance at our own expense. As for the police, they also issued a request to strengthen security in our facility as of June 8, 2004. In this document, they used the expression, "voluntary guarding," which means that they suggest that we should voluntarily intensify the guarding of our facility. As I said, there is neither funding nor regulation attached to those requests. Therefore, there is no enforcement power.

The national government did provide, however, some funding for hiring private security guards to patrol transit facilities.

Today the transit operators of Tokyo's two main subway systems, the Tokyo Metro and the Toei Subway,[134] perceive terrorism as "a very serious threat" to their subway systems, says an official of the Transportation Bureau of the Tokyo Metropolitan Government. In the wake of the attack against Iraq, the national government sent a note to transit operators warning them to be on alert for suspicious persons and objects and asking them to increase surveillance of their system. The number of security guards was increased in some stations, trash cans were removed, and employees in supervising positions were asked to patrol the stations and check the way other employees work in the stations and on trains. For the first time in 2003, drills designed for explosives and sarin were initiated in the Toei Subway.[135]

The Role of Transit Operators

The subway operators in Tokyo pursue some mutual collaboration, coordination, and information exchange regarding security strategies against terrorism with the use of nuclear, biological, and chemical weapons. They also keep in touch with police and fire authorities and are informally exchanging information with other transit companies. This information is particularly relevant for emergency response, rather than preparedness. According to an official in the Subway and Streetcar Service Division of the Transportation Bureau, each of the railway companies has its own traffic control office that is in charge of operations management. But the traffic control office of the Transportation Bureau (which operates the Toei Subway) and that of Tokyo Metro are connected, so that information on unusual incidents on both systems is directly exchanged.

For Tokyo Metro, broad security directives and strategies are decided by the Board of Directors, while smaller issues are discussed and decided upon by the company's Safety Affairs Division. The company is composed of five divisions,[136] and all division chiefs have regular meetings to discuss what security measures to employ in response to the security guidance issued by the Ministry of Land, Infrastructure, and Transport. For the Toei Subway, the four divisions of the Transportation Bureau are responsible for the inception and implementation of security strategies.[137] The Bureau has established a safety committee, which is composed of the Director-General and the director of each division. According to an official of the Subway and Streetcar Service Division of the Transportation Bureau, the committee holds meetings four times a year to discuss security concerns and decide on security strategies and measures.

Security Strategies

The sarin attack of 1995 prompted Japanese transit operators to identify the need for two different categories of antiterrorist measures: measures aimed at restraining terrorist activities and preventing attacks, which include a mixture of surveillance, technology, information, and design strategies; and measures aimed at emergency preparedness and disaster response. The second category of measures initiated a disaster response protocol, which includes the development of instructional manuals with detailed guidance for employees as to how to react and respond in the case of a terrorist incident.[138]

In terms of priorities, Japanese transit operators tend to favor policing and patrolling strategies by private security guards and their staff, and surveillance with the help of security cameras and CCTV technology, says an official from the Subway and Streetcar Service Division of the Transportation Bureau. Following the sarin attack, both the Tokyo Metro and Toei Bureau of Transportation contracted out policing to private security companies. Additional patrols were added to the Toei Subway after the Japanese government announced its intention to send a force to Iraq. In addition to the private guards, municipal police have been on patrol in the most sensitive stations since the railway bombing in Madrid. These include terminal stations, stations that have major civic and government buildings in close proximity, and stations attracting large numbers of passengers. Transit officials reason that "our passengers feel safer seeing our company making efforts for improving transit security. Patrolling has allowed the main office employees to communicate with our customers, such as being asked directions and getting to directly know the customers' opinions on our subway services."

The purpose of these patrols is to warn of suspicious persons and contain criminal acts. At the same time, Japanese transit operators hope that potential terrorists can be dissuaded by the presence of security guards. They argue that the increased level of policing on their transit system has effectively minimized crime, but they are not as certain regarding its effect on terrorist prevention. As an official from the Subway and Streetcar Service Division of the Transportation Bureau stated, "It is really hard to claim that such patrolling efforts have paid off and have prevented terrorism in our system."

Figure 19 Monitoring Notice, Kiyosumi-Shirakawa Station, Tokyo Suburb

Figure 20 Increased Security Notice, Kasumigaseki Station, Downtown Tokyo

Since the sarin attack, 2,200 security cameras have been installed at all stations. They are placed at strategic points covering the different platform areas, ticket gates, and restroom areas. Prior to the sarin attack, there existed only simple surveillance cameras without videotaping functions. Transit authorities believe that such cameras can be very beneficial against criminal acts. Indeed, installing security cameras has become the main crime prevention strategy by the Tokyo Metropolitan Government. They also believe that cameras may have the potential to deter terrorists, since suspicious actions can be observed by the staff in the controls and operation center. The station staff monitors camera images but cannot monitor the screens every second. Other security hardware includes two metal detectors, one in Kasumigaseki Station and the other in Ginza Station.

A third strategy is user outreach. Takagaki reasoned that,

> The railway system is open to the general public. It is impossible to check every person. Therefore, we have to take preventive measures by reaching out to our passengers. We have made posters, placed stickers on train windows, and have public announcements that ask passengers to report suspicious persons and objects to station staff or the police. The warning note in Japanese and English is being run on electronic information boards for train schedules at the platforms. With the passengers' cooperation, we can improve security in our system. Informing

> passengers will facilitate their cooperation when something happens. For example, when we guide passengers to evacuate, informed customers will be more prepared and less likely to be panicked, and they will be more cooperative with the station employees.

Before the recent terrorist attacks in New York and Madrid, design strategies for security were not on the agenda of Tokyo transit operators. According to an official from the Construction and Maintenance Division of the Transportation Bureau, station planning and design in Japan takes into consideration the safety, comfort, and convenience of passengers. However, in the design of existing stations, safety considerations primarily have involved preventing accidents and fires. Because of the low transit crime rates in Japan, operators did not perceive a major need to incorporate CPTED elements in station design. According to officials from the Transportation Bureau,

> If anything, concerns about fires have greatly influenced the station design since it is closed underground space. In general, the subway is not a place with high crime rates in Japan. Drunk passengers and gropers have been our main concerns… It does not mean that crime prevention is not considered at all in station design. It has affected lighting and views in the stations to some degree. But crime prevention was not our top priority in station design.

The recent terrorist events, however, have caused Japanese transit operators to reconsider their attitude towards the role of design. In our interviews, they expressed a concern with dead spaces and lack of visibility at stations. According to Transportation Bureau officials,

> ...there is not much flexibility in underground subway stations, and the available space is highly limited. In the limited space, designers arrange platforms, concourses, and station offices, trying to minimize dead spaces and obstructed views. But some dead spaces cannot be avoided at certain locations. That is a problem to be solved, but we do not create large dead spaces any more.

Similar views were expressed by Yukio Takagaki and Makoto Himeda, from the Tokyo Metro, Safety Section:

> We have made efforts to minimize dead space, especially around the places where employees are stationed. Since subway stations are built underground, the space arrangement is limited. Therefore, some dead spaces are necessarily generated, for

example, when the station has entrances far away from ticket gates. But we place security cameras and monitor those dead spaces.

According to Transportation Bureau officials, crime prevention through environmental design has been increasingly incorporated in station design. For example, the walls of station elevators are now constructed with translucent materials. Because elevators and escalators are often dead spaces and difficult to watch by stationmasters, they are now equipped with surveillance cameras. The newly opened Oedo Line has fewer station employees than other lines, but there are more surveillance cameras monitoring dead spaces, and those images on the cameras are checked in the monitor room.

Sweeping design changes are difficult and costly to implement in existing stations. Therefore, only selected design and security measures are incorporated in the retrofit of existing stations, such as the installation of security cameras and emergency buttons and securing and making inaccessible to the public certain station areas (for example, storage spaces, basements, electrical rooms). Renovation projects also include the construction of restroom areas away from secluded station spaces, with wide, unobstructed entrances intended to be more inviting for passengers.

Figure 21 CCTV Monitor, Kasumigaseki Station, Downtown Tokyo

Figure 22 Emergency Button, Kasumigaseki Station, Downtown Tokyo

Figure 23 Restroom Entrance, Kasumigaseki Station, Downtown Tokyo

Since February 2004 (when the Japanese government announced its intention to send some troops to Iraq), trash cans have been removed from stations and subway trains.[139] Authorities have also removed all cigarette receptacles, since smoking has been prohibited in all stations. According to Takagaki, this antiterrorist measure had a surprising effect. The system now has much less trash, because the Japanese passengers take their trash home with them and do not discard it in the trains and stations.

According to an official in the Rolling Stock and Electricity Division of the Transportation Bureau,

> We have also made train materials fireproof. We have installed a communication system that enables a train crew or a stationmaster in the traffic control office to talk to passengers over emergency phones. But all those things have been done in preparation for accidents, not for terrorism. Maybe the only design change adopted as part of an antiterrorism measure is the stickers put on the train doors that ask passengers to report suspicious persons and objects to the station staff.

According to Makoto Himeda of the Tokyo Metro, the sarin attack prompted a few design changes on train wagons. "Due to the increased use of air-conditioning, many of our train windows used to be designed not to open, but we have installed train windows that can be opened and shut more easily since we learned the importance of ventilation after responding to the sarin attack."

A Disaster Prevention Network has been established, and all the Tokyo Metro lines are now divided into fifteen districts. All Tokyo Metro employees who work outside the train stations, such as rolling stock, railroad, electronic line, and facility maintenance engineers, are assigned to one of the fifteen districts near their workplace. In the case of a disaster at a station in their district, these employees from outside have to come to support the station employees to respond to the incident. The district assignment is designed to facilitate mutual support among the districts. Our interviewees stressed the importance of coordination and information sharing in the case of a terrorist attack, and Takagaki from the Tokyo Metro said:

> We have learned the importance of sharing information. For immediate response to an incident, it is most important that it is reported quickly as to what is happening and where. The stationmaster works as the chief of the Incident Headquarters at the station for response and recovery. The Incident Headquarters and the General Control Office exchange the information. If it is a large accident, the Incident

> Headquarters is established in the General Control Office. The staff in the General Control Office receives the accident information from the station employees and provides response and recovery strategies to them.

The adjustment from the perception of a “safe society” to a “risk society” is slowly but surely taking place in Tokyo, as in other cities. The importance of having a safe and secure transit system was underlined by Yukio Takagaki.

> Of course, it is costly to add security measures. However, we should take some financial burden and invest in maintaining safe transit services for our customers. Once something happens, we can easily lose trust from our customers. No matter how hard we may work to maintain safety, only one accident can ruin trust and lose customers. Thinking this way, we should be willing to invest in security and safety to some degree.

An official from the Subway and Streetcar Service Division of the Transportation Bureau also emphasized the challenges of striking a right balance between security and passenger convenience, expressing the view that “subways should be easily accessible by passengers, as long as they pay the fare. The passengers cannot be security-checked as they are at an airport or seaport. If the same security level at those facilities were introduced into the subway system, it would be just too inconvenient for the passengers. We have to strike a balance between security and convenience.”

Another issue that troubles transit operators is finding the right balance between cost effectiveness and adequate security. As explained by an official from the Subway and Streetcar Service Division of the Transportation Bureau,

> It is unrealistic to say that our security measures are perfect. As transit operators, we have to do as much as we can to guard our system, but we cannot afford an extra budget on security more than what we are implementing right now. We are implementing our security measures to an extent in which the society feels that we are doing as much as one transit operator can do to improve transit security. At the same time, our budget is too limited to spend enormous amounts of money. Our current security level is a product of balancing out those things.

London

Because of the attacks of the Irish Republican Army over the last thirty years, the British have had a long and intense experience dealing with terrorist attacks on their railway system. As a result of this, they have developed a layered system of directives, security standards, and procedures that far exceeds those encountered in the other countries included in this study. For many years prior to 9/11, the British authorities put many strategies into action to prevent terrorist events on what is perceived to be the most vulnerable part of their railway network, the London Underground. The attack against the Tokyo Metro, and subsequently the 9/11 attack and the attacks on the Madrid and Moscow railway systems, made the British realize that they had to deal with a different brand of terrorism than the one they were accustomed to—one that involved coordinated attacks on a much larger scale and on multiple targets, and which was carried out not by opportunist terrorists avoiding capture but by determined individuals, who had meticulously planned their actions and who often did not care about escape options.

First, the sarin attack against the Tokyo subway served as a wake-up call for the British authorities in terms of their system's vulnerability to massive chemical attacks. According to Adrian Dwyer of the British Transport Police,

> Tokyo impacted on the activities of the British Transport Police dramatically. You have a system in Tokyo that is not dissimilar in many respects to the London Underground, although cleaner and arguably more efficient. And it was very clear that they got so many things wrong in their response because they weren't expecting what happened. They didn't stop trains quickly; they didn't stop people moving ahead; they didn't identify what had happened as an attack within the first hour. They didn't know it was a chemical agent called sarin until three hours after the event. So we looked in detail at Tokyo. We had the Japanese railway persons over here talking to us. We sent people out to Japan. A lot of contact was made particularly with our colleagues over in the States looking at their interaction because they're much closer to the Japanese than we are. And I think it's fair to say again that for us there was a more dramatic change in the way we police the railways following Tokyo than there was in the way we police the railways following 9/11.

According to London Underground officials, even though the 9/11 events did not bring about an immediate or dramatic change, they did result in a change in mindset about security among transit operators—the recognition that this is an international threat and there needs to be a reevaluation of security procedures, more training on security awareness and contingency planning, and even a closer collaboration with other countries and coordination and help from the British government.

According to Graham Marshall, the security specialist of Network Rail, the infrastructure manager of the railway responsible for all major stations in London:

> Post-9/11, the thinking has moved more toward a terrorist base that does not follow the norms we knew until then. As we saw in Madrid, there were extensive civilian casualties. If we look at other parts of the world, we have terrorists that are prepared to die. All of that brings a different dimension to it. And although for probably about five years before 9/11, we were talking about and thinking about the issues to deal with chemical, biological, and radiological terrorism, post-9/11 that has taken on a new energy because this weaponry may well be used by this type of terrorists. We never really thought the Irish Republican terrorists were going to get into these weapons. Whereas perhaps the more international type terrorists, the more fundamentalist terrorists will perhaps be able to do so. 9/11 has injected a new sense of urgency. 9/11 was a different scale of things, and subsequent to that there has been more work about what we are calling catastrophic scale terrorism in London and what role the railway industry could play in part of that response.

The Role of Government and Centralized Planning

Transit security in Great Britain includes a web of governmental agencies, which interact with the police and the local transit operators to define the criteria for prevention planning and emergency response. At the national level, the Rail Safety and Standards Board is a nonprofit company responsible for setting safety standards, and the Department for Transport is the agency that oversees the railway industry and mandates its security requirements. The Department has a number of boards and committees. The most important for transit safety and security is Transport Security, shortened to TRANSEC, which regulates airports, seaports, and most recently (after 9/11) the rail transport industry in terms of security. TRANSEC is responsible for a document called the National Railway Security Program (NRSP), which sets out the minimum standards to which rail operators must adhere if they want to run a rail line. Such standards include the layout and design of station facilities, and their equipment such as type and location of lockers, bicycle-securing facilities, "litterbins" (that is, trash cans), and

CCTV technology. TRANSEC also issues guidance to local authorities regarding the street furniture and parking around the station. TRANSEC has regulatory powers and issues recommendations on how security should be enacted. In certain instances, it also issues statutory instructions, which relate to the operation of stations and have the force of law. TRANSEC also has enforcement powers and employs inspectors to ensure that the statutes and standards are being met by the railway companies. "Given the fragmentation of the former National British Railway into a number of private companies, TRANSEC's regulatory action helps to make sure that common security standards are applied across the railway industry," said Adrian Dwyer of the British Transport Police.

In addition to the baseline security mandates, the government informs the transit operators about the threat level, which defines the strategies to be followed. According to Graham Marshall of Network Rail (the infrastructure manager of the railway in charge of the London stations),

> The government security services and TRANSEC give us the threat level and the British Transport Police give us their steer on operational response. And depending on what they tell us, we then determine what we are going to do. The transit operator will reach an agreement with the transport security regulators as to what is realistic according to the threat and risk level. We can vary what we do within reason.

Another important contribution of the central government is in the area of funding. Despite the fact that the railway operators are now private companies, they still receive significant public subsidies for operation and security purposes. While in general railway companies are supposed to cover expenses for security from their income, it is possible to make special cases to the government for special funding to cover emergency services or specific security equipment.

Another governmental body, this at the municipal level, is Transport for London (TfL), which coordinates all the different modes of transportation in the greater London area. According to Barrie Wickens, TfL and the London Resilience Team coordinate and facilitate the efforts of all the disparate transportation agencies in emergency planning and disaster recovery. They interact closely with the British Transport Police (BTP), the police force of the railways in England, Scotland, and Wales. Dwyer says that BTP typically responds to incidents of a security nature, but also gives advice and informational briefings to transit operators about the implications of their security decisions. BTP has developed assessment procedures for unattended items, as well as a threat analysis process, to evaluate whether or not a phone call threat should be taken seriously. According to officials from London Underground,

> ...our relationship with BTP is quite key, and it has probably been the cornerstone of our response to deal with terrorism for the last thirty years. We pay for their services, something in the region of thirty million pounds per year, and for that we get a pretty good service.... The big advantage of having BTP is that they understand the environment and the importance of not interrupting the service unnecessarily, and so they've always got in their mind this balance between what is a real threat and the fact that if we've got trains still in tunnels that creates potentially a bigger risk for us. They work very closely with us if there is an item that is identified as suspicious or they believe that it's one that needs to be taken seriously. BTP liaises closely with other police forces and emergency services. If they get suspicious items they'll make an assessment using X-ray or other equipment. If they deem the item as explosive, they'll call in the bomb squad. If they think there's a real terrorist incident, they will call the antiterrorist branch of the metropolitan police.

The Role of Transit Operators

While the government provides the baseline mandates and security standards, different transportation companies also develop an additional layer of security measures, based on advice they pull in from TRANSEC, TfL, and BTP. While security on trains is the responsibility of transit operators, security on the station is primarily the responsibility of Network Rail, the infrastructure manager, which is responsible for all major railway stations in London. Twenty-six private transit operators of passenger trains and some freight trains pay access fees to use the lines maintained and secured by Network Rail. According to Graham Marshall of Network Rail,

> The transit operators expect Network Rail to deal with the security at the stations and the infrastructure it controls. They are quite happy because they know that we are going to do that. We would of course consult with them if what we would do impacts on their operations. They will deal with the security on their trains and depots if that's appropriate to them.

At the same time transit operators, like London Underground, have their own security division, which provides advice to the management about the security of their system, oversees the implementation of security standards, and at times develops better ways to meet them.

These multiple layers of agencies from the public, private, and nonprofit sectors that legislate, regulate, implement, and police require a very significant level of coordination. This interagency coordination received high marks by everyone interviewed. Graham Marshall of Network Rail said,

> ...coordination is pretty good, actually, because there is usually one person in each of the companies responsible for security and we get to know each other even though it's roughly 30 people… Inevitably, there are some issues and areas where our business needs are slightly different and so one has to deal with that. But actually, it's a fairly cooperative process, with no frictions, and a good working relationship. There are some times where TRANSEC would indicate that they want to introduce some security instructions and the industry and operators will enter into a dialogue about the practicality of that because you know clearly they are coming from a perspective of saying "we really want to introduce these security measures," and we are coming from a perspective of "well how do we do that and run a railway?" But I don't think that is so much of a friction. I think it is a practicality issue, one of pragmatism. And there is an acceptance that terrorism has to be dealt with and threat levels have to be abided by and responded to. So I've found that it's always been a very close working relationship.

However, coordination and partnership require work and time investment. As the officials from London Underground state,

> A couple of things learned are through actual incidents in London, one of which is that terrorism is not an opportunity for point gathering or for making out which agency is the best. We all have to make our contribution. The other thing is that partnership is not easy. You have to invest time, and emergencies are not the time to meet your counterpart in other agencies. So that means you have to do drills and exercises and more drills and more exercises, to not just know that they exist and what the organization is, but to know who our colleagues are and what they look like and coordinate with them and all these sorts of issues that take time and

> resources, but at the end of the day it makes that incident management run so much more effectively and smoother.

Coordination with European Agencies

At the same time that the different British agencies coordinate with one another to tackle issues of transit security, they are also recognizing that the threat is international, and hence the collaboration and coordination should also be at a level that transcends national boundaries. Like the French, who discussed the merits of a pan-European cooperation, the British also stressed the importance of sharing information and knowledge about security with their neighbors on the Continent. According to Graham Marshall,

> There have been some well established links with continental Europe, and there are a number of committees that a few of us go to that are related to railway security across Europe. We share best practices and such on these issues, which is quite effective. Different countries approach security in slightly different ways and the threat to those countries is different. Some of them perceive themselves to be more at risk than others. But there is a good relationship there. We have not had the same collaboration with our American counterparts—not because there has been any problem—it's not just seen to be necessary at the moment to have that relationship with American transport operators.

Security Strategies

The British make a distinction between "counterterrorism" and "resilience" and craft different strategies to address each. They develop counterterrorist measures to try to prevent terrorist acts on their railway systems and resilience measures to respond in an expedient and efficient way if such acts occur. Our interviewees in Great Britain talked about an integration of security strategies that include a mix of security technology, customer outreach, design, and policing measures. As one official of the London Underground put it, "I don't think one of these four strategies sits out on its own. You've got to do each one. And you've got to have an element of each one in terms of being able to combat terrorism or crime in general. One can't work in isolation."

The London Underground vehicles and stations are equipped with an extensive system of over 6,000 CCTV cameras, some of which have been in place for twenty years and are being upgraded or replaced. The British Transport Police advises railway operators in terms of what sort of CCTV to install, where to locate it, where to view the system, how long to hold the tapes, and who has access to them. Cameras in sensitive areas are connected to alarms, which will go off in the case of an intrusion, and the CCTV will automatically switch to the appropriate monitor. There are two distinct CCTV systems in the London railways: a CCTV system that is in place for the safe running of the trains, so that the driver, for example, can see whether the last set of doors are clear of the platform (known as Platform Train Interface—PTI); and a CCTV system that is used to safely manage the station environment, but that also has an additional crime prevention and detection role by using real-time monitoring and recording capabilities. A significant number of these cameras are fed back to a central location that is under both operational and police control.

In the early years, the system was placed as a deterrent to crime, and according to BTP, many prosecutions of criminals have been successful primarily because of the quality of the CCTV evidence that was presented. However, the TfL representative expressed some doubt about the current effectiveness of the system against crime:

> As a generality in the UK, we seem to be great believers in CCTV systems. Personally, I think their value is often overstated, particularly in the media. Criminals have reached a point where they have realized that most CCTV systems are not monitored all the time. They also can disguise themselves. So the probability is that there won't be a rapid enforcement response if an incident happens. I'm not talking about major incidents like bombs, but about basic crimes like shoplifting, assaults, robberies, things like that.

In regards to CCTV's effectiveness against transit terrorism, the British Transport Police stated,

> It's a little more difficult to prove it has deterrent value. But what we can say is that there is good circumstantial evidence that terrorists who do not want to get caught go out of their way not to be seen by CCTV. That either means they do not carry through their terrorist act at CTTV stations or they start doing things like putting up their collars and pulling down baseball caps and actually drawing attention to themselves as people who are trying to avoid CCTV. And that's just as good as actually putting up a flag and saying, "Hey, look at me." You can certainly chart a move away in terms of terrorist attacks from stations with CCTV to stations

> without CCTV. That could be coincidental, although I don't think it is. But there's no way to prove it because the terrorists won't tell us what influenced their decision.

The difficulty of constant monitoring of the TV screens of the system by humans was emphasized as a weakness of CCTV. Nevertheless, Marshall of Network Rail expressed his conviction that surveillance technology will spread to "virtually every facet of [public] life in the UK over the next 10 to 20 years," because this intrusion of privacy for security reasons is generally accepted by the British people.[140]

Other than the CCTV technology, transit operators in Great Britain are trying to keep abreast with emerging new technologies that could help them identify the spread of chemical, biological, nuclear, or radiological agent (CBNR) attacks on their system. Whereas bomb explosions typically cover a relatively small geographic area, CBNR agents can spread quickly through the tunnels of a railway system. Indeed, as in the other cities of our case studies, transit operators seemed to be particularly concerned with CBNR attacks because of the difficulty of detecting and responding to them in the railway network, and the agencies' relative lack of experience in dealing with such attacks.

Policing by the trained officers of the BTP is considered absolutely essential for the safe and secure operation of the railways in Great Britain, and for this reason the number of officers has steadily increased in the last years. Currently, the London Underground commissions 530 dedicated officers, and this number will likely increase to 630 by the end of 2004. This is from a total, nationwide force numbering some 3,000 officers. Interestingly, BTP is not an armed police force. Dwyer said the British believe that having a force dedicated completely to transit security is advantageous as it provides consistency across the system and familiarity on the part of the officers with issues and concerns that may be unique to transit systems.

While the presence of dedicated police officers helps give transit passengers a perception of protection, transit operators argue that they also rely on vigilance by their staff and customers. Dressed in very visible blue uniforms, the staff often conducts station patrols and checks station entrances. They are trained on how to deal with unattended bags and how to recognize potential chemical and biological agents. Nevertheless, they are always instructed to call the BTP for any incident that may require immediate response.

The transit operators value customer feedback and have launched information and outreach campaigns to raise the vigilance of the public. Posters at the stations and stickers on train windows remind passengers to report any suspicious activity or unattended bag. Officials from the London Underground described the importance of public participation:

> We've got over three million customers who use our system every day and they are very good at reporting things that are unusual and bringing them to our attention. The community must help police itself; the police can't do it all by themselves. There are just not enough of them. We've been really careful about raising awareness without raising fear, which is a thin line… In that sense, the public here are well educated especially where you've got regular commuters. They understand after all those years of IRA terrorism that they've got to be careful and alert and raise the alarm. One of the difficulties from our part is not to keep on raising public awareness too often or unduly because people will switch off. We haven't reached that point, fortunately.

Indeed, people are so vigilant and "raise the alarm" so frequently that the London Underground has to deal with reports of about 10,000 unattended items every month.

In Great Britain, the strategy of using environmental design to design out crime and terrorism in transit facilities emerged gradually in the last decade. According to Thom Rhys Jones, Managing Director of Jefferson Sheard Architects, a London-based architectural firm that specializes in public transportation facilities, security is one of the major factors considered in the design of a railway station. As he argued, "the consequences of not designing for security are overwhelmingly more dire than the consequences of maybe not achieving some of the other factors such as good image or accessibility." He distinguished between passive means of security (for example, good sightlines, lighting, elimination of dead spaces) and active security means, such as CCTV systems built into the design. Today, Barrie Wickens of TfL characterizes design as the key criterion, explaining that:

> ...it's much easier, quicker, and certainly cost effective to have a trained security professional sit down with an architect or an engineer with the plans of whatever type of structure it is and for that security specialist to say well "Why is that door there?" "Does it have to be that way?" "What sort of glazing have you got there?" "Don't you think that would be better if it was laminated with bullet-resistance glazing?" "Why do you have to have a glass roof?" If a bomb went off below that, we know that fragmentation is the biggest killer, not necessarily the blast. There is so much risk potential that you can design out.

Some of the design measures that transit operators in Great Britain are focusing on include the elimination of places where people can conceal explosives without being noticed. Vending machines and telephone booths are built with sloping tops, so that nothing can be hidden on top of them. Hiding places have been eliminated from the rolling stock. Trash cans have been completely banned from the stations that TRANSEC perceives as the most vulnerable; at the remaining stations, they have been replaced with receptacles that have a plastic ring holding a bin of see-through plastic.

London Underground also tries to secure the in-between spaces—the walkways, the escalators, the storage rooms, the power supply rooms—which often receive less attention from a planning and design perspective than the platforms and entrances. Rooms with no public access remain locked. For some public restrooms, the station management has just instituted mechanically operated latches so that the staff know when someone wants to use them and who is going in. Finally, the system does not have one centralized control room, but many scattered in different places. According to London Underground officials, this is a security measure, as terrorists cannot knock out with one blow all of London's transport because it is not all in one place.

The cost of retrofitting the subway stations of the London Underground was mentioned as a major hurdle in the effort to design out terrorism. According to the London Underground officials,

> If you can make those design changes before the bricks and mortar, it saves a fortune in monetary terms… The problem for us is that we have a system that's 140 years old and of course it's not just cut and cover like you have in places like New York and Washington. But you've got deep-level tube, and the very nature of the original design will give you places to conceal things. Working them out of the system is always very difficult.

Additionally, many stations are built under historic buildings (or "listed" buildings as called by the British), which makes a deep retrofit impossible.

In discussing the mix of security strategies that make up their arsenal against terrorists, our interviewees in London did not fail to mention the many hurdles and challenges they have to encounter. These include: the inherent vulnerability of a railway system, the balance between security measures and passenger convenience, and the high costs of safety.

The BTP were the first to stress the challenges of securing an open mass transit system:

> There is an inherent vulnerability and if you want to run an open mass transit system you live with the vulnerabilities and you probably tackle them through intelligence. You have to take them out before they pose a threat. Once they are in it, it's probably going to be quite difficult to do anything about it. When I was in Moscow back in March, and there you have a system where the Moscow metro has loads of police, it has loads of armed militia, it has loads of dedicated security guards guarding individual cross passages on the system, and yet they get suicide bombers on the trains. Now if they can't stop it, it seems unlikely that anyone else is going to, to be honest. So if we're looking at advances, I think probably what we're looking at are more strategic advances in terms of better intelligence and stopping these people before they actually get in. The flip side of that of course is that if they do get in and something happens, you should deal with it much more effectively. One of our main concerns is that we don't want to end up doing the terrorists' job for them by shutting the system unless you absolutely have to, or maximizing the disruption over a larger area than is necessary. Therefore having a system that rapidly proves it is all right again is actually as important as establishing what has gone wrong.

The issue of striking the right kind of balance between adequate levels of security and operational efficiency was emphasized by the officials of London Underground:

> It's very difficult to apply aviation-type controls to a rapid transit system. We've got 250 access points just by stations alone. Let alone all the interchanges, that probably brings us up to 1,000 or more. You can't put those sorts of controls into place in a railway system. It's just not practical. So we have got measures in place that are appropriate for the environment and for the type of system that we run, but some of the things you can't do. You don't want people to have to wait too long in the course of their travel.

For this reason transit operators reject at this time the idea of mass screening of passengers, unless new sensing and radar technologies are developed.

Finally, there is the tension between what Graham Marshall of Network Rail called "the twin demands of security and operating a railway." Funding the security improvements is always an issue for transit operators trying to run a profitable business. Striking the right balance between what will make their customers feel protected and what they can afford paying for is a challenge. As one operator admitted, “As a security specialist, I could do a lot more but I’d probably ruin the business.” As Marshall so poignantly stated,

> You always have to find the right balance, and this balance probably is more than the balance of money, the availability of funds to do these [security improvements]. It is about allowing people to go about their normal daily business using the railway as part of that daily business. But in a way that brings the maximum security. And that’s always a balance.

Madrid

Similar to the British, the Spaniards also have long experience with terrorism because of the activities of the Basque autonomist organization ETA over the last four decades. Nevertheless, as described in the previous section, Al Qaeda’s attack on the national commuter rail system RENFE Cercanias in Madrid on March 11, 2004, took them by surprise. As a result of this attack, the Spaniards now understand that the terrorist threat can be “general” and “international” and can hit any train system in any country. Taking action to diffuse such a threat and make passengers feel safe again has been the overriding consideration of the transit operators in Madrid since the attack of 3/11. According to Manuel Rodriguez Simons, Director of the Security and Civil Protection of RENFE, the largest railway company of Spain,

> We know that the security is a parameter without which nothing can work. You can have the cleanest trains in the world, you can have the most luminous stations in the world, and you can have the most comfortable trains in the world, and you can have the most punctual trains in the world. But when you go in a train and you do not feel safe because there are people that produce insecurity, you’re not going to use the train. So, we, not as department, but as the entire company, have a philosophy. Security is a very important factor and it is necessary to take care of it. You go to other cities that after certain hours, people do not use public transport because they are afraid of what can happen. We do not want anyone to stop using our trains because of their fear.

Similar views were expressed by Javier García Cadiñanos, Director of Security of Madrid’s metro system.

> When riders demand security, we need to give them security. Today, the first demand of the citizen is security. You have to consider that there is a condition that

> must always be considered. There is a premise that is strictly fulfilled in all public transportation—that security does not make public transportation work well. But if the security does not work well, public transportation does not work well.

While Spanish transit operators perceive security as the overriding factor for the successful operation of their system, they also believe that first and foremost it is the national government that should have the onus of identifying and tackling security threats.

The Role of Governmental Agencies

The role of the government is to provide information to transit operators about security threats as well as instigate regulations pertaining to security standards. According to RENFE officials, the strategy of the rail companies is to follow the instructions given by the Ministry of Defense, Ministry of Interior, and the police, and follow the preventative measures as part of a national strategy and plan. Manuel L. Rodríguez Simons, Director of Security and Civil Protection at RENFE says planning for stations and trains is, therefore, not completely in the hands of transit operators, but RENFE and Metro Madrid can "count on the Security Forces because they are really those who have the vision most adjusted to reality because they are living this day to day and have the pertinent information."

Another important actor in the security of the railway systems is the police force. RENFE has its own force and receives assistance from Spain's Civil Guard and National Police, while Metro Madrid is protected by the municipal police. The police give the transit operators "the most pertinent points and suspicions." Transit operators immediately report to the police any suspicious item or activity observed in their premises. Coordination between the governmental, municipal, and transit agencies is very important; therefore, representatives from each agency meet regularly to discuss security threats, measures, and strategies. According to Rodríguez Simons, this close coordination was crucial in preventing another fatal blow to RENFE, on April 1, 2004. On that date, a RENFE operator detected a suspicious cable on a high velocity (AVE) train from Madrid to Seville. RENFE immediately notified the Civil Guard, who discovered 12 kilograms of explosives and were able to deactivate the bomb.

Coordination of Transit Operators

The two major rail operators in Madrid are Metro Madrid and RENFE. At the moment, transit operators in Spain are public sector companies.[141] Each company has its security department, which is responsible for the prevention of and response to criminal acts and accidents. Transit operators are coordinated by the CRTM, a public sector agency that coordinates services, networks, and fares so as to offer consumers a consistent and high-quality service.

Representatives of CRTM, RENFE, and Metro Madrid meet consistently to discuss common security strategies. According to Rodríguez Simons of RENFE and García Cadiñanos of Metro Madrid,

> There is a great relationship between CRTM, RENFE, and Metro Madrid. We have activities together and always join in the same strategies. We habitually act together on requests to the administration. We not only have good relations with departments of security similar to ours, but we have relations with other systems of security—with other train and metro systems, other organizations; even if they're not train systems, they have common problems. For example, big commercial centers, the highway transport system security, the telephone company. That is, we have relations with the biggest users of security in the country. We have an association in which we're all members. We meet two times a month and we discuss all the problems that we have and we look at all the solutions that each agency has taken in security matters.

Security Strategies

The 3/11 terrorist attack on RENFE has resulted in increased security measures. Officials claim that this is primarily a response to citizen demand, as surveys have shown them that riders want more security on their system. At the same time, they emphasize that despite their desire to be responsive to passenger requests, they want to also achieve the appropriate level of security so that their systems do not turn into "armored bunkers." Similar to other transit operators in other countries, RENFE and Metro Madrid believe that the primary responsibility of security lies with the government. As stated by Garcia Cadiñanos,

> We in the Metro are going to continue increasing the security for attacks of all types—from common delinquency to terrorism—with the measures that we can, but we know that the way to fight terrorism is not through the metro security service. It is through the security services of the state. It is the police with information services that must prevent terrorist attacks. And we collaborate with them, but we, for example, are not going to put explosive detectors in all the entrances of the metro because it is impossible. We have thousands of people who

> enter the network, it would produce chaos in the city, and we cannot do this. No metro in the world does this. Not even in a country that actually had more terrorist attacks in their network, such as Moscow.

RENFE and Metro Madrid have retrofitted their stations with anti-intrusion and detection systems and have added many more video and security cameras. Passengers embarking on the high-speed (AVE) trains of RENFE have to enter a pre-embarking area with scanners, where only passengers can pass. According to RENFE officials, "This is a great method from the security point of view. And contrary to what we thought when we implemented this, passengers appreciate it and understand it like another attribute—something good that makes them feel more calm. It also seems that passengers consider this space as a luxury—nobody can bother them, they have free air, etc." This measure, which started in 1992, applies to the line connecting Seville to Madrid, and Madrid to Leida, but it is in the plans to provide such pre-embarking spaces for many more lines.

Figure 24 Security Scanner, Atocha Station, Madrid

Public outreach focuses on the training of employees so that they know how to respond in cases of emergency and how to protect the system more effectively. Unlike transit operators in Great Britain who give a big emphasis on outreach campaigns with warning posters and advice for the public, the Spaniards have not pursued such a policy, due to fear that they may scare their passengers. According to RENFE officials, "We wanted the passengers to feel the same as before March 11. A lot changed, but what we wanted was for the people not to notice."

Police surveillance is a critical component of the security strategy. RENFE has contracted private security officers who constantly monitor their facilities and watch over the passengers and staff. In the first months after the 3/11 attack, the national police provided an additional layer of surveillance at the stations. Similar to the situation in Tokyo, transit operators in Spain have observed that this increased police presence has resulted in a considerable decrease in crime at the stations and on trains.

The importance of design for station security was emphasized by officials at RENFE and Metro Madrid.

> Security is based on prevention, and prevention begins with design. A station designed without security criteria in mind would be much more insecure and much more expensive to protect. To feel safer and for a facility to be safer, you must count on design elements. In the past, the stations were created with other criteria. For example, we had many entrance points to bring citizens closer to the metro. Today, things have changed. One hundred years later, the citizen does not care so much if he walks along the street or inside the metro. What he does worry about is feeling secure that nobody is going to rob or attack him.

Javier García Cadiñanos and Rodríguez Simons offered the following recommendations for the design of new stations:

- Have one entrance point, if possible at the same level with the street, so that the rider does not have to enter an access by stairs.
- Utilize central platforms instead of lateral platforms because the most risky elements are the passageways. If you have a central platform where the train goes, you can avoid passageways.
- Use transparent materials in station design; make platforms, waiting areas, halls, and corridors as clear and transparent as possible.
- Construct footbridges and above-ground passageways so passengers can see and be seen.
- Install panoramic elevators (you should be able to see everything from inside).
- Eliminate dark zones; install good lighting.
- Eliminate long and winding corridors.
- Fit vending and automatic teller machines (ATMs) in specific niches of the wall with no space on top or underneath, and supervise the recharge/reload area by CCTV.

- Instead of having trains with several compartments, the wagons should be converted into one long wagon.

Figure 25 Nooks and Crannies Offer Hiding Places, Madrid Metro

In contrast to the other systems of our study, the Spaniards do not think that the elimination of trash cans from stations would help security. According to Jesus Rodriguez Molina of CRTM, "If there is an attack like the one on 3/11, there is nothing about the trash cans that would make a difference; the trash cans are an element of low importance. If somebody wants to be a suicide bomber, trash can or no trash can [it's] not going to do anything."

The challenges that transit operators in other cities and countries had described were also echoed in the responses of Spanish operators. For one, they were concerned with maintaining a proper balance between safety and convenience. As RENFE officials pointed out,

> When you have to pass from a scanner, this is an inconvenience. So what we try to do is explain to the passenger that we know it's an inconvenience, but at the same time, communicate that it's important for him, so that he feels more secure….If you put more barriers, more barriers, more barriers, the more you put, the safer the system, but it's more uncomfortable for the passengers. That is the problem. The

security is possible, it's easy to put up several barriers. But, it is also necessary to have limits.

Figure 26 Police at Central Madrid Station

The inherent vulnerability of an open system against terrorists who could attack suddenly, anywhere, and with no regard for their own lives was also discussed. At least one Spaniard, the Technical Director of Concorcio Transportes Madrid, appeared quite cynical about the effectiveness of security measures. According to him, the best thing that measures can do is to make passengers feel safe.

> In the first place, unlike those politicians who guarantee security, from the point of a technical person, I have to say that security does not exist. What does exist are methods to lessen insecurity. You never know what's going to happen and I'm telling you this because when the politicians tell you that these methods will guarantee our security, it's all false. What we can do is implement some measures that make us feel more secure and those measures depend on the costs….We can implement the most methods possible and create a theater of security, but this does not mean that anything is more secure in the face of terrorism. In its own quality, inflicting pain is very easy and preventing pain is extremely hard. And in a public mass transportation, like the one we provide, the only way to guarantee security in the metro is to close the metro. Yes, they do things, they put into works projects of putting in more CCTV and they're developing ideas. But, all of this is because you

> have to do something to increase the feeling of security or diminish the feeling of insecurity. We're not convinced that the methods that we can adapt are going to do anything against Islamic terrorism. To control everything is very complicated. We have to be humble and attempt to improve other types of insecurity of aggressions, theft, etc. If we speak about general security, yes we can do a lot. But regarding terrorism, no. The security against terrorism makes more sense in the airport and planes, because they have the luxury of time. Here, in this transportation, no.

The above attitude was, however, the exception rather than the norm. While most transit operators we talked to readily admitted that they had no way of measuring the effectiveness of their different security measures, they also believed that these measures did make things more difficult for potential terrorists.

A Pan-European Collaboration: UITP

The events of 9/11 in New York and 3/11 in Madrid have triggered a new type of cooperation among European operators, and the European community has become more active in the field of security than before. The European transit officials in our interviews stressed the importance of this pan-European collaboration in the fight against transit terrorism. In their view, such collaboration is imperative because many trains transcend national borders, connecting cities in different countries. The organization that works to promote this collaboration is the International Union of Public Transport, which has its headquarters in Brussels, Belgium. The European Union has allocated a significant budget for cooperation on issues of public transit, and of course security has become a very important element in this cooperation. UITP has regional offices in different parts of the world (but not in the United States), and members in eighty different countries. Its members are public transport operators, transit authorities, and bus and train manufacturers. One of their research projects, the Voyager Project, is financed by the European Union and dedicated to developing future urban transport policies.

UITP has instituted setting primary guidelines, benchmarking, and recommendations for coordinating security standards across the European Union.[142] UITP also promotes and makes known examples of security measures or new designs that have been most successful in anticipating terrorist threats and minimizing the risk of terrorist attacks. UITP also disseminates security information drawing from experiences in the United States and Japan. It also informs and contributes to projects such as Prismatica/Chromatica dedicated to optimizing audio-video surveillance.

In early 2003, a subcommittee of the Voyager Project took on the task of creating policy for transport security. So far UITP has established a platform for discussion and policy making, creating a permanent security group of UITP members from different countries. It has also signed a declaration emphasizing security issues in public transport. One of the declaration requirements urges every transit operator to carry out a vulnerability analysis on their system. According to Andrea Soehnchen, Project Manager of the Voyager Project,

> UITP wants to work with the big operating companies who have resources necessary to develop security guidelines, technologies, and methodologies that could be used by smaller-scale operators who simply don't have the resources to start from scratch to redo everything. Something we have in mind could, for instance, be like a checklist of weak points in infrastructure where you have to think about. So this could be very helpful for small-scale operators.

The motivation for UITP activity around security is the realization that the terrorist threat is international and that the public transport network is a very easy target for terrorists. While in the past terrorism was considered a localized event, the events of 9/11 showed to the world that the threat could touch everyone. Then the attacks in Madrid and Moscow demonstrated that it could happen in Europe's public transport. This has led to an increasing awareness of European operators and by the European Union, which plans to invest significant funds in assisting member states to carry out vulnerability analysis and inspections at stations.

UITP believes that the fight against terrorism will be much more effective if agencies across countries join hands. "Preventing terrorist attacks costs a lot of money, so we need to work together at the international level. We cannot work in an isolated way. Speaking of terrorists, they collaborate. They have international networks of terrorism and we need to also have international antiterrorism efforts. To inform each other about the threat as soon as there is a risk is very important." UITP hopes, therefore, for an interagency, interdepartmental, and international dialogue around security to define a common understanding of security aspects, and hopefully lead toward the adoption of common standards and common emergency plans in the mass transit industry—an approach already followed by the airline industry. This is certainly a challenge because different agencies are structured differently. In terms of policing, for example, some operators have their own dedicated police, while others rely on municipal or even federal police. Since the fight against transit terrorism involves agencies at different levels, a major concern, according to UITP, is to establish who is responsible for what and how agencies can better support each other rather than compete. According to Mohamed Mezghani of UITP:

> What is important to remember is that public transport companies are responsible for operations. They are not security agencies. So first they have to satisfy the mobility needs of their citizens—of course, in a secure environment. But they are not the security agencies and the responsibility of each one has to be defined very, very clearly. The public authorities are responsible for security and if there is an incident or attack, the public transport companies are responsible to restore traffic as soon as possible. They should help the authorities organize the first aid in the emergency situations, but they are not responsible to follow up the threat or to investigate the terrorist threat, if we are speaking about terrorism. This is the task of the public authorities and the security agencies. So having a discussion on who is responsible for what is very important.

While coordination between the different agencies responsible for transit security is imperative, UITP also stresses the importance of coordination and communication with the press and other mass media. According to Mezghani:

> The relationship with the media and the press is very important. How they report on security problems and how they report on attacks, reasons of an attack, and consequences of an attack is very important. We have to establish confident relationships with the media and to communicate with them in a permanent way, not only when there is a problem. If you take the example of Paris, they have periodic meetings with the journalists to communicate about public transport, and not only when there is a problem. I think this is very important to make them better understand. Because if you only speak with them when there is a problem then they don't know your system, they focus only on the problem and don't try to understand what is happening and why you reacted in that way.

According to UITP, standardization would be helpful in emergency procedures, security audits, announcements and signs, as well as design and materials. In Europe, there are a variety of standards at the moment, which may create confusion to passengers. Coordination in staff training would also be cost-effective, since agencies would not have to develop their own training programs, and which could take place in selected centralized locations and follow a commonly adopted procedure. This would save money and also may lead to greater security. As explained by Andrea Soehnchen, "If something were to happen in Paris, for example, they could bring staff to help from other places and this staff would automatically know his place in the whole system, in the information chain, in the reaction chain, and they could handle the equipment."

In summary, the message that UITP seeks to send to its members is that collaboration, coordination, communication, and standardization of strategies, tools, and procedures are the all-important attributes in the transit industry's fight against terrorism.

WHAT HAVE WE LEARNED, WHERE ARE WE HEADED?

You can have the cleanest trains in the world, you can have the most luminous stations in the world, you can have the most comfortable stations in the world, and you can have the most punctual trains in the world. But if you cannot step on a train without feeling safe, you are not going to use that train.

—Madrid transit official following the March 11, 2004 attack

Overview: Public Transit in a Post-9/11, Post-Madrid, Post-London World

Public transit systems around the world have for decades served as a principal venue for terrorist acts. While the most significant of these attacks—such as the sarin attack in Tokyo or the bombing of the Paris Metro—garnered worldwide public attention during the 1990s, popular and political response in the United States was generally muted. Perhaps this was because attacks on U.S. transit systems were still quite rare; perhaps this was due to Americans' legendary parochialism; or perhaps it simply reflected wishful thinking. Whatever the reasons for this indifference among many elected officials, it was not justified.

During the mid-1990s, four separate acts of terrorism and extreme violence on U.S. transit and rail systems killed 14 and injured more than 1,000.[143] While police and intelligence officials who oversee transit properties grew much more vocal in the late-1990s in calling for increased attention to the vulnerability of public transit systems to terrorist acts, the issue still had not caught the attention of most transit passengers, voters, members of the media, or elected officials.

This all changed, of course, on September 11, 2001. While the focus of the 9/11 attacks was on a different part of the transportation system, the effects on the affected public transit systems were dramatic and, in the case of New York, long-lasting. The vulnerability of open, accessible public transit systems and their passengers to terrorist acts was cast in sharpest possible relief. Concern over the vulnerability of transit systems has been heightened further by the more recent, deadly March 11, 2004, attacks on commuter rail trains in Madrid, Spain, and the July 2005 attacks on the London Underground and bus system. The London attacks in particular dominated news coverage for at least a week and raised popular concern over transit terrorism in the United States, such that transit security in the United States is now widely viewed as an important public policy issue.

The attention and subsequent fear generated by these attacks clearly motivated policymakers into action. Indeed, one of the more sobering lessons from this research is that significant system- or industrywide changes in security planning have often required either prolonged exposure to lower-scale attacks (such as those perpetrated by the IRA against transit systems in greater London) or a mass casualty event (such as in Tokyo or Madrid). Absent such events, concern, even repeated, dire warnings by vigilant police and intelligence officials, have too often gone unheeded by many elected officials.

Research on transit security in the United States has mushroomed since 9/11; this study is part of that new wave of research. This study contributes to our understanding of transit security in several ways. Perhaps most important, we employ a wide array of approaches and methods to examine a complicated issue: How are transit managers around the United States and around the world working to better protect their systems and passengers from terrorist attacks? To address this question we have pursued a multipronged research approach.

First, we reviewed and synthesized nearly all previously published research on transit terrorism and updated previous efforts to systematically chronicle previous terrorist attacks on transit systems around the globe.

- We complemented these detailed case studies and interviews with a comprehensive survey of 113 of the largest transit operators in the United States regarding prior threats and attacks, past and current security planning and policing efforts, and approaches to four security strategies—policing, technology/hardware, public education/outreach, and crime prevention through environmental design (CPTED).
- We conducted detailed interviews with federal officials here in the United States responsible for overseeing transit security, and with transit industry representatives both here and abroad to learn about efforts to coordinate and finance transit security planning.
- We conducted detailed case studies of terrorist attacks on transit systems in London (prior to July 2005), Madrid, New York, Paris, Tokyo, and Washington, D.C. These case studies involved reviews of documentary evidence and other written materials, in-depth interviews with transit officials and other key stakeholders, and physical inspections of the systems and sites of the attacks.

Thus, our multipronged research approach is both domestic and international, as well as qualitative and quantitative, all in an effort to increase the reliability of our findings on this complex issue.

A second distinguishing feature of this research reflects the experience and expertise of the research team. We are scholars of architecture and urban design, civil and transportation engineering, and transportation and urban planning, and not intelligence, policing, or security. We have, therefore, approached this research from the perspective of the people who finance, design, build, operate, and use public transit systems, rather than from the perspective of those who police them.

For example, the role of system design in transit security has received far less attention in most previous research on transit security than policing or surveillance. A specific focus of this work is on system design. We conducted inspections of transit stations in each of the systems studied, and we collected detailed information on attitudes toward and applications of crime prevention through environmental design (CPTED) strategies in our survey of U.S. transit operators.

A third and final distinguishing feature of this research is that it updates the findings and conclusions of many previous studies in this fast moving and rapidly evolving literature. We found from our survey, for example, that security planning efforts have progressed significantly at U.S. transit systems since a 2002 U.S. GAO survey of transit operators was published in 2003.

Given this overview of our research, the next section provides a synthesis and discussion of twelve principal findings from the study.

Findings: A Dozen Lessons Learned

1. **Public transit systems are open, dynamic, and inherently vulnerable to terrorist attacks; they simply cannot be closed and secured like other parts of the transportation system.**

Public transit systems are a central part of urban life. They assemble strangers from diverse economic, social, ethnic, and religious backgrounds and convey them though a wide array of neighborhoods and districts. They are, by definition, open, dynamic systems that cannot be closed and regulated like the air transport system.[144] Such sentiments were expressed repeatedly by the hundreds of people interviewed and surveyed for this research. Not surprisingly, most of the transit managers and security officials who responded to our survey viewed their transit systems as “very vulnerable” to terrorist attacks.

While public officials understandably call for efforts to make transit systems 100 percent safe, it is simply impossible to secure the thousands of bus stops, hundreds of miles of bus routes, many dozens of miles of rail rights-of-way, and the hundreds of stations used daily by millions of passengers in most large metropolitan areas. The challenge is especially daunting given a growing wave of suicide bombers who are willing to risk capture or death to execute an attack. According to an official interviewed in Madrid, "I have to say that security does not exist. What does exist are methods to lessen insecurity. You never know what is going to happen. I am telling you this because when the politicians tell you that these methods will guarantee our security, it is all false."

Said another Madrid official, "You should accept that there is an inherent vulnerability to the system, and if you want to run an open mass transit system you live with the vulnerabilities and try to tackle them through intelligence and stopping these people before they actually get in."

Such sentiments raise legitimate, and perhaps troubling, questions about whether transit security planning efforts are perceived by transit officials as more symbolically effective (at creating a sense of safety among the public) than substantively effective (in reducing the likelihood and/or magnitude of a terrorist attack). At the very least, they reflect the daunting challenges to security planning for open, accessible transit systems.

2. **The threat of transit terrorism is probably not universal; most attacks in the developed world have been on the largest systems in the largest cities.**

While the chronology of terrorist attacks on transit systems reviewed in the second section, "Securing Urban Rail Transit Systems against Terrorism: A Review of the Literature," and in "Appendix A: Chronology of Terrorist Events," documents hundreds of incidents occurring over many decades, the deadliest and most politically influential of these have occurred on the largest transit systems in the most politically and economically powerful world cities, such as London, Madrid, Moscow, New York, Paris, and Tokyo. This suggests that efforts to combat transit terrorism should be focused on cities and transit systems where the likelihood and potential effects of terrorism are greatest.

This observed asymmetry of risk likely reflects both the symbolic importance of particular world cities, and the fact that transit use tends to be concentrated in the largest and most densely developed metropolitan areas. As noted in the section "Securing Transit Systems in the

Post-9/11 Era: A Survey of U.S. Transit Operators," the ten largest U.S. transit systems (operating in nine metropolitan areas) carried 65 percent of all transit trips reported to the Federal Transit Administration for 2002, while the rest of the transit systems carry the remaining 35 percent. Thirty-nine percent of all 2002 U.S. transit trips occurred in one metropolitan area, New York, and 31 percent of all U.S. transit trips were carried by just one system, the New York MTA.[145]

While the most dramatic attacks have occurred mostly on major systems in world cities, this does not mean, of course, that local bus service or smaller cities are safe from attack. In the developing world, terrorist attacks on transit are more likely to occur on buses than on trains. Further, as noted in the sections "Securing Urban Rail Transit Systems against Terrorism: A Review of the Literature," and "Institutional Responses to Increasing Transit Security Threats: Interviews with Key U.S. Stakeholders," security experts report that some terrorists have on occasion chosen to attack unexpected targets in order to elevate fear and anxiety among the general population. But while smaller U.S. cities—like Oklahoma City—are clearly not safe from terrorist attacks, the very small role played by public transit in these cities (where the mode share of trips can dip below 1 percent) suggests that they are a far less likely venue for an attack than larger cities where the role and visibility of public transit are proportionally much greater.

3. The asymmetry of transit terrorism risk is at odds with a political system of public finance that favors distributing funding somewhat equally across jurisdictions.

Given the observed asymmetry of risk, how should security resources be deployed? If strategic transit security policies start from the premise that attacks will inevitably occur, then "success" is not elimination of all attacks, but preventing and/or minimizing the most damaging attacks—which are most likely and most deadly on the largest transit systems. While focusing security efforts on large transit systems in New York, Washington, D.C., and Los Angeles, for example, may motivate terrorists to shift their focus to smaller systems and smaller cities, such a shift could be viewed as evidence of success in securing the most symbolically significant and attractive targets.

However, there is a strong tendency in the public finance of transportation, and indeed in most realms of public finance, to distribute funding widely among political districts and jurisdictions. This helps to explain why federal per-rider subsidies tend to be far higher in places like Chapel Hill, North Carolina, than in places like New York City. This natural tendency to spread out money evenly does not square with the asymmetry of transit systems' risk of terrorist attack and may undermine the effectiveness of federal and state transit security policies and programs. Thus, despite New York's domination of U.S. public transit patronage, it is unlikely that the U.S. Congress—comprising entirely geographically based representatives concerned with the distribution of resources among their competing jurisdictions—will see fit to devote a third or more of all federal transit security resources to the New York metropolitan area.

4. **Transit managers are struggling to balance the costs and (uncertain) benefits of increased security against the costs and (certain) benefits of attracting passengers.**

Transit managers are in the business of attracting and conveying paying customers. They endeavor to provide safe, fast, and reliable service at a reasonable price, but transit systems worldwide have struggled in a losing, century-long battle with private vehicles for market share in urban travel—especially in most U.S. cities. Thus, from the perspective of transit system planners and managers, safety and security are important, albeit intermediate, means to the end goal of carrying passengers. As one transit industry official put it, "What's important to remember is that public transport companies are responsible for satisfying the mobility needs of citizens. They are not security agencies."

With respect to the sometimes competing objectives of maximizing security versus maximizing ridership, one London interviewee noted,

> Our primary function is to get loads of people to use trains. Security, I would suggest, is still seen as a secondary but integral function. So you won't have the world's most secure station built, but you'll have the world's most cost-effective station built with security enhancements.

Calls for increased attention to security have come in recent years from passengers, the media, local officials, and state and federal governments. With respect to the latter, mandates for regular and comprehensive security planning, more formalized safety and emergency response procedures, increased policing and surveillance, and so on, were criticized by many of the transit officials we interviewed (both domestic and internationally) as unfunded mandates that strain already depleted transit system budgets. Indeed, the need for increased security funding was the central finding of the 2003 GAO study of transit security in the United States, and such calls for increased funding were echoed in this research.

According to one transit official interviewed, transit terrorism is a tremendous burden for agencies because they "have to be lucky all the time, while the terrorists only have to be lucky once." Regarding the need for public subsidies to support security expenditures, another interviewee noted, "In the end public transport is a business… There comes a point at which the businessman will say that the security measures will cost him more than the revenues. The key issue for addressing risk is to get things down to 'ALARP' as we call it, 'as low as reasonably practical.'"

In addition to concerns over the costs of security programs that many of those surveyed and interviewed see as tangential to the central goals of transit agencies, many of those surveyed and interviewed also expressed concerns over the uncertain nature of the risks and the uncertain effectiveness of increased security expenditures. "How," several of those interviewed asked, "should systems evaluate costs and benefits in such uncertain environments?" Further, what techniques or approaches offer systems the most security bang for the buck? In response to such questions, the transit systems examined for this study have pursued an array of ways to prioritize expenditures on security:

- customizing security measures based on a detailed evaluation of risk for each site (Paris).
- assessing risks based on station location, sociodemographics of the region, and delinquency rates of surrounding population (Madrid).[146]
- focusing efforts on terminal stations, the most heavily patronized stations, and stations near government buildings (Tokyo).
- giving top priority to securing sites with concentrations of hazardous materials (Paris).
- conducting public surveys of riders' perceptions and concerns to help prioritize needs (Madrid).

5. Given the varying roles and mandates of agencies of the central government (ministries, federal agencies, and so on), intelligence services, police agencies, and transit operators on matters of security, close coordination and cooperation are critical to effective transit security planning.

Many of our interviewees spoke of the need for a multilayered and multipronged system of security in which various agencies play very different roles. Many transit officials with whom we spoke suggested that interagency cooperation is common to the industry, which bodes well for increased coordination with police and security agencies in the years ahead. One U.S. transit industry representative put it this way:

> The transit industry, because it's public, is very mutually supportive. Transit agencies aren't in competition with each other. In fact, we have a long history of aiding one another with training programs. Even if you've hired a consultant to help you with a program, we've seen people really sharing that program or that information. One of the roles that {the American Public Transportation Association} plays {is that} we're a conduit for the sharing of a lot of that information.

Many of those interviewed emphasized the importance of clearly defining roles and responsibilities among actors. Several also stressed the need for frequent and regular interaction among agencies to share information and agree on common strategies and tactics. Concluded one London interviewee,

> Partnership is not easy. You have to invest time, and emergencies are not the time to meet your counterpart in different agencies... Resilience is about coordinating and facilitating efforts of all the disparate, separate agencies to ensure better quality of performance, aiding and leading to a more effective prevention or recovery than might otherwise be the case.

Finally, several of the transit officials interviewed noted that the American Public Transit Association (APTA), the leading U.S. transit industry organization, has come to play an increasingly central security coordinating and information-brokering role, and, in doing so, has come to more closely resemble the activities of the International Union of Public Transport (UITP) outside of the United States.

6. An important benefit of improved coordination is standardization of emergency training, security audits, and disaster preparedness procedures, and the issuance of common guidelines about security.

While the airline industry has adopted common international security standards and procedures, many other modes—and in particular public transit—have not done so. For example, several of our European interviewees noted that while many EU member countries have developed highly integrated international passenger rail service, similarly integrated systems of rail security have been slow in coming.

Likewise, while the many transit agencies typically operating in larger metropolitan areas have developed reciprocal integrated fare and passenger information protocols, efforts to integrate and standardize security practices and procedures among transit systems within metropolitan areas and between them are relatively new.

Such standardization can be particularly helpful to smaller transit operators that do not have the resources to independently develop security standards and procedures. For example, standardizing safety guidelines and signage, the structure and content of security announcements, and the marking of emergency exits on trains and in stations can all help passengers avoid confusion in times of emergency. Likewise, standardizing security training of personnel—drivers, supervisors, and managers—can improve coordination with police, fire, and intelligence officials in times of emergency. Many of the respondents from U.S. transit agencies surveyed for this research noted that, under the guidance of the federal government, standardized security plans and training programs were being integrated into already established emergency response training programs traditionally aimed at responding to personal and property crime and smaller-scale emergencies.

7. **Despite significant progress in increasing coordination between transit and police/intelligence agencies, however, much work remains.**

Despite significant and ongoing efforts to improve the coordination and cooperation between the many, largely independent transit agencies operating in large U.S. metropolitan areas, seamless integration of routes, schedules, and fares has long proven elusive. Given the widely divergent goals and objectives of public transit and police/intelligence agencies, the challenges to increased coordination and cooperation are even greater.

Perhaps the greatest challenge to improved coordination identified in this study concerns ambiguity and uncertainty over lines of authority and responsibility. Put simply, it is not always clear who is responsible for what. Said one European transit industry representative we interviewed,

> The public authorities are responsible for security. If there is a terrorist incident or attack, the transit authorities are responsible to restore traffic as soon as possible. They [the transit agencies] should also help the public authorities to organize first aid and emergency response, but they are not responsible to follow up the threat or to investigate the threat.

Despite the many challenges, nearly everyone queried agreed that increased coordination was needed. Such coordination could take many forms: (1) coordination between neighboring transit agencies; (2) coordination among local, state, and federal law enforcement officials; (3) information sharing with the media and the public; (4) the improved dissemination of best practices in security planning; (5) consistent emergency response procedures and protocols; (6) improved integration of different security-related technologies; and (7) increased international cooperation in sharing information and best practices. With regard to the latter, one official interviewed noted, "The threat is international and the way you need to deal with it is an international effort," although several other interviewees cautioned that while international threats call for international collaboration, security measures should not be applied equally in all places; they should be customized according to local organizational/governmental structures, transit system size, age, and characteristics, and the specifics of local cultures and norms.

8. Passenger education and outreach is a challenge; informed passengers can increase surveillance and safety, fearful passengers may stop using public transit.

While most of the officials surveyed and interviewed agreed that public education and outreach had become an important part of transit security planning, respondents were in general more ambivalent about education and outreach than about policing, technologies, or crime prevention through environmental design. In particular, many cited the challenge of raising awareness without raising fear. One of the officials we interviewed in Madrid said that their goal following the March 11, 2004, attacks was to augment feelings of security and diminish feelings of insecurity: "The methods we chose and implemented after the March attack were not so much about combating terrorism; rather they were used to help riders recover a feeling of security."

While our interviews suggest that passenger outreach efforts on security have been more common outside the United States, nearly all those to whom we spoke agreed that it is a delicate balance between creating a perception of excessive, pervasive security (which is both costly and can incite fear among passengers) and too little security (which can promote a sense of danger and unchecked lawlessness). Said one transit industry official, "You have to reassure but not scare off passengers, because if you exceed a certain level [of police activity] it might be considered that you are in a very insecure place."

Enlisting the public's help in security surveillance can be effective, but entails risks. Excessive marketing of vigilance can create an environment of paranoia, where everything and everyone can be viewed as potential threats. Such paranoia can suppress ridership while overwhelming transit officials with security tips, and panicked passengers can compound damage after an attack.

Further, a strong emphasis on police and public surveillance can lead to social profiling, and with it losses of privacy and civil rights. Said one interviewee,

> Here [in Spain] there would be a lot of problems and it wouldn't be convenient to start screening passengers. People will not accept being identified, profiled, and searched, even if it is a random manner, because when you select, you elect and you have to do this with a certain objective and clear parameters. You will be accused of discrimination because this is labeling, marking people with certain physical features.

9. The role of crime prevention through environmental design in security planning is waxing.

Most of our survey and interview respondents were familiar with the concept of crime prevention through environmental design (CPTED), and most viewed CPTED—which considers how the physical design of spaces can affect both the likelihood and impact of criminal or terrorist activity—as an important longer-term strategy to address both crime and terrorism on transit systems. According to the respondents to our survey, CPTED was given much less weight in security planning prior to 9/11. Since 9/11, however, over 80 percent of the respondents now believe that CPTED is a somewhat or very effective strategy in preventing terrorist attacks. This ranking of effectiveness is similar to both policing and security hardware and technology strategies, and well ahead of public education and outreach.

According to one of our interviewees in Madrid, "Security is based on prevention, and prevention begins with design. A station designed without security criteria would be much more insecure and expensive to protect."

While the potential effectiveness of CPTED was widely touted by those queried, many also noted that design is a longer-term strategy. CPTED strategies can be cost-effectively incorporated into new stations and terminals, such as in the new Météor and Eole Lines in Paris, the new Line 11 in Madrid, and the new Bilbao subway in Spain. On the other hand, most interviewees thought retrofitting old stations to be extremely costly for the most part. Concluded one interviewee regarding the retrofit of older stations, "The best you can do is to use some passive methods such as mirrors, cameras, and increased lighting."

Even among officials interviewed who work primarily in policing and security, knowledge of and enthusiasm for CPTED principles was widespread. For example, one London transit police official said,

> If you take a station like Baker Street, it's a very dark [and listed as a historically significant] building so there are limitations on what can be done to change the appearance and structure. Not very much can be done at all. We'd like better lighting, more CCTV (closed-circuit television). We'd like cleaner lines—any vending machines that are brought in, we'd like them to have sloping tops so nothing can be put on top of them. We'd like them to be totally accessible or totally enclosed so they're easy to search or impossible to put something in. We look at tamper-evident seals [on entryways to areas closed to the public], which can't be physically locked. When it comes to new stations, bigger, brighter areas, clear sight lines, certainly those are the kinds of things that we would seek to influence.

10. Since 9/11, transit agencies are more likely to adopt comprehensive, multipronged approaches to security planning than in years past.

Our survey and interviews focused in detail on four types of security strategies—policing, technology, education and outreach, and CPTED. We found that attention to all these strategies has increased since 9/11, and over half of the respondents now view all four strategies as central or significant parts of security planning efforts.

Prior to 9/11, most of the respondents to our national survey of large transit operators emphasized policing and hardware/technology in security planning and placed far less stock in either public education or CPTED. While the survey respondents believed that the importance of policing and hardware/technology increased after 9/11, their assessments of the importance of public education and, especially, CPTED increased even more.

This broad support for all four security strategies reflects a consensus among those surveyed and interviewed regarding the need for a comprehensive, multipronged approach to transit security planning. Several interviews cautioned against becoming too reliant on just one or two strategies. As one of our London interviewees noted, "Each one {strategy} on its own can't work in isolation. I don't think that one of them sits out on its own. You've got to do each one. And you've got to have an element of each one in terms of being able to combat terrorism or crime in general."

11. **The public transit industry is vulnerable to security policies or programs that reduce the speed, comfort, or convenience of transit, and may benefit significantly from policies that increase the attractiveness of transit.**

Despite significant public investments over the past three decades, public transit systems around the United States continue to lose market share to private vehicles. Many transit systems have made important strides in increasing the comfort, safety, and convenience of using transit, but matching the speed and flexibility of private autos remains a challenge. Transit security policies and programs that increase the hassle of, or delays in, riding buses and trains may significantly undermine an already vulnerable and distressed industry. For example, the random bag and parcel inspections instituted on the New York City transit system following the July 2005 attacks on the London public transit systems added stress and delays to travel on the United States' most heavily patronized transit system—stress and delays that inevitably make traveling by other modes relatively more attractive.

Many of the transit system managers interviewed for this study expressed concerns than new security measures should enhance the perceived safety and attractiveness of their systems and not add to delays, inconvenience, or perceptions of heightened risk. The importance of creating safe, attractive systems for passengers, report some transit officials queried, is sometimes lost on security officials; as one interviewee from London stated prior to the July 2005 attacks,

> It's trying to balance providing maximum security while still providing the kind of service people expect. People still want to go from point A to point B as fast as possible. They don't want to be delayed, even for security reasons. So that's the balance...it's still a struggle...I think that is something that in the future has to evolve, to where you have that perfect balance where you can say, "I think we're providing as much security as we can," but it's also seamless to the customer so you don't have an operational slowdown.

12. Given the uncertain effectiveness of antitransit terrorism efforts, the most tangible benefits of increased attention to and spending on transit security may be a reduction in transit-related personal and property crimes.

Terrorist attacks on transit systems in the United States and abroad have increased in recent years in both frequency and severity. Likewise, public and political concern over the issue has skyrocketed since 9/11. The fact remains, however, that transit patrons remain far more likely to be victimized by personal crime than a terrorist act.

According to Federal Transit Administration data, an average of 279 people have been killed on or by public transit each year over the past decade. In addition, an annual average of 18,784 people have been injured on or by public transit over the same period. Crime ostensibly unrelated to transit use—such as being robbed and killed while waiting at a bus stop—would push those figures far higher. This means that, between September 11, 2001, and August 11, 2005, more than 1,100 people have been killed on or by public transit, and more than 75,000 have been injured on or by transit in the United States.[147]

Further, studies have repeatedly shown that fear of crime is a significant deterrent to transit use for many people.[148] So while political attention and public resources are currently focused on transit terrorism, reductions of personal and property crimes on public transit systems could prove to be a significant collateral benefit of safer, more secure public transit systems.

In both our review of the research literature and in several of our interviews were repeated suggestions for a "dual-use strategy," whereby antiterrorism measures may be effective in reducing transit crime. Coincident with new security measures on the Tokyo Metro, both robberies and thefts are down substantially. Likewise, fewer crimes were reported in the period following the implementation of random parcel inspections in Madrid.

Such complementary benefits, however, are not assured without careful attention to congruency between anticrime and antiterrorism measures. Some of those interviewed suggested that anticrime and antiterrorism efforts are not always reciprocal and complementary. "By preparing your system to react to terrorist attacks, you also prepare it to react to different types of crime… But the other way around is not always true" (Madrid transit official).

However, others argued that anticrime and antiterrorism efforts worked very much hand-in-hand. Said one London transit security official,

> It's easier for a terrorist to operate in an environment that is disorderly, that does not give the appearance that someone is in charge, the area does not look secure. Actually taking care of the little things, and insuring that there is order and maintenance, sends a signal that it's hard to operate illegally or carry out an attack in this environment. There's a deterrent effect.

Postscript

Whether these findings are discouraging or heartening depends on one's perspective. The stakes are high, the risks uncertain, and the solutions unclear. The July 2005 subway and bus attacks in London offer a sobering reminder that transit systems remain inherently vulnerable to terrorist actions, even on systems where security and vigilance have been the modus operandi for decades. While public transit systems are likely to remain attractive and vulnerable targets for terrorists, U.S. transit systems are today better coordinated, policed, monitored, and designed, and staff and passengers are better informed and prepared than just a few years ago. How effective these efforts will be (or have already been) in deterring or minimizing a terrorist attack is unclear. What is clear, however, is that crimes of all types—political, personal, and property—drive riders away from transit systems. So if the recent rise in transit security planning deters a major terrorist attack, or simply the activities of a lone pickpocket, the transit industry will be better off as a result.

APPENDIX A: CHRONOLOGY OF TERRORIST EVENTS

(Starts next page.)

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
1	31-Aug-04	Russia	Moscow	Suicide bombing kills 10 outside Moscow subway	Bomb	Station Perimeter	Above		10	Islambouli Brigades	A female suicide bomber set off a powerful homemade bomb outside a Moscow subway station Tuesday evening, shooting metal shrapnel through a crowd of commuters and killing at least 10 people. Suicide bomber turned away from the subway station after seeing police officers checking documents at the entrance.	http://www.washingtonpost.com/wp-dyn/articles/A49376-2004Aug31.html
2	7-Apr-04	Thailand	Songkhla Province	Two bomb blasts on southern Thailand rails	Bomb	Train	Above	75	3		First bomb exploded in station. Killed one child and injured 37 others. Evidence indicates that the bomb was put in a suitcase and left at an information counter on the platform. Police report having found evidence of C-4 explosives. A third explosion (second was at a hotel) occurred on Saturday night at a gas plant next to the railway station in Songkla province. The blast derailed a train running from Yala to Bangkok. Authorities haven't ruled out that the explosion might have been accidental.	http://www.irrawaddy.org/news/2001/april-7.html
3	2-Apr-04	Spain	Madrid	Guard finds bomb on high-speed train line tracks	Bomb	Train	Above	0	0		Bomb-disposal experts alerted by a railway employee found 22-24 pounds of dynamite under the rail line about 40 miles south of Madrid on the rail line running to Seville. Explosives were connected to a detonator with a 430-foot cable.	http://www.cbsnews.com/stories/2004/04/03/world/main610143.shtml
4	12-Mar-04	Greece	Serres	Greek train bomb plot thwarted: Five propane rail cars crossing Bulgarian border were rigged to explode	Sabotage	Train	Above	0	0	Bulgarian Mafia	Five train cars due to transport propane were rigged with a large quantity of explosives. Train was traveling from Bulgaria to Thessalonica.	http://www.freerepublic.com/focus/f-news/1096423/posts
5	11-Mar-04	Spain	Madrid	Simultaneous explosions kill 191, injure 1,800		Train	Above	1,800	191		Ten near-simultaneous explosions during rush hour on 4 separate trains. Backpack bombs	Various
6	6-Feb-04	Russia	Moscow	Suicide bomber blows up a subway car in the Moscow metro during rush hour	Bomb	Train	Below	100	41	Chechen rebels	Russia, Moscow: a suicide bomber blew himself up on a Green Line Subway train during morning rush hour. The bomb equivalent in force to 9-11 pounds of TNT, made of ammonia saltpeter and aluminum powder, exploded in a tunnel between Avtozavodskaya station and Paveletskaya station; 41 people died, and more than 100 were injured.	http://www.cbsnews.com/stories/2004/02/06/world/main598471.shtml
7	5-Feb-04	Russia	Moscow	A bomb blast in Moscow's Byelorusskaya subway station injures 15 people	Bomb	Station	Below	15	0		A bomb blast in Moscow's Byelorusskaya subway station injures 15 people. The bomb was probably meant to explode after a train arrived on the platform to cause more casualties.	http://www.cnn.com/2001/WORLD/europe/02/06/russia.explosion/

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
8	24-Dec-03	Spain	Madrid	Police thwart Basque plot for Christmas Eve train bombing	Bomb	Train	Above	0	0	ETA	Police foiled a plot to detonate two powerful bombs aboard a train headed to busy Madrid railway station on Christmas Eve. One of the two 25-kilo (55-pound) bombs was found on Wednesday on the train traveling from the Basque city San Sebastian to Madrid, but police stopped the train in the northern city of Burgos, evacuated it and removed the bomb. One of the two detainees was found carrying a similar bomb before it could be planted on the train. Both bombs were hidden in suitcases or knapsacks. The one found on the train was timed to go off just before 4 p.m. (1500 GMT) at Madrid's Chamartin Station.	http://www.aljazeerah.info/News%20archives/2003%20News%20archives/December/24%20n/Police%20thwart%20Basque%20plot%20for%20Christmas%20Eve%20train%20bombing.htm
9	5-Dec-03	Russia	Southern Russia	Suicide bombing of a commuter train in southern Russia.	Bomb	Train	Above	150	44	Chechen rebels	The 10-kg bomb detonated as the train was pulling into Yessen-tuki Station, on a line that had been bombed just three months ago. Surviving passengers said a woman detonated the bomb (suicide), thought to have been in a bag packed with bolts and other metal objects.	http://www.channel4.com/news/2003/12/week_1/05_russia.html
10	27-Sep-03	Ethiopia	Adiquala	A bomb kills two and injures nine on a passenger train traveling from Djibouti to Ethiopia	Bomb	Train	Above	9	2		The bomb exploded under a seat when the train was near the town of Adiquala, about 190 kilometers (115 miles) from the border with Djibouti.	http://news.bbc.co.uk/1/hi/world/africa/3144190.stm
11	8-Jul-02	Thailand	Yala Province	Two injured in southern Thai train bomb explosion	Bomb	Train	Above	2	0		The two injured--a railway policeman and a security officer--were inspecting the train after it had reached the final stop. They found a box left in the last car and were trying to examine it when it blew up, the railway officials said.	http://www.nationmultimedia.com/page.arcview.php3?clid=2&id=62373&usrsess=1
12	14-Mar-03	India	Bombay	Eleven people were killed in a bomb explosion on a commuter train.	Bomb	Train (in station)	Above	50	11		Blast hit carriage reserved for women passengers. The explosion happened in the busy Mulund Station during the evening rush hour.	http://news.bbc.co.uk/2/hi/south_asia/2848123.stm
13	10-Aug-01	Angola		Land mine attack by rebels on a passenger train kills 100, injures 150	Landmine	Train	Above	152	146	UNITA (National Union for Total Independence of Angola)	Train was carrying civilian passengers when it was derailed by a landmine and then attacked by UNITA rebels. Train was 150 km southeast of the capital Luanda as the train headed for the town of Dondo.	http://news.bbc.co.uk/1/hi/world/africa/1489317.stm
14	30-Dec-00	Philippines	Manila	Bomb kills nine on metro	Bomb	Station		60	9	Abu Sayyaf	Bomb on light rail train explodes as it enters Blumentritt Station	Jenkins
15	16-Dec-00	Russia	Moscow	Bomb threat against Moscow metro	Threat	Station	Below	0	0		Bomb threat forces closing of Dmitrovskaya Station	Jenkins
16	26-Oct-00	India	Punjab	Bomb on passenger train kills one	Bomb	Train	Above	30	1		Bomb explodes on train	Jenkins
17	20-Oct-00	United States		Bomb threat halts Amtrak train	Threat	Train	Above	0	0		Bomb threat forces the evacuation of an Amtrak train	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
18	17-Oct-00	United Kingdom		Train accident raises terrorism concerns	Sabotage	Line	Above	35	4		High-speed train derails	Jenkins
19	14-Aug-00	India	Uttar Pradesh	Bomb on train kills 10	Bomb	Train	Above	36	10	Kashmiri Extremists	Bomb explodes on express train	Jenkins
20	10-Aug-00	Russia	Moscow	Explosives found in Moscow railway station	Bomb	Station		0	0		Explosives found in Kazansky Station lost luggage office	Jenkins
21	8-Aug-00	Russia		Bomb kills eight in underground passage	Bomb		Below		8	Chechens	Bomb explodes in underground passage	Jenkins
22	31-Jul-00	India	Assam	Bomb on passenger train kills 12	Bomb	Train	Above		12	ULFA (Liberation Front of Assam)	Bomb explodes on passenger train	Jenkins
23	27-Jul-00	Germany	Düsseldorf	Bomb explodes at entrance to Düsseldorf Underground	Bomb	Station	Below	9	0		Bomb explodes in underground station	Jenkins
24	24-Jul-00	Ukraine		Passenger train derailed	Sabotage	Line	Above	40	0		Damaged track causes derailment	Jenkins
25	20-Jul-00	Russia	Moscow	Terrorist plots failed	Bomb	Station		0	0	Chechens	Bomb plot for Kursky and Volgograd stations foiled	Jenkins
26	19-Jul-00	United Kingdom	London	Bomb threats disrupt Underground	Threat	Station	Below	0	0	IRA	Bomb found and detonated in an Underground station	Jenkins
27	16-Jul-00	Pakistan	Hyderabad	Bomb on train kills nine	Bomb	Train	Above	35	9		Bomb explodes on train just outside of Hyderabad	Jenkins
28	30-Jun-00	United Kingdom	Belfast-Dublin	Rail line linking Belfast and Dublin bombed	Bomb	Line	Above	0	0		Bombing of tracks	Jenkins
29	23-Jun-00	Latvia	Riga	Group threatens a war of the rails	Bomb	Line	Above			Fighters of Democratic Latvia	Bomb damages tracks	Jenkins
30	13-Jun-00	United Kingdom	Coventry	Vandals attack commuter train	Sabotage	Line	Above	0	0		Equipment placed on track in an attempt to derail train	Jenkins
31	12-Jun-00	United Kingdom	Daventry	Vandals attempt to derail high-speed train	Sabotage	Line	Above	0	0		Equipment placed on track in an attempt to derail train	Jenkins
32	7-Jun-00	Philippines	Manila	Bomb found on Manila Metro	Bomb		Below	0	0		Bomb found and detonated in Manila metro	Jenkins
33	3-May-00	Russia	St. Petersburg	Bomb threats delay trains in St. Petersburg	Threat			0	0		Bomb threat delays several trains	Jenkins
34	18-Apr-00	Belgium		Three boys cause trains to derail, killing one	Sabotage	Line	Above	22	1		Train derailed	Jenkins
35	28-Mar-00	Brazil	Sao Paulo	Angry commuters set fire to train	Fire	Train	Above	0	0		Commuter set fire to train after it broke down	Jenkins
36	21-Mar-00	India	Bombay	Bomb injures four on commuter train	Bomb	Train	Above	4	0		Bomb exploded on local commuter train	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
37	6-Feb-00	Pakistan	Hyderabad	Bomb on train kills five	Bomb	Train		44	5		Bomb explodes on passenger train after it left Hyderabad Station.	Jenkins
38	26-Jan-00	India	Bombay	Explosive device found on Mumbai train	Bomb	Train		1	0		Small bomb in a clock found on a train exploded	Jenkins
39	19-Jan-00	India	Assam	Bomb derails train	Bomb	Line	Above			ULFA (Liberation Front of Assam)	Bomb explodes on track causing derailment of freight train	Jenkins
40	6-Jan-00	India	Old Delhi	Bomb injures 12 at rail station	Bomb	Station		12	0		A bomb in a suitcase was placed under a seat in the railway station and exploded.	Jenkins
41	27-Dec-99	Japan	Tokyo	Bomb explodes at train station	Bomb	Station		1	0		Bomb explodes in locker at Urawa train station	Jenkins
42	26-Dec-99	Japan	Narita	Fires on three trains to Narita	Fire	Train		0	0		Arsonists set fire to express trains	Jenkins
43	24-Dec-99	Japan	Osaka	Bomb found in trash bag on bullet train	Bomb	Train	Above	0	0		Bomb found in trash bag of train	Jenkins
44	1-Dec-99	Pakistan	Hyderabad	Fifteen-pound bomb found on main track	Bomb	Station		0	0		Bomb found at Kotori railway station and defused	Jenkins
45	11-Nov-99	India	Jammu-Kashmir	Thirteen killed in bomb explosion on train	Bomb	Train	Above	50	13		Bomb explodes on express train	Jenkins
46	4-Nov-99	Pakistan	Muridke	Bombs kill one	Bomb	Station	Above	3	1		Bomb explodes near a railway station	Jenkins
47	20-Oct-99	Brazil	Sao Paulo	Bomb explodes on commuter train in Sao Paulo	Bomb	Train		7	0		Bomb explodes on a commuter train	Jenkins
48	17-Aug-99	Russia	North Caucasus	Attempted bombing of passenger train	Bomb	Train	Above	0	0		Man stopped while boarding a train with a bomb	Jenkins
49	16-Aug-99	India	Calcutta	Explosives found at railway station	Bomb	Station		0	0		Explosive found in rail station	Jenkins
50	9-Aug-99	India		Bomb derails train in northeast	Bomb	Train	Above	5	0		Bomb caused freight train derailment	Jenkins
51	7-Aug-99	India		Bomb damages bridge just ahead of passenger train	Bomb	Bridge	Above	0	0	ULFA (Liberation Front of Assam)	Bomb destroys bridge	Jenkins
52	6-Jul-99	Australia	Sydney	Bomb explodes at commuter railway station	Bomb	Station		3	0		Bomb explodes in station	Jenkins
53	17-Mar-99	Sri Lanka	Colombo	Bomb found on rail line	Bomb	Line	Above	0	0	LTTE (Tamil Tigers)	Bomb found on tracks and disarmed	Jenkins
54	19-Dec-98	Germany		Three rail sabotage incidents	Sabotage	Line	Above	0	0	Friends of the Railways	Tracks tampered with	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
55	18-Dec-98	Germany		Three rail sabotage incidents	Sabotage	Line	Above	0	0	Friends of the Railways	Tracks tampered with	Jenkins
56	10-Nov-98	Mexico	Chihuahua	Gunmen attack train, killing one	Gun	Train	Above	3	1		Gunmen attack passenger train	Jenkins
57	10-Nov-98	Colombia		Guerrillas dynamite railroad track	Bomb	Line	Above	0	0	FARC (Revolutionary Armed Forces of Columbia)	Tracks bombed	Jenkins
58	28-Sep-98	Congo	Brazzaville	Several killed at rail station		Station					Attack occurred at Goma Tsese Station, killing several	Jenkins
59	19-Sep-98	Russia	Moscow	Bomb threat at St. Petersburg railway station	Threat	Station	Below	0	0		Bomb threat forces evacuation of Moskovsky Station	Jenkins
60	28-Jul-98	Bosnia	Sarajevo	Bomb explodes on Sarajevo trolley	Bomb	Train	Above	0	0		Bomb explodes on trolley	Jenkins
61	27-Jul-98	Germany		Bomb threats disrupt Deutsche Bahn service	Threat	Station		0	0		Bomb threats force evacuation of several stations	Jenkins
62	25-Jun-98	India		Train derailed in Kashmir	Bomb	Line	Above	23	0	Kashmiri Extremists	Bomb explodes on rail line causing passenger train to derail	Jenkins
63	24-Jun-98	India		Assam separatists detonate bomb in railway station	Bomb	Station		80	9	ULFA (Liberation Front of Assam)		Jenkins
64	1-May-98	Japan		Unidentified saboteurs strike high-speed bullet train tracks	Sabotage	Line	Above	0	0	Kakumaruha	Saboteurs removed bolts from high-speed rail track, but it was discovered before train passed	Jenkins
65	19-Mar-98	Russia	Moscow	Poison gas attack threatened	Threat		Below	0	0	Aum Shinrikyo	Man threatened to release gas on Moscow metro	Jenkins
66	10-Mar-98	Pakistan	Lahore	Bomb on commuter train kills eight	Bomb	Train	Above	34	8		Bomb explodes on a commuter train	Jenkins
67	8-Mar-98	Pakistan	Punjab	Bomb in Punjab kills seven	Bomb	Train	Above	35	7		Bomb explodes on express train	Jenkins
68	3-Mar-98	Germany		Antinuclear activists sabotage railway cables	Sabotage	Infra-structure	Above	0	0	antinuclear activists	Power lines downed serving the track	Jenkins
69	23-Feb-98	Algeria	Algiers	Bomb kills 18 on commuter train	Bomb	Train	Above	25	18		Bomb exploded on a commuter train	Jenkins
70	15-Jan-98	Belgium	Antwerp	Bomb injures five near central train station	Bomb	Station		5	0		Bomb explodes at a café near the central train station	Jenkins
71	12-Jan-98	Russia	Moscow	Gunmen open fire on tram	Gun	Train	Above	3	1		Man opened fire on a crowded tram	Jenkins
72	1-Jan-98	Russia	Moscow	Bomb injures three in subway station	Bomb	Station	Below	3	0		Bomb explodes in Tretyakovskaya Metro Station	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
73	30-Dec-97	Turkey		Bomb on commuter train injures six	Bomb	Station		6	0		Bomb explodes under a seat in Bakirkoy Station	Jenkins
74	6-Dec-97	India	Tamil Nadu	Three bombs on trains kill 11	Bomb	Train	Above	54	11	Islamic Defense Force	Three bombs explode on separate passenger trains	Jenkins
75	14-Nov-97	Tajkistan	Dushanbe	Bomb destroys railroad tracks on bridge	Bomb	Bridge	Above	0	0		Bomb explodes on bridge	Jenkins
76	1-Oct-97	India		Three bombs on train	Bomb	Train	Above	2	30	Kashmiri Extremists	Three bombs explode on New Delhi to Amristar train	Jenkins
77	28-Sep-97	Georgia	Zugdidi	Bomb explodes on passenger train	Bomb	Train		1	0		Bomb explodes on train	Jenkins
78	20-Sep-97	Germany		Antinuclear protestors sabotage railway	Fire	Line	Above	0	0	antinuclear activists	Demonstrators set fire to railway	Jenkins
79	9-Sep-97	Venezuela	Caracas	Explosive device in Caracas subway station	Bomb	Station	Below	0	0		Small bomb found in subway and deactivated	Jenkins
80	9-Sep-97	Russia	Moscow	Bomb threat on Moscow Metro	Threat	Station	Below	0	0		Inactive grenade found in Komsomolskaya Metro after a bomb threat	Jenkins
81	7-Sep-97	India	Jammu-Kashmir	Passenger train damaged by bomb	Bomb	Line	Above	5	0	Kashmiri Extremists	Remote control bomb explodes on track as passenger train passes	Jenkins
82	21-Aug-97	Czech Republic	Prague	Bomb threat to Prague metro	Threat		Below	0	0		Bomb threat halted service for hours on metro line	Jenkins
83	4-Aug-97	India	Bangalore	Bomb explodes in passenger train	Bomb	Train	Above	15	0		Explosion on train	Jenkins
84	4-Aug-97	India	New Delhi	Train sabotage injures ten	Sabotage	Train	Above	10	0		Train derailed	Jenkins
85	8-Jul-97	India	Punjab	Bomb on train kills 36	Bomb	Train	Above	70	36	Sikh separatists	Bomb planted under the floor of a passenger train	Jenkins
86	1-Jul-97	Hungary	Kelei	Firebomb thrown at railway station in Budapest	Fire	Station		0	0		Firebomb thrown at station, setting fire to a shop	Jenkins
87	26-Jun-97	Algeria	al-Harrach	Bomb explodes on a train	Bomb	Train	Above	40	0		Bomb in coach explodes	Jenkins
88	11-Jun-97	India	Raya Morh	Bomb explodes on train track in Jammu-Kashmir	Bomb	Line	Above	0	0		Bomb on tracks damages cargo train	Jenkins
89	4-Jun-97	India	Hyderabad	Naxalites damage railway in Andrah Pradesh	Sabotage	Line		0	0	Naxalites	Sabotage of train and station	Jenkins
90	21-May-97	Thailand	Narathiwat	Bomb destroys train track in Narathiwat province	Bomb	Bridge	Above	0	0		Bomb destroys part of track on bridge	Jenkins
91	21-Apr-97	United Kingdom	London	Bomb threats strand commuters	Threat	Station	Below	0	0	IRA	Bomb threats at several stations cause evacuations.	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
92	18-Apr-97	United Kingdom	Leeds	Two explosions and bomb threats cause rush hour havoc	Bomb	Station		0	0	IRA	Bombs at Leeds and Doncaster stations	Jenkins
93	8-Apr-97	Spain	Alsasua	Disturbances in Basque region, attack on train	Bomb	Train	Above	0	0	Basque Separatist Movement (ETA)	Firebombs thrown at passing train	Jenkins
94	25-Mar-97	Turkey	Istanbul	Twelve-pound bomb rendered safe in subway	Bomb	Station	Below	0	0		Bomb found and rendered safe in Aksaray Station	Jenkins
95	14-Mar-97	India	Jalandhar	Bomb in Punjab injures at least six	Bomb	Train		10	7		Bomb explodes in train after it left New Delhi station	Jenkins
96	25-Feb-97	Germany		Saboteurs attack train lines	Sabotage	Line	Above	0	0	antinuclear activists	Power lines downed serving the track	Jenkins
97	14-Feb-97	Germany		Rails sabotaged	Sabotage	Line	Above	0	0	antinuclear activists	Power lines downed serving the track	Jenkins
98	21-Jan-97	Turkey	Istanbul	Bomb in Istanbul rendered safe	Bomb	Station		0	0		Bomb found by a bank cash machine in Sirkeci Station	Jenkins
99	17-Jan-97	Russia	Moscow	Bomb threat in two train stations	Threat	Station		0	0		Threats closed Kazansky and Kursky stations	Jenkins
100	17-Jan-97	Germany		Pylon damages train in extortion attempt	Sabotage	Infra-structure	Above	0	0		A pylon was sabotaged and fell onto an empty train	Jenkins
101	16-Jan-97	Russia	Dagestan	Chechen rebels attack train		Train	Above		1	Chechens	Rebels attacked a passenger train	Jenkins
102	2-Jan-97	India	Goreswar	Bomb on railroad bridge in Assam state	Bomb	Bridge	Above	0	0	Bodo militants	Bomb destroys bridge	Jenkins
103	31-Dec-96	India	Assam	Bomb on passenger train kills at least 50 people; bombed bridge may be linked	Bomb	Train	Above		160	Bodo militants	Bomb explodes on train	Jenkins
104	23-Dec-96	France	Marseilles	Bomb rendered safe in Marseilles	Bomb	Station		0	0		Bomb left in a plastic bag in front of a post office near St. Charles train station	Jenkins
105	5-Dec-96	India	Jammu-Kashmir	Bombs rendered safe along train track in Jammu-Kashmir	Bomb	Line	Above	0	0		Bomb disabled on track	Jenkins
106	4-Dec-96	France	Paris	Bomb at Paris RER station kills two people, injures 83	Bomb	Station	Below	83	2	GIA (Armed Islamic Group)	A propane canister packed with projectiles exploded in a rail car as it pulled into Port Royal RER station.	Jenkins
107	2-Dec-96	India	Jammu-Kashmir	Twelve killed, 37 injured on train blast in Punjab	Bomb	Train	Above	37	12		Bomb explodes in sleeper car	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
108	19-Nov-96	Japan	Tokyo	Gas attack on Tokyo train	Chemical	Train		0	0		Teenagers sprayed an unknown gas on a commuter line, causing irritation to and suspending service.	Jenkins
109	4-Nov-96	Pakistan	Punjab	Explosion on passenger train kills five people	Bomb	Train	Above	20	5		Bomb in toilet compartment exploded	Jenkins
110	31-Oct-96	Australia	Sydney	Bomb in toilet of Sydney subway station	Bomb	Station	Below	0	0		Bomb explodes in the men's toilet of St. James Cityrail subway station. Officials closed all toilets	Jenkins
111	28-Oct-96	Algeria	Baba Ali	Train bombing kills eight and injures at least 30	Bomb	Line	Above	30	8	GIA (Armed Islamic Group)	Bomb under tracks explodes as passenger train passed	Jenkins
112	24-Oct-96	Germany		Railways sabotaged	Sabotage	Infra-structure	Above	1	0	antinuclear activists	Power lines downed serving the track	Jenkins
113	14-Oct-96	Hong Kong		Anonymous threat of gas attack on Hong Kong subway	Threat		Below	0	0	Aum Shinrikyo	Threat to gas subway network	Jenkins
114	30-Sep-96	United Kingdom		IRA had planned Chunnel blackout	Threat	Infra-structure	Below	0	0	IRA	Plan foiled to blow up electricity to the Channel Tunnel	Jenkins
115	14-Aug-96	South Africa		Bombing at Pretoria's Properitas railway station	Bomb	Station		0	0		Bombing at Pretoria's Properitas railway station	Jenkins
116	13-Aug-96	Russia	Trubnaa	Bomb on Volgograd-Astrakhan train	Bomb	Train		9	0		Bomb explodes in train stopped at Trubnaya Station	Jenkins
117	12-Aug-96	Algeria	Naciria	Train derailed by Muslim militants	Bomb	Line	Above	0	0	GIA (Armed Islamic Group)	Bomb on track causes derailment	Jenkins
118	6-Aug-96	Russia	Astrakhan	Bomb found on train	Bomb	Train		0	0		Two bombs were found on trains	Jenkins
119	25-Jul-96	Sri Lanka	Colombo	At least 70 killed, 200 injured in train blast	Bomb	Train	Above	200	70	Tamil Exiles	Bombs explode in two separate train compartments	Jenkins
120	21-Jun-96	Ethiopia	Dire Dawa	Train bomb kills one, injures five	Bomb	Train	Above	5	1		Bomb explodes on train	Jenkins
121	12-Jun-96	Russia	Moscow	Subway bomb blast kills four, injures 12	Bomb	Train	Below	12	4		Bomb attached to the bottom of a seat explodes in a subway car near Tulskaya Station	Jenkins
122	23-May-96	Myanmar	Yangon	Nine killed in train attack	Bomb	Train	Above	7	9	KNU (Karen National Union)	Bomb explodes under train	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
123	30-Apr-96	Germany		High-speed train link closed after bomb threat	Threat	Line	Above	0	0	antinuclear activists	A fake bomb was found after a bomb threat	Jenkins
124	15-Apr-96	Greece	Salonika	Bomb explodes in empty train car	Bomb	Train	Above	0	0		Bomb on empty train	Jenkins
125	28-Mar-96	South Africa	Umlazi	Three killed, five wounded when gunmen fire on train	Gun	Train	Above	5	3		Gunmen open fire on train	Jenkins
126	13-Mar-96	Algeria	Oran	GIA train bombing kills 12	Bomb	Line	Above	20	12	GIA (Armed Islamic Group)	Bomb explodes on tracks under a train	Jenkins
127	22-Feb-96	Greece	Thessoloniki	Bomb destroys train	Bomb	Station	Above	0	0		Bomb explodes in a train at the rail station	Jenkins
128	12-Feb-96	United Kingdom	Docklands	IRA bomb blast kills two, injures 100 in London	Bomb	Bridge	Above	100	2	IRA	Bomb explodes under a bridge	Jenkins
129	26-Jan-96	Egypt	Asyut	One person wounded in train attack	Gun	Train	Above	1	0	al-Gamya al-Islamiya	Gunmen open fire on train	Jenkins
130	30-Nov-95	Egypt		Another attack on tourist train	Gun	Train	Above	0	0	al-Gamya al-Islamiya	Gunmen open fire on train	Jenkins
131	27-Nov-95	United States	New York City	Subway token booth set on fire, clerk seriously injured	Fire	Station	Below	1	0		Attackers sprayed flammable liquid in token booth and ignited	Jenkins
132	18-Nov-95	Egypt		al-Gama'a members fire on tourist train	Gun	Train	Above	1	1	al-Gamya al-Islamiya	Gunmen open fire on train	Jenkins
133	9-Nov-95	Egypt	Farshut	Islamic extremists fire on train	Gun	Train	Above	2	0	al-Gamya al-Islamiya	Gunmen open fire on train	Jenkins
134	17-Oct-95	France	Paris	GIA bomb blast in central Paris, 24 hurt	Bomb	Line	Below	24	0	GIA (Armed Islamic Group)	Bomb explodes on subway line in the tunnel between Musée d'Orsay and St. Michel stations	Jenkins
135	10-Oct-95	United States	Arizona	Terrorist sabotage possible in Amtrak derailment	Sabotage	Line	Above	65	1	Sons of the Gestapo	Tracks were sabotaged, causing a derailment of the Amtrak line	Jenkins
136	9-Oct-95	France	Paris	Two GIA bomb attacks over the weekend	Bomb	Station	Above	13	0	GIA (Armed Islamic Group)	Bomb found and detonated outside of the Maison Blanche metro station	Jenkins
137	28-Sep-95	Algeria	Algiers	Railway bomb kill five, injures 11	Bomb	Train	Above	11	5		Bomb explodes under a locomotive	Jenkins

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138	26-Aug-95	France	Lyon	Unexploded bomb found on train	Bomb	Train				GIA (Armed Islamic Group)	Bomb found on railway line	Jenkins
139	18-Aug-95	France	Paris	Bombing near Arc de Triomphe injures 17	Bomb	Station	Above	17	0	GIA (Armed Islamic Group)	Bomb explodes in trash can outside the Charles de Gaulle Metro station	Jenkins
140	14-Aug-95	Switzerland	Bern	Arsonists hit French TGV train	Fire	Train	Above	0	0		Arsonists firebomb and empty train	Jenkins
141	27-Jul-95	France	Paris	Bombing on Paris commuter rail line kills 8	Bomb	Train	Below	80	8	GIA (Armed Islamic Group)	A propane canister packed with projectiles exploded in a rail car as it pulled into St. Michel Station.	Jenkins
142	12-Jul-95	South Africa		Two killed in train station explosion	Bomb	Station	Above		2		A mine explodes in a train station	Jenkins
143	5-Jul-95	Japan	Tokyo	Cyanide devices found in subway	Chemical	Station	Below	0	0	Aum Shinrikyo	Two chemical release devices were found in the subway system, one in the Kayabacho Station women's toilet and one in the men's toilet of Shinjuku Station. Devices designed to release cyanide gas.	Jenkins
144	27-Jun-95	Cambodia		Khmer Rouge blow up northwest rail link	Bomb	Line	Above	0	0	Khmer Rouge	Guerrillas destroyed rail link	Jenkins
145	7-Jun-95	Chile	Santiago	Groups threaten sarin attack	Threat		Below	0	0		Threats of sarin release in the subway system of Santiago	Jenkins
146	5-May-95	Japan	Tokyo	Another attempted poison gas attack on subway	Chemical	Station	Below	0	0	Aum Shinrikyo	Chemicals to make hydrogen cyanide were left in the men's toilet of Shinjuku Station. It was found before the chemicals could mix and spread through the ventilation system	Jenkins
147	19-Apr-95	Japan	Yokohama	Mystery gas detected in Yokohama	Chemical	Station	Below	200	0		Strange gas found in Yokohama Station, causing eye and throat irritation	Jenkins
148	18-Apr-95	Sweden	Stockholm	Bomb found on Stockholm subway	Bomb	Station	Below	0	0		Crude bomb found in Hotorget subway station	Jenkins
149	20-Mar-95	Japan	Tokyo	Sarin nerve gas in Tokyo subway	Chemical	Train	Below	5000	12	Aum Shinrikyo	Five subway lines were contaminated by sarin gas. Gas spread throughout system as trains continued to run after the incident was detected.	Jenkins
150	27-Feb-95	India	Assam	Bomb on train kills 27	Bomb	Train	Above	30	27	National Socialist Council of Nagaland	Two bombs exploded in a passenger train	Jenkins
151	12-Jan-95	Egypt		Gunmen open fire on train	Gun	Train	Above	6	0	al-Gamya al-Islamiya	Gunmen fire on train	Jenkins

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152	21-Dec-94	United States	New York City	Bomb explodes on subway	Bomb	Train	Below	48	0		Bomb explodes in subway car	Jenkins
153	15-Dec-94	United States	New York City	Bomb explodes on subway	Bomb	Train	Below	2	0		Bomb explodes in subway car	Jenkins
154	8-Nov-94	Lithuania		Explosion demolishes bridge	Bomb	Bridge	Above	0	0		Bridge bombed	Jenkins
155	31-Oct-94	Cambodia	Battambang	Six die, 15 hurt in bomb attack on train	Bomb	Train	Above	15	6	Khmer Rouge	Bomb hidden in a vegetable basket explodes on a train	Jenkins
156	10-Oct-94	Cambodia	Battambang	Khmer Rouge sabotage key railway line	Sabotage	Bridge	Above	0	0	Khmer Rouge	Guerrillas bomb bridges	Jenkins
157	28-Sep-94	Egypt	Malawi	Gunmen attack tourist train	Gun	Train	Above	2	0	al-Gamya al-Islamiya	Gunmen fire on train	Jenkins
158	13-Sep-94	Ireland	Dublin	UVF bombs Belfast-Dublin train	Bomb	Train		2	0	UVF (Ulster Volunteer Force)	Small bomb explodes under seat as train arrives in Dublin	Jenkins
159	6-Sep-94	India	Allahabad	Bombs found on express train in Uttar Pradesh	Bomb	Train	Above	0	0		Five unexploded bombs found in the bathrooms of a train	Jenkins
160	28-Jul-94	Cambodia	Kampong Trach	One hundred held after Khmer Rouge ambush train	Hijack	Train	Above		9	Khmer Rouge	Guerrillas attack train and take passengers hostage	Jenkins
161	26-Jul-94	Israel	Tel Aviv	Bomb found on train	Bomb	Train	Above	0	0		Bomb found on train	Jenkins
162	6-Jun-94	United Kingdom	Kent	Bomb discovered at a railway station	Bomb	Station		0	0	IRA	Bomb safely detonated in Kent Station	Jenkins
163	6-Jun-94	India	Rajnandgaon	Bomb on train kills two	Bomb	Train	Above	25	2	Naxalites	Bomb explodes on train as it leaves Rajnandgaon Station	Jenkins
164	23-May-94	Egypt	Manfalout	Gunmen fire on tourist train	Gun	Train	Above	1	0	al-Gamya al-Islamiya	Gunmen fire on train	Jenkins
165	3-May-94	Venezuela	Caracas	Bomb on Caracas Metro wounds five	Bomb	Station	Below	5	0	Urban Commando Union of the Popular Resistance Front	Leaflet scattering bomb explodes in metro train as it stopped at Parque del Este Station	Jenkins

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166	25-Apr-94	Thailand	Nakhon Sri Thammarat	Bomb kills three at southern railway station	Bomb	Station		22	3		Grenade explodes at a station restaurant after a man left a parcel	Jenkins
167	18-Apr-94	Egypt	Abu Tig	Gunmen fire on train near Asyut	Gun	Train	Above	0	0	al-Gamya al-Islamiya	Gunmen fire on train	Jenkins
168	14-Apr-94	Russia	Dagestan	Train blast kills four in south	Bomb	Station	Above		4		Bomb explodes in train at Dagestanskiye Ogni Station	Jenkins
169	30-Mar-94	Thailand	Sungai Kolo	Train derails after explosion	Bomb	Line	Above				Bomb explodes under track causing derailment	Jenkins
170	21-Mar-94	Algeria	Boumerdes	Gunmen hold up train in tunnel	Hijack	Train	Below	0	0		Train hijacked in a tunnel and set on fire	Jenkins
171	19-Mar-94	Azerbaijan		Subway bombed	Bomb	Train	Below				Bomb exploded under the seat of the first car in a subway train	Jenkins
172	15-Mar-94	United Kingdom	Kent	IRA bomb found near rail line	Bomb	Line	Above	0	0	IRA	Bomb found near rail line	Jenkins
173	8-Mar-94	Thailand	Hat Yai	Bomb damages train in south	Bomb	Train	Above	0	0		Bomb explodes on tracks under a train	Jenkins
174	7-Mar-94	Egypt	Sanabu	Trains attacked in Upper Egypt	Gun	Train	Above	12	0	al-Gamya al-Islamiya	Train fired upon	Jenkins
175	24-Feb-94	Egypt	Asyut	Bomb on train wounds six tourists and five Egyptians	Bomb	Train	Above	11	0	al-Gamya al-Islamiya	Bomb in luggage rack explodes as train left station	Jenkins
176	23-Feb-94	Cambodia	Pursat	Khmer Rouge attacks train		Train	Above	8	3	Khmer Rouge	Guerrillas attack train	Jenkins
177	22-Feb-94	Egypt	Asyut	Militants attack luxury train	Gun	Train	Above	4	0	al-Gamya al-Islamiya	Gunmen fire on train	Jenkins
178	14-Feb-94	Turkey	Istanbul	Bomb in Istanbul train station	Bomb	Station	Above	26	5	PKK (Kurdish Workers Party)	A bomb exploded in a trash can in a suburban train station	Jenkins
179	24-Jan-94	India	Hardwar	Six injured in Uttar Pradesh train blasts	Bomb	Train	Above	6	0		Bomb explodes on express train	Jenkins
180	20-Dec-93	Italy	Florence	Small bomb explodes on railway	Bomb	Station		1	0		Bomb explodes at station	Jenkins

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181	14-Dec-93	United Kingdom	Woking	Blast disrupts rail traffic	Bomb	Line	Above	0	0	IRA	Bomb explodes on tracks	Jenkins
182	6-Dec-93	India	Hyderabad	Train blast kills one, injures 22	Bomb	Train		22	1		Bomb explodes on express train	Jenkins
183	29-Oct-93	India	Bombay	Fifteen injured in Bombay train blast	Bomb	Station		15	0		Bomb explodes on train when it arrived to Matunga Station	Jenkins
184	13-Oct-93	Thailand	Khok Pho	Homemade bomb on railway track	Bomb	Line	Above	0	0	PULO (Patani United Liberation Organization)	Bomb found under railroad tracks	Jenkins
185	8-Oct-93	Germany	Saarbruecken	Bombing at train station	Bomb	Station		1	0	RZ (Revolutionary Cells)	Bombing at main train station	Jenkins
186	2-Oct-93	United Kingdom	London	Three bombs explode in North London	Bomb	Station	Above	0	0	IRA	Bomb explodes opposite a railway station	Jenkins
187	21-Sep-93	Italy	Rome	Explosives found aboard Palermo-Turin overnight train	Bomb	Train		0	0		Bomb found in lavatory of train at Ostiense Station	Jenkins
188	30-Aug-93	Egypt	Ismailiya	Three time bombs defused in Ismailiya	Bomb	Infra-structure	Above	0	0		Bombs defused on footbridge serving train stations	Jenkins
189	24-Aug-93	Thailand		Muslim separatists attack train	Rocket/ Gun	Train	Above	7	2	PULO (Patani United Liberation Organization)	Militants attack train	Jenkins
190	16-Aug-93	Cambodia		Two killed in Khmer Rouge train ambush	Rocket/ Gun	Train	Above	5	2	Khmer Rouge	Guerrillas ambush train	Jenkins
191	4-Aug-93	Cambodia	Kampot	Railway line ambushed	Gun/ Bomb	Train	Above	30	10	Khmer Rouge	Mines stopped train and attackers fired upon train	Jenkins
192	15-Jul-93	United Kingdom	Belfast	Bombing at Central Station in Belfast	Bomb	Station	Above	0	0	IRA	Bomb explodes in front of Central Belfast Station	Jenkins
193	14-Jul-93	Russia	Vladikavkaz	Explosion derails Caucasus train	Bomb	Line	Above	0	0	Ossetian Separatists	Bomb explodes on rail line causing freight train derailment	Jenkins
194	1-Jul-93	Angola	Huila	At least 19 die in railway attack	Bomb	Train	Above	2	19	UNITA (National Union for Total Independence of Angola)	Mine on tracks hits passenger train	Jenkins

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195	7-Jun-93	India	Bombay	Two blasts in Bombay, security concerns	Bomb	Train	Above	0	0		Bomb explodes in empty car at station	Jenkins
196	27-May-93	Angola	Huila	Rebels attack train, 100 dead		Train	Above	100	100	UNITA (National Union for Total Independence of Angola)	Rebels attacked a passenger train	Jenkins
197	25-May-93	Egypt	Cairo	Bomb found in subway	Bomb	Station	Below	0	0	al-Gamya al-Islamiya	Bomb found on the tracks at al-Marj subway station and deactivated	Jenkins
198	24-May-93	Egypt	Cairo	Bomb near Cairo train station	Bomb	Station	Above	20	7	al-Gamya al-Islamiya	Car bomb explodes outside of Masr train station	Jenkins
199	12-May-93	Philippines	Manila	Rail bombings in metro Manila	Bomb	Station	Above	23		Abu Sayyaf	Bombs explode on commuter trains and in the train terminal in Pasay City	Jenkins
200	6-May-93	Cambodia		Khmer Rouge attack train	Gun/ Bomb	Train	Above	80	13	Khmer Rouge	Guerrillas bombed a train and opened fire on the occupants	Jenkins
201	26-Mar-93	Mexico	Guadalajara	Blast at Guadalajara station	Bomb	Station		1			A guard was injured when he picked up a package in the station	Jenkins
202	22-Mar-93	India	Calcutta	Railway terminus blast in Calcutta	Bomb	Station		12	1		A man was carrying a suitcase that detonated as he got off of the train	Jenkins
203	16-Mar-93	Egypt	Abu Tig	Bombs found on train	Bomb	Train	Above	0	0		A suitcase full of explosives found on train	Jenkins
204	12-Mar-93	India	Bombay	Bomb blasts in Victoria railway station	Bomb	Station					Series of bombs explode throughout Bombay	Jenkins
205	1-Mar-93	Russia	Gudermes	Baku-bound train bombing kills 13	Bomb	Train	Above	12	13		Bomb explodes in passenger train	Jenkins
206	11-Feb-93	Myanmar	Ye	Rebels blow up train, nine dead	Bomb	Train	Above	18	9	New Mon State Party	Cargo train bombed	Jenkins
207	4-Feb-93	United Kingdom	London	Bomb explodes on train	Bomb	Station	Below	0	0	PIRA	Bomb in Kensington Tube station explodes after evacuation	Jenkins
208	3-Feb-93	United Kingdom		IRA bombs London to Kent train	Bomb	Train	Above	0	0	IRA	Train evacuated before a bomb exploded	Jenkins

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209	23-Dec-92	United Kingdom	London	IRA bombs Hampstead tube	Bomb	Station	Below	0	0	IRA	Bomb explodes at Hampstead Station	Jenkins
210	18-Dec-92	India	Borivli	Four injured in Bombay train blast	Bomb	Train		4			Bomb explodes in train	Jenkins
211	9-Dec-92	United Kingdom	London	PIRA bomb subway station	Bomb	Station				PIRA	Bomb detonated near Woodside Park subway station	Jenkins
212	1-Dec-92	Brazil	Rio de Janeiro	Bomb in Rio's train station	Bomb	Station		2	0		Bomb carried into the central railway station in a bag and detonated	Jenkins
213	26-Oct-92	Turkey	Tatvan-Elazig	Passenger train hits PKK mine, plunges into river	Bomb	Train	Above	3	47	PKK (Kurdish Workers Party)	Train hit a mine, derailing it into a river	Jenkins
214	22-Oct-92	United States	Chicago	Hand grenade discovered at a rail platform	Bomb	Station		0	0		Grenade found at a station	Jenkins
215	22-Oct-92	United Kingdom	London	IRA bombs London rail lines	Bomb	Line	Above	3	0	IRA	Bombing of track as passenger train passed	Jenkins
216	21-Oct-92	United Kingdom	London	PIRA bomb railway	Bomb	Line	Above	0	0	PIRA	Bombing on tracks	Jenkins
217	20-Oct-92	United Kingdom	Belfast	IRA bombs train line in Belfast	Bomb	Line	Above	0	0	IRA	Bombing on tracks	Jenkins
218	14-Oct-92	India	Assam	Train bombing in Assam kills 25	Bomb	Train	Above	50	25	BSF (Bodo Security Force)	Two bombs exploded in separate compartments of a passenger train	Jenkins
219	6-Oct-92	Egypt		Bomb explodes on train in Dayrut	Bomb	Train		10	3	al-Gamya al-Islamiya	Bomb explodes in train	Jenkins
220	2-Oct-92	Turkey	Istanbul	Bomb at Istanbul's train station	Bomb	Station		0	0		Bomb explodes in empty car at station	Jenkins
221	1-Sep-92	Turkey	Mus	PKK derails passenger train		Train	Above	4	0	PKK (Kurdish Workers Party)	Train derailed	Jenkins
222	28-Aug-92	United Kingdom	Belfast	IRA bomb hits Belfast train	Bomb	Station	Above	0	0	IRA	Bomb left in car as station was evacuated	Jenkins
223	28-Aug-92	United Kingdom	London	IRA bomb threat halts London trains	Threat			0	0	IRA	Bomb threat causes evacuation	Jenkins

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224	19-Aug-92	Pakistan	Karachi	Trains searched for bombs	Threat	Train	Above	0	0		Bomb threat forces evacuation	Jenkins
225	19-Aug-92	South Africa	Soweto	Soweto train attack, one dead	Gun	Train	Above	5	1		Gunman opened fire in train	Jenkins
226	28-Jul-92	Argentina	Villa Gobernador Galvez	Bomb defused on Mitre rail line	Bomb	Line	Above	0	0		Bomb defused on tracks	Jenkins
227	11-Jun-92	United Kingdom	London	London Tube hit by IRA bomb hoaxes	Threat		Below	0	0	IRA	Threats to Underground	Jenkins
228	21-May-92	Russia	St. Petersburg	Terrorists bomb railroad station	Bomb	Station	Above	12	1	Palestinian militants	Bomb placed in trash can near ticket office	Jenkins
229	8-May-92	United Kingdom	London	Victoria Station in London evacuated for bomb search	Threat	Station	Above	0	0	IRA	Victoria Station evacuated due to threat	Jenkins
230	29-Apr-92	Pakistan	Hyderabad	Ten die in Sind train attack	Rocket/ Gun	Train	Above	30	10		Rockets and small arms fire on passenger train	Jenkins
231	17-Apr-92	Malaysia	Sedenak	Rail lines sabotaged	Sabotage	Line	Above	0	0		Saboteurs damaged tracks	Jenkins
232	3-Apr-92	Kenya	Nairobi	Explosion at train station	Bomb	Station	Above	0	0		Bomb in unused toilet near main station	Jenkins
233	2-Apr-92	Peru	Puno	SL attacks train near Bolivia border		Train	Above	4	1	Shining Path	Terrorists attack train near Bolivia	Jenkins
234	1-Apr-92	Argentina	Buenos Aires	Bomb on train line	Bomb	Line	Above	0	0	Striking Rail workers	Bombing on tracks	Jenkins
235	26-Mar-92	Greece	Athens	Bombs hit train carrying BMW cars	Bomb	Train	Above	0	0	November 17	Bomb explodes in Ath Rendis train station, damaging shipments of BMW's	Jenkins
236	10-Mar-92	United Kingdom	London	Bombing near train station	Bomb	Line		0	0	IRA	Bomb exploded on the tracks near Wandsworth Common Station, disrupting rail service	Jenkins
237	2-Mar-92	United Kingdom	London	Three IRA bombs over weekend	Bomb	Station	Above	0	0	IRA	Bomb found on the tracks at White Hart Lane Station	Jenkins
238	1-Mar-92	United Kingdom		Bomb hoaxes delay peace trains	Threat	Train		0	0	IRA	Bomb threats on tracks	Jenkins

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239	28-Feb-92	United Kingdom	London	At least 25 wounded in London subway blast	Bomb	Station	Below	28	0	IRA	Bomb exploded in the toilet of the London Bridge subway station.	Jenkins
240	8-Feb-92	India	Narwana	Six die, 50 hurt in train blast	Bomb	Train	Above	6	50	Sikh separatists	Bomb on train	Jenkins
241	7-Feb-92	United Kingdom	London	Incendiary device on east London track	Fire	Line	Below	0	0	IRA	Incendiary device ignited on the subway tracks at Barking	Jenkins
242	30-Jan-92	United Kingdom	London	Unexploded firebomb	Fire	Train	Below	0	0	IRA	Firebomb found under seat of subway car	Jenkins
243	29-Jan-92	United Kingdom	Belfast	IRA bomb causes Belfast train chaos	Bomb	Station		0	0	IRA	Bombing on tracks near central station	Jenkins
244	18-Jan-92	India	Samana	Bomb derails train	Bomb	Station	Above	7		Sikh separatists	Bombing at Golwar railway station causes derailment	Jenkins
245	6-Jan-92	Italy	Leece	Time bomb aimed at mass casualty explodes	Bomb	Line	Above	0	0		Bombing on tracks just before passenger train arrived	Jenkins
246	28-Dec-91	United Kingdom	Belfast-Dublin	IRA bombs railroad to end ceasefire	Bomb	Line	Above	0	0	IRA	Bombing on tracks	Jenkins
247	23-Dec-91	United Kingdom	London	Incendiary devices discovered on commuter train	Fire	Train		0	0	PIRA	Incendiary devices found hidden on commuter train	Jenkins
248	16-Dec-91	United Kingdom	London	Bomb explodes at rail station	Bomb	Station	Above	0	0	PIRA	Bombing near Clapham Junction Station	Jenkins
249	11-Nov-91	India	Kalyan	Bomb blast on train near Bombay	Bomb	Train	Above	60	12		Bombing in train as it pulled into a station	Jenkins
250	5-Nov-91	South Africa	Johannesburg	Bomb damages railway line as strike continues	Bomb	Line	Above	0	0		Bombing on tracks	Jenkins
251	24-Oct-91	South Africa	Soweto	Train attack in Soweto	Gun	Train	Above	36	9		Gunmen attack commuter train	Jenkins
252	9-Sep-91	India		Goodwill Train attacked again		Train	Above	3	0	Sikh separatists	Train attacked	Jenkins
253	6-Sep-91	India		Goodwill Train Attacked		Train	Above		1	Sikh separatists	Train attacked	Jenkins

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254	29-Aug-91	United Kingdom	London	Three bombs found in subway car	Bomb	Train	Below	0	0	PIRA	Incendiary devices found under seats of subway train	Jenkins
255	17-Aug-91	Spain		Bomb explodes on Madrid-Irun railway track	Bomb	Line	Above	0	0	Basque Separatist Movement (ETA)	Bomb knocks over electric pylon causing it to fall across the tracks and collide with freight train	Jenkins
256	31-Jul-91	Soviet Union	Moscow-Baku	Passenger train bombed	Bomb	Train	Above	16	14		Bomb concealed in a briefcase and left in a reserved compartment exploded	Jenkins
257	29-May-91	Peru	Lima	Shining Path torches a railroad station	Fire	Station				Shining Path	Torched railroad station	Jenkins
258	1-Mar-91	Australia		Bomb threat on subway station	Threat	Station	Below	0	0		Threat of bombing on subway stations	Jenkins
259	25-Feb-91	United Kingdom	St. Albans	PIRA suspected in railway bombing	Bomb	Line	Above	0	0	PIRA	Bombing on tracks	Jenkins
260	18-Feb-91	United Kingdom	London	PIRA claim responsibility for explosions	Bomb	Station	Below	43	1	PIRA	Victoria and Paddington stations bombed, one on a scaffolding and the other in a trash can	Jenkins
261	9-Feb-91	Austria	Innsbruck	Stretch of track bombed	Bomb	Line	Above	0	0		Track bombed because it is used by U.S. military	Jenkins
262	3-Dec-90	France		Three incendiary devices went off along railway line	Fire	Line	Above					Jenkins
263	3-Nov-90	South Africa	Bloernfontein	Two explosions cause railway damage	Bomb	Line	Above	0	0		Bombing on tracks	Jenkins
264	20-Aug-90	Spain	Leon	Railroad tracks near Leon bombed	Bomb	Line	Above	0	0	Basque Separatist Movement (ETA)	Bombing on tracks	Jenkins
265	15-Aug-90	United Kingdom	Belfast-Dublin	Army defuse bomb	Bomb	Line	Above	0	0	IRA	Bomb defused on tracks	Jenkins
266	15-Aug-90	Spain		Two bomb explosions	Bomb					Basque Separatist Movement (ETA)	Bombs explode	Jenkins
267	6-May-90	Pakistan	Lahore	Bomb explodes on express train	Bomb	Train	Above	35	11	Afghan Agents	Express train bombed	Jenkins

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268	14-Sep-89	Spain		France-Spain railway bombed	Bomb	Line	Above	0	0	Basque Separatist Movement (ETA)	Bombing on tracks	Jenkins
269	20-Jul-89	India	Assam	Bombing kills eight people	Bomb	Station		22	8	Bodo militants	Bomb explodes in Kokrajhar Railroad station	Jenkins
270	30-Jun-89	France	Paris-Madrid	Bomb explodes on railway line	Bomb	Line	Above			Iparretarak	Bombing on tracks	Jenkins
271	26-Jun-89	China		Explosion on train kills 20 people	Bomb	Train	Above	11	20		Dynamite placed in wash basin of train	Jenkins
272	2-Jun-89	Thailand/ Malaysia	Narathiwat	Bomb explodes as train passes by	Bomb	Line	Above	3	0	Pulo Pattini	A remote control bomb derails train	Jenkins
273	26-Apr-89	Czechoslo-vakia		Bomb explodes on international express train	Bomb	Train	Above	0	0		Bombing on train	Jenkins
274	19-Apr-89	India	Jhansi	Train derails killing at least 67 people	Sabotage	Line	Above	137	67		Express train derailed	Jenkins
275	9-Apr-89	Spain	Cioridia	Bombs explode at railroad tracks in Navarre region	Bomb	Infra-structure	Above	0	0	Basque Separatist Movement (ETA)	Bombings target rail power lines	Jenkins
276	1-Dec-88	Peru	Cuzco-Machu Picchu	Guerrillas sabotage a VIP tourist train	Sabotage	Train	Above	9	2	Sendero Luminoso	Train sabotaged	Jenkins
277	14-Oct-88	Sri Lanka	Kadugannawa	Bomb destroys part of railway station	Bomb	Station	Above	0	0	Sinhalese People's Liberation Front	Bomb explodes in station	Jenkins
278	4-Sep-88	Pakistan	Karachi	Bomb explodes at train station	Bomb	Station	Above	5	0		Bomb explodes at Karachi train station	Jenkins
279	3-Sep-88	Pakistan	Islamabad-Peshawar	Bomb goes off on train	Bomb	Train	Above	13	3		Bomb explodes on train	Jenkins
280	19-Jul-88	Peru	Chosica-Lima	Bombing on railway track	Bomb	Line	Above	0	0		Bomb explodes on tracks	Jenkins
281	27-Apr-88	Germany		U.S. military train damaged by blast	Bomb	Train	Above	1	0	PFLP-GC	Bomb explodes on tracks as military train passed	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
282	11-Apr-88	Pakistan	Peshawar	Bomb explodes on train	Bomb	Train	Above	3	2		Bomb explodes on train	Jenkins
283	1988-1989	United Kingdom	Belfast-Dublin	More than 60 bombings disrupt rail service	Bomb	Line	Above			IRA	Between 1988 and 1989, more than 60 bombings on the Belfast-Dublin line	Jenkins
284	31-Dec-87	Mozambique		Attack on train kills 22 people		Train	Above	71	22		Train attacked by guerrillas	Jenkins
285	22-Dec-87	Pakistan		Bomb discovered on railroad track	Bomb	Line	Above	0	0		Bomb found on tracks and disarmed	Jenkins
286	27-Nov-87	United Kingdom	Belfast-Dublin	Bomb disrupts rail service	Bomb	Line	Above	0	0	IRA	Bomb explodes next to track as freight train passed	Jenkins
287	26-Sep-87	Brazil	Rio de Janeiro	Homemade bomb injures 11 people	Bomb	Station	Above	11	0		Bomb explodes at a station	Jenkins
288	1-Sep-87	Germany		Bomb goes off on railroad tracks	Bomb	Line	Above	0	0	PFLP-GC	Bomb explodes on tracks, damaging freight train	Jenkins
289	5-Jul-87	Pakistan	Lahore	Three bombings in Lahore	Bomb	Station		50	6		Bomb explodes in a trash can on a railroad platform and by a kiosk just outside of a station	Jenkins
290	15-Apr-87	India	New Delhi	Police defuse bomb	Bomb	Station		0	0	Sikh separatists	Bomb found in crowded station waiting room	Jenkins
291	15-Mar-87	India	Madras	Bombing under railway bridge	Bomb	Bridge	Above	150	25	Tamil Exiles	Bomb explodes on bridge as train passed over it	Jenkins
292	15-Feb-87	Germany		U.S. passenger train sabotaged	Sabotage	Infra-structure	Above	0	0		Overhead cables disabled	Jenkins
293	27-Oct-86	United Kingdom	Belfast-Dublin	Bombing derails freight train	Bomb	Line	Above	0	0	IRA	Bomb derails freight train	Jenkins
294	20-Oct-86	Pakistan	Peshawar	Explosion injures two people	Bomb	Station		2			Bomb on train explodes at station	Jenkins
295	30-Sep-86	Peru	Lima	Three bombings	Bomb	Line	Above	1	0		Bombing on tracks	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
296	4-Sep-86	France	Paris	Bomb planted on subway train	Bomb	Train	Below	0	0	CSPPA (The Committee of Solidarity with the Arab and Middle East Political Prisoners)	Bomb failed to explode on subway	Jenkins
297	15-May-86	Bangladesh	Bheramara	Train sabotaged; 25 people killed	Sabotage	Train	Above	45	25	Marxist Sarbahara	Express train derailed	Jenkins
298	21-Mar-86	France	Paris	Bomb defused in commuter train in Paris	Bomb	Train		0	0	CSPPA (The Committee of Solidarity with the Arab and Middle East Political Prisoners)	Bomb found and defused on a commuter line	Jenkins
299	18-Mar-86	France	Paris	High-speed train bombed	Bomb	Train	Above	10	0	Islamic Jihad	High-speed train bombed	Jenkins
300	1-Dec-85	Japan		Radical leftists cut communication cables	Sabotage	Infra-structure		0	0	Middle Core Faction	Cut communication lines, disrupting operations	Jenkins
301	25-Nov-85	India	Punjab	Bombing on train kills 2, injures 18	Bomb	Train	Above	18	2	Sikh separatists	Bomb on a train	Jenkins
302	13-Aug-85	Chile	Santiago	Two bombs explode	Bomb	Station		1	0		Bombs explode in Valparaiso and Valencia stations	Jenkins
303	2-Aug-85	Mozambique		Suspected train sabotage kills 58 people	Sabotage	Train	Above	160	58		Sabotage on train	Jenkins
304	3-Jun-85	Switzerland	Geneva	Explosion at Geneva railway station	Bomb	Station				Martyrs of Tel Al-Zaltar	Bombing of the Geneva Railway station	Jenkins
305	26-Mar-85	Canada	Toronto	Threats by ASALA to bomb city's subway system	Threat					ASALA (Armenian Secret Army for the Liberation of Armenia)	Threats to Toronto's subway system	Jenkins
306	25-Jan-85	South Africa / Mozambique	Maputo	Bomb severs rail bridge	Bomb	Bridge	Above	0	0		Bomb explodes on bridge	Jenkins
307	20-Jan-85	Sri Lanka	Mankulam-Murukandy	Guerrillas attack train, killing 36 people	Gun/ Bomb	Train	Above		36	Tarnil Separatists	Bomb explodes, stopping train, and terrorists began firing on train	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
308	24-Dec-84	Italy	Florence-Bologna	Train bombing kills at least 15 people	Bomb	Train	Below	80	15	Neo-fascist terrorist	Bomb explodes on a train in the Direttissima tunnel	Jenkins
309	1-Sep-84	Canada	Montreal	Bomb explodes in Montreal main railroad station	Bomb	Station		29	3		Bomb in Montreal main railroad station	Jenkins
310	19-Aug-84	France	Grenoble	M-5 group bombs Grenoble train station	Bomb	Station		0	0	M-5	Bomb in Grenoble station	Jenkins
311	13-Aug-84	France	Lyons	Bomb explodes in railway station in Lyons	Bomb	Station		0	0	ASALA (Armenian Secret Army for the Liberation of Armenia)	Bomb in locker of Central Railway Station in Lyons	Jenkins
312	26-Apr-84	India	Punjab	Bombs exploded along northern railway sections	Bomb	Line	Above			Sikh separatists	Bombings on railway line	Jenkins
313	15-Apr-84	India	Punjab	Multiple arson attacks	Fire	Station				Dashmesh Regiment	Group torched 37 stations in Punjab	Jenkins
314	15-Feb-84	France		Basques sabotage Paris-Madrid Express train	Sabotage	Line	Above	0	0	Basque Separatist Movement (ETA)	Line sabotaged, causing derailment	Jenkins
315	31-Dec-83	France	Marseilles	Bombs in Marseilles railroad station killed six people	Bomb	Station			6	Ilyich Ramirez Sanchez AKA Carlos	Bomb explodes in Marseilles Station and aboard a train, killing six and injuring scores more	Jenkins
316	14-Sep-83	India	New Delhi	Bomb thrown at crowded platform injures 19	Bomb	Station	Above	19	0	Sikh separatists	Bomb thrown onto a crowded platform of the main station	Jenkins
317	28-Jul-83	France	Lyons	ASALA threats against French government	Threat	Station		0	0	ASALA (Armenian Secret Army for the Liberation of Armenia)	Threat evacuates Perrache Station	Jenkins
318	11-Aug-82	United Kingdom	Armagh County, No. Ireland	Bombing at railroad	Bomb	Line	Above	0	0	IRA	Bomb explodes on freight line	Jenkins
319	29-Mar-82	France	Paris-Toulouse	Bomb exploded on train, killing five passengers	Bomb	Train	Above	27	5		Explosives on train	Jenkins
320	14-Feb-82	United Kingdom	Portadown	Bomb damages rail station	Bomb	Station	Above	0	0	IRA	Bomb damages Portadown Station	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
321	18-Nov-81	France	Paris	Bomb threat at Paris Gare du Nord	Threat	Station		0	0	Orly Organization	Bomb threat at Gare du Nord	Jenkins
322	16-Nov-81	France	Paris	Bomb in train station	Bomb	Station	Above	2	0	Orly Organization	Bomb in locker of Gare de l'Est terminal	Jenkins
323	5-Nov-81	France	Paris	Bomb explodes in train station	Bomb	Station	Below	1	0	Orly Organization	Bomb in locker in underground section of Gare de Lyon Station	Jenkins
324	16-Sep-81	Germany		Time bombs on rail line defused	Bomb	Line	Above	0	0	Red Army Faction	Bomb defused on tracks at U.S. Base	Jenkins
325	6-Aug-81	United Kingdom	Belfast-Dublin	Bombings at several locations	Bomb	Line	Above			IRA	Bombs on rail line	Jenkins
326	31-Jul-81	Pakistan	Karach-Lahore	Train derailed		Line	Above		30	Anti-Muslim group	Train carrying Muslims during Ramadan derailed	Jenkins
327	22-Jul-81	Switzerland	Geneva	Bombs in Geneva railway station	Bomb	Station	Above	4	0	Ninth of June Organization	Two bombs left in lockers explode in main Geneva rail station	Jenkins
328	18-Jul-81	India	Dangarva	Train sabotaged, 35 people killed	Sabotage	Train	Above		35		Derailment	Jenkins
329	29-Jun-81	South Africa	Natal	Bomb explodes on Richards Bay rail line	Bomb	Line	Above	0	0	ANC	Explosion on Richards Bay rail line, closing freight service	Jenkins
330	27-Jan-81	United Kingdom	Belfast-Dublin	Bombings on Belfast-Dublin rail line	Bomb	Line	Above	0	0	IRA	Explosion on rail line, closing service	Jenkins
331	21-Dec-80	United States	New York City	Pipe bombs in Pennsylvania Station, New York City	Bomb	Station		0	0	Puerto Rican Armed Resistance (RAP)	Pipe bombs in locker explode, no injuries	Jenkins
332	21-Oct-80	Switzerland	Paris-Interlaken	Attempted bombing of train	Bomb	Train	Above	0	0	October 3 Organization	Bomb placed on train and failed to explode	Jenkins
333	2-Aug-80	Italy	Bologna	Bologna train station bombed	Bomb	Station	Above	200	84		Station bombing	Jenkins
334	10-Jun-80	Cambodia	Battanbang-Phnom Panh	Train attack results in at least 150 deaths	Gun/ Bomb	Train	Above	250	150	Khmer Rouge	Stopped train with a bomb or missile and opened fire when train stopped	Jenkins
335	26-Apr-80	France	Paris-Moscow	Right-wing group attacks train	Fire	Train	Above			National Youth Front	Molotov cocktails thrown at Paris-Moscow express train	Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
336	2-Nov-79	Israel	Tel Aviv	Passenger train explosion	Bomb	Train	Above	0		Palestinian Military	Bomb explodes under train	Jenkins
337	2-Jul-79	France	St. Jean de Luz	Train attacked	Gun	Train	Above			Basque Separatist Movement (ETA)	Terrorists fire on train	Jenkins
338	4-Mar-79	Israel	Jerusalem-Tel Aviv	Rail service suspended	Bomb	Line	Above			Palestinian Military	Bomb explodes on a track, derailing a train	Jenkins
339	26-Dec-77	France	Paris	Bombs explode in Christmas attack	Bomb	Station	Above			Corsican National Liberation Front	Bomb explodes at Villepinte railway station	Jenkins
340	5-Dec-77	Yugoslavia		Bomb aboard train from West Germany	Bomb	Train	Above				Bomb found on West German railways train, intentionally detonated	Jenkins
341	4-Dec-77	Austria	Spiefeld	Bomb aboard train	Bomb	Train	Above				Bomb explodes in express train lavatory	Jenkins
342	23-May-77	Netherlands	Groningen	South Moluccan terrorists seize express train	Hijack	Train	Above		2	Free South Moluccan Youths	Fifty-six people taken hostage before police raided and killed two terrorists	Jenkins
343	9-Mar-77	Egypt	Al-Alamein	Police arrest five bombing suspects	Bomb	Line	Above			Libyan Intelligence Service		Jenkins
344	14-Aug-76	Egypt	Alexandria	Bomb on train kills eight passengers	Bomb	Train	Above	59	8	Libyan Intelligence Service	Time bomb	Jenkins
345	18-Mar-76	United Kingdom	London	Subway station bombing	Bomb	Station	Below	1		IRA	Wood Green Station	Jenkins
346	15-Mar-76	United Kingdom	London	Explosive on subway	Bomb	Train	Below	1	2	IRA	West Ham Station	Jenkins
347	4-Mar-76	United Kingdom	London	IRA bomb explodes on commuter train	Bomb	Train	Above			IRA	Minutes after Cannon Street Station	Jenkins
348	12-Feb-76	United Kingdom	London	IRA bomb defused	Bomb	Station	Below			IRA	Oxford Circus Station	Jenkins
349	2-Dec-75	Netherlands	Beilen	Armed extremists kill passengers and take hostage on train	Hijack	Train	Above	2	3	Free South Moluccan Youths		Jenkins

ID	Date	Country	City/Region	Event Summary	Device	Facility	Above/ Below Ground	Injuries	Fatalities	Responsible Party	Terrorist Event Description	Source
350	9-Oct-75	United Kingdom	London	Bomb explosion kills one person, injures 20	Bomb	Station	Above	20	1	IRA		Jenkins
351	4-Aug-74	Italy	Florence-Bologna	Train bombing kills 12 people, injures 48	Bomb	Train	Below	48	12	Right Wing Extremists		Jenkins
352	17-Apr-74	Austria	Vienna	Bomb threat on train bound for Rome	Threat	Train	Above			Justice Guerrillas		Jenkins
353	6-Apr-74	United Kingdom	Birmingham	Bombing in railway station, shops	Bomb	Station				IRA		Jenkins
354	8-Sep-73	United Kingdom	London	Bombing at Victoria Station	Bomb	Station		4		IRA		Jenkins
355	8-Sep-73	United Kingdom	London	Bombing at King's Cross and Euston stations	Bomb	Station		13		IRA		Jenkins
356	27-Jan-72	Austria	Vienna-Zagreb	Croatian terrorists bomb train	Bomb	Train	Above	6		Croatian		Jenkins

APPENDIX B: RESPONDENT TITLES

Administrative, Management, Director, Chief Positions	
Administrative Analyst	1
Administrative Officer	1
Administrator	1
Assistant Director	1
Assistant General Manager	2
Chief	2
Chief of Staff	1
Chief Operating Officer	1
Director	1
Executive Director	5
General Manager	7
Public Transportation Administrator	1
Public Transportation Director	1
Superintendent	1
Transit Administration Manager	1
Transit Director	2
Transit Service Manager	1
Transportation Coordinator	1
Transportation Director	1
	32

Operations/Maintenance	
Assistant General Manager, Operations	1
Deputy Chief of Operations	1
Director of Operations	3
Director of Operations & Maintenance	1
Director of Transit Operations	1
Maintenance Manager	1
Maintenance Superintendent	1
Manager of Operations	4
Manager of Operations Support	1
Operations & Grants Manager	1
	15

Other	
Chief Engineer	1
Consultant	1
Director of Customer & Community Services	1
Director, Service Development	1
Facilities & Procurement Director	1
Information Systems Manager	1
Manager of Special Projects	1
Manager, Central Communications	1
Project Manager, Technical	1
Senior Deputy General Counsel	1
Special Projects Coordinator	1
Transit Planner	1
Transportation & Parking Director	1
Transportation Planner	2
VP Legal Affairs	1
	16

Security, Safety, Risk, Emergency Preparedness	
AGM Public & Operation Safety	1
Chief of Police/Director of Security	1
Chief of Protective Services	1
Chief of Security	3
Chief Safety/Security Officer	1
Deputy Director of Safety	1
Director of Safety	1
Director of Safety & Training	1
Director of Safety & Security	1
Director of Security	1
Director of Transportation/Safety & Security	1
Director Risk Management & Security	1
Director, Security Programs	1
Emergency Preparedness Manager	1
Homeland Security Officer/Manager	2
Interim Risk Manager	1
Lieutenant-Commander Emergency Preparedness	1
Lieutenant	1
Manager of Safety & Instruction	1
Manager of Safety & Security	4
Manager of Security	2
Manager Protective Services	1
Manager Public Safety	4
Manager Safety & Training	2
Manager, Health, Safety & Environmental	1
Operations Safety & Security Coordinator	1
Police Officer	1
Risk Management Analyst	1
Risk Manager	3
Safety & Security Officer	1
Safety, Training & Security Coordinator	1
Security Coordinator	1
Security Superintendent	1
Senior Security Engineer	1
Supervisor of Risk Management	1
Transit Safety Supervisor	1
VP Safety	1
VP Safety & Security	1
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APPENDIX C: SUMMARY OF CPTED STRATEGIES FOR SYSTEM COMPONENTS

CPTED Strategies for Platforms

Most respondents mentioned lighting as the primary CPTED strategy for platforms. Good visibility (uninterrupted lines of sight) is considered essential, which includes keeping platforms clear of obstacles (some do not permit trash receptacles, pay phones, or newspaper boxes) and eliminating hidden corners and dead areas. Control over ingress and egress by limiting foot access paths is suggested. Security cameras were also mentioned by a number of respondents.

CPTED Strategies for Entrances and Exits

Cameras, lighting, electronic control, good visibility with clear sight lines (predominant use of glass and natural light around entrances), limited number of entrances and exits, proper alignment of walls and doors to minimize hiding places.

CPTED Strategies for Elevators

Cameras, emergency telephones, lighting, clear lines of sight, glass or clear material for shaft and cab.

CPTED Strategies for Escalators

Lighting, clear lines of sight, monitored by security personnel.

CPTED Strategies for Restrooms

Cameras, lighting, curved entrances with no exterior doors, clear sight paths to entrance and exit, located where staff can monitor entrances.

CPTED Strategies for Trash Cans

Containers can be see-through and/or bomb (explosive) resistant, and they are often relocated away from benches and loading areas, or eliminated completely in high-density areas.

CPTED Strategies for Pathways

Lighting, clear lines of sight, kept clear of debris and obstacles (vegetation), minimal landscaping, common access.

CPTED Strategies for Parking Lots

Cameras, lighting, fencing, limited (controlled) access points, security guards, clear lines of sight with visibility from street, low landscaping, emergency phones.

CPTED Strategies for Vehicles

Cameras, emergency (panic) alarms, public information signage, low platform buses with large windows, parked in secure spaces with clear lines of sight, vandal- and graffiti-proof interiors.

CPTED Strategies for Vending Machines

Machines are placed in form-fitting recessed alcoves to limit side and back access and to allow them to be gated if needed. They can be relocated away from restrooms and other areas of congregation, and monitored with cameras and alarms.

CPTED Strategies for Gates

Cameras, lighting, electronic access control (card readers), security personnel, good signage, configure location of gates to be able to close off sections of station.

APPENDIX D: SURVEY INSTRUMENT

TRANSIT SECURITY SURVEY

CODEBOOK

Survey Content by Camille Fink
Codebook/Coding by Norman Wong
UCLA Institute of Transportation Studies
www.its.ucla.edu/security

Transit Security Online Survey Instructions

You have been selected by your general manager as a key staff person knowledgable about security issues at your agency. We are asking for your help in conducting a comparative study of domestic and international transit security strategies.

This questionnaire will not take long for you to complete. It should take approximately 30 minutes to complete the questionnaire if your agency **does not** provide rail service and approximately 40 minutes if your agency **does** provide rail service.

You can log off and return to the questionnaire at any time using your username and password. Each page of the survey is saved when you click "**Next**." If you click "**Logoff**" all changes to that page will be lost so if you choose to logoff, we suggest that you do so immediately after clicking "**Next**". Also, please **DO NOT** press Return/Enter at anytime. Doing so will log you out of the survey.

When you have completed the entire questionnaire, you will have the following options:

1. You can save and check over your answers by clicking on "**Return to Start**."

2. You can save what you have entered so far and return later to complete and submit the survey by clicking on "**Save**."

3. Or you can finalize and submit the survey by clicking on "**Finalize Survey**." When you click on "Finalize Survey" your responses will be recorded and you will no longer be able to change your answers.

If you are not sure about an answer to a particular question, please select the "Don't know/Not sure" option to return to it at a later time or tell us who we should contact for more information at the end of the survey. All responses in this survey will be remain confidential unless you specify otherwise.

If you have any questions about this survey, please contact Camille Fink at UCLA at 310.903.3278 or its@spa.ucla.edu.

For questions regarding the website, please contact Norman Wong at 310.903.3278 or nwong@ucla.edu.

Please use the following definitions for terms used throughout this survey:

- ***Terrorism***: "The unlawful use of force or violence committed by a group(s) of two or more individuals, against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." (FBI)

- ***Multi-modal transfer facility***: A station, terminal, or facility with two or more public transit modes (transit modes typically include bus rapid transit, commuter rail, dial-a-ride, express bus, light-rail transit, local bus, and subway) where public transit passengers transfer from one transit vehicle to another during the course of their journey.

We begin this survey by asking you a series of general questions about the transportation modes your agency operates and features of your systems.

Q1. Which modes of transportation does your agency provide (either directly or by contract)? (Please check ALL that apply)

- ☐ (**a**) Commuter Rail
- ☐ (**b**) Heavy Rail
- ☐ (**c**) Light Rail
- ☐ (**d**) Bus
- ☐ (**e**) Ferry
- ☐ (**f**) Paratransit

Other:

Next

- **Q2.** Does your rail system have the following types of stations? (Please check ALL that apply)

  - (**a**) Elevated
  - (**b**) Below-ground/subway
  - (**c**) At grade
  - (**n**) Don't know/Not sure

- **Q3_1.** What is the name of the busiest station in your system (i.e., the station with the most boardings and alightings)?

  (**n**) Don't know/Not Sure

- **Q3_2.** What year was this station built?

  (**n**) Don't know/Not sure

- **Q3_3.** Does your bus service operate out of an enclosed bus terminal or multi-modal transfer facility?

  - (**a**) Yes
  - (**b**) No
  - (**n**) Don't know/Not sure

Now we would like to ask you about threat and vulnerability assessments at your agency. This series of questions will help us understand how and why different agencies assess threats and vulnerabilities in their systems.

- **Q4.** Has your agency ever conducted threat and vulnerability assessments of its key infrastructure (e.g., stations, tracks, vehicles, power stations, rights-of-way, bridges, tunnels, yards and shops, control centers, etc.)?

  - (**a**) Yes, comprehensive (covering all elements of the system)
  - (**b**) Yes, moderate (covering most elements of the system)
  - (**c**) Yes, partial (covering some elements of the system)

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- ☐ (**d**) No
- ☐ (**n**) Don't know/Not sure

- If you answered "No" in the previous question, why has your agency not conducted a threat and vulnerability assessment?

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- **Q5.** How often does your agency conduct threat and vulnerability assessments?

  (**a**) More than once a year
  (**b**) Once a year
  (**c**) Once every 2 years
  (**d**) Once every 3 years
  (**e**) Other (Please specify) Q5_Text
  (**n**) Don't know/Not sure

- **Q6.** What year was the most recent threat and vulnerability assessment conducted?

  Q6_Text (year) (**n**) Don't know/Not sure

- **Q7.** What was the purpose of this most recent threat and vulnerability assessment? (Please check ALL that apply)

  (**a**) To assess terrorism-related vulnerabilities
  (**b**) To assess natural disaster-related vulnerabilities (e.g. earthquake, flood, hurricane)
  (**c**) To assess crime-related vulnerabilities
  (**d**) Other (Please describe below)
  (**n**) Don't know/Not sure

  Other:

- **Q7_1.** How did your agency use the results of this threat and vulnerability assessment? (Please check ALL that apply)

  (**a**) To identify effective security technology and procedures
  (**b**) To support preparation of budgets

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- ☐ (**c**) To support decision-making at the executive level
- ☐ (**d**) To fulfill the requirements of the System Security Program Plan and/or the State Safety Oversight Program
- ☐ (**e**) To apply for Urban Area Security Intiative grants
- ☐ (**f**) To support FTA's security outreach and technical assistance program
- ☐ (**g**) Other (Please describe below)
- ☐ (**h**) We have not yet used this threat and vulnerability assessment
- ☐ (**n**) Don't know/Not sure

Other:

- **Q8.** Who conducted this threat and vulnerability assessment? (Please check ALL that apply)

- ☐ (**a**) In-house team
- ☐ (**b**) Sheriff's or police department
- ☐ (**c**) Contracted security consultants
- ☐ (**d**) Contracted other consultants (Please specify below)
- ☐ (**e**) Other: (Please explain below)
- ☐ (**n**) Don't know/Not sure

Other:

- Other than threat and vulnerability assessments, how does your agency seek to identify and assess security vulnerabilities in your transit system?

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This next section asks about general security strategies at your agency.

Start Finish

Logout

Transit security strategies can be grouped into four general categories:

- policing
- public education and user outreach
- security hardware and technology
- environmental design strategies

▪ How important were each of these strategies in your agency's security planning **before September 11th, 2001**?

	(**a**) Central to security planning	(**b**) Significant, but not central	(**c**) Part of security planning, but a minor part	(**d**) Not a part of security planning	(**n**) Don't know/Not Sure
Q10A. Policing	◯	◯	◯	◯	◯
Q10B. Public Education/User Outreach	◯	◯	◯	◯	◯
Q10C. Security Hardware/Technology	◯	◯	◯	◯	◯
Q10D. Environmental Design Strategies	◯	◯	◯	◯	◯

▪ Did the emphasis on each of these strategies change in your agency **after September 11th, 2001**?

	(**a**) Central to security planning	(**b**) Significant, but not central	(**c**) Part of security planning, but a minor part	(**d**) Not a part of security planning	(**n**) Don't know/Not Sure

Q11A. Policing	◻	◻	◻	◻	◻
Q11B. Public Education/User Outreach	◻	◻	◻	◻	◻
Q11C. Security Hardware/Technology	◻	◻	◻	◻	◻
Q11D. Environmental Design Strategies	◻	◻	◻	◻	◻

[Q11_1x appears for each Q10*a* not equal to Q11*a*]

- You indicated a change in your agency's emphasis to the following strategies before and after September 11th. Please indicate how they have changed:

  Policing

  Public Education/User Outreach

  Security Hardware/Technology

  Environmental Design Strategies

- **Q12.** In general, how does your agency tend to consider anti-terrorism and anti-crime strategies?

- (**a**) The strategies (anti-terrorism and anti-crime) are considered completely separate from one another
- (**b**) The strategies partly overlap with one another
- (**c**) Both sets of strategies are generally considered hand-in-hand
- (**n**) Don't know/Not sure

Comments:

Back Next

- Who provides policing for your system? (Total must equal 100%)

Sworn transit law enforcement	%
Non-sworn transit police (i.e. private security)	%
Contracted local police	%
Dedicated bureau of local law enforcement	%
No formal security, rely exclusively on local law enforcement	%
Other (please describe below)	%
TOTAL	%

Q13. If you indicated "Other", please specify:

(**n**) Don't know/Not sure

- **Q14.** How many full-time equivalent (FTE) security/police personnel does your agency contract for or employ?

(**n**) Don't know/Not sure

- **Q14_1.** In your view, how effective do you think policing strategies are in preparing for terrorist attacks on your system?

(**a**) Very effective
(**b**) Somewhat effective
(**c**) Not effective at all
(**n**) Don't know/Not sure

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 Updated 071204

- **Q15.** Do you have an information and outreach strategy to educate transit riders about general emergency and safety issues?

  - (**a**) Yes, we have an extensive information and outreach strategy
  - (**b**) Yes, we have a modest information and outreach strategy
  - (**c**) No, we do not have an information and outreach strategy
  - (**n**) Don't know/Not sure

  If you selected "yes", please describe this information and outreach strategy

- **Q16.** Do you have an information and outreach strategy to educate transit riders specifically about dealing with terrorist attacks?

  - (**a**) Yes, we have an extensive information and outreach strategy
  - (**b**) Yes, we have a modest information and outreach strategy
  - (**c**) No, we do not have an information and outreach strategy
  - (**n**) Don't know/Not sure

  If you selected "yes", please describe this information and outreach strategy

- **Q18.** In your view, how effective do you think information and outreach strategies are in preparing for terrorist attacks on your system?

  - (**a**) Very effective
  - (**b**) Somewhat effective
  - (**c**) Not effective at all
  - (**n**) Don't know/Not sure

 Updated 071204

Next we would like to ask you about the security hardware and technology strategies your agency uses.

Start Finish

Logout

- Which of the following security hardware strategies does your agency employ in your system? You may also write in your own security hardware strategy in the boxes provided.

Not extensively/ few or no locations 1 <--> 5 Very extensively/ most or all locations

	(**0**) Not in our system	(**a**) 1	(**b**) 2	(**c**) 3	(**d**) 4	(**e**) 5	(**n**) Don't know/Not sure
Q19A. Closed-circuit (CCTV) cameras							
Q19B. Emergency telephones							
Q19C. Emergency alert/notification systems on transit vehicles							
Q19D. Personnel radio communications systems							
Q19E. Public address system							
Q19F. Chemical/biological (C/B) sensors							
Q19G. Reversible fans							
Q19H. Metal detectors at entrance and exit points							
Q19I. Intrusion detection systems (e.g., at tunnel entrances)							
Q19J. Automatic track and signal monitoring systems							
Q19K. GPS locators							
Q19L. Electronic access control							
Q19M. Portable explosive detection equipment							
Other 1 Q19N_Text							
Other 2 Q19O_Text							
Other 3 Q19P_Text							

- **Q20.** In your view, how effective do you think security and hardware are in preparing for terrorist attacks on your system?

  - (**a**) Very effective
  - (**b**) Somewhat effective
  - (**c**) Not effective at all
  - (**n**) Don't know/Not sure

Back Next

The last set of strategies we would like to ask you about are the environmental design strategies your agency uses.

Start Finish

Logout

- **Q21**. The term "crime prevention through environmental design" (CPTED) can mean different things to different people. How would you define this term?

  - (**a**) I am familiar with the term and I would define it as:
  - (**b**) I have heard the term, but I'm not certain what it means.
  - (**n**) Don't know/Not sure.

- **Q22**. Does your agency currently use CPTED strategies in its security planning?

  - (**a**) Yes, we have an extensive CPTED strategy program
  - (**b**) Yes, we have a moderate CPTED strategy program
  - (**c**) No, we do not have a CPTED strategy program
  - (**n**) Don't know/Not sure

  [Q22A and Q23 appear IF Q22 = a or b]

- **Q22A.** In your view, how important are CPTED strategies in your agency's overall security planning?

  - (**a**) Very important
  - (**b**) Somewhat important
  - (**c**) Not important at all
  - (**n**) Don't know/Not sure

- **Q23.** For which components of your system's stations/bus terminal(s) has your agency used CPTED strategies? (Please check ALL that apply)

  - (**a**) Platforms
  - (**b**) Entrances and exits
  - (**c**) Elevators
  - (**d**) Escalators

- [ ] (**e**) Restrooms
- [ ] (**f**) Trash cans
- [ ] (**g**) Pathways
- [ ] (**h**) Parking lots
- [ ] (**i**) Vehicles
- [ ] (**j**) Vending machines
- [ ] (**k**) Gates
- [ ] (**l**) Other

(**n**) Don't know/Not sure

If you indicated "Other" above, please specify:

Back Next

The last set of strategies we would like to ask you about are the environmental design strategies your agency uses.

Start Finish

Logout

[Q23x appears FOR EACH option selected (a-l) in Q23]

- You indicated the following components in your system. Please describe the CPTED strategies used in each component.

Platforms

Entrances and Exits

Elevators

Escalators

Restrooms

Trash cans

Pathways

Parking lots

Vehicles

Vending Machines

Gates

blah

- Previously, you listed one or more CPTED security strategies used by your system. Please list and rank the one, two, or three strategies that you believe provide the most "**bang for the buck**" in terms of transit security.

Example

1. Most "bang for the buck"

2. Second most "bang for the buck"

3. Third most "bang for the buck"

Comments

[Q24_1 for Rail only]

- **Q24_1**. For which components of your rail system has your agency used CPTED strategies? (Please check ALL that apply)

  - (**a**) Tracks
  - (**b**) Station Tunnels
  - (**c**) Control Center(s)
  - (**d**) Maintenance Facilities (yards and shops)
  - (**e**) Traction Power Stations and Distribution
  - (**f**) Other
  - (**n**) Don't know/Not sure

  If you indicated "Other" above, please specify:

- **Q25**. In your view, how effective do you think CPTED strategies are in preventing for terrorist attacks on your system?

  - (**a**) Very effective
  - (**b**) Somewhat effective
  - (**c**) Not effective at all
  - (**n**) Don't know/Not sure

- **Q26**. Does your agency have CPTED guidelines in place?

- (**a**) Yes
- (**b**) No
- (**n**) Don't know/Not sure

[Q26A appears IF Q26 = a]

- **Q26A**. If yes, how were these guidelines developed?

- (**a**) In-house team
- (**b**) Sheriff's or police department
- (**c**) Contracted security consultants
- (**d**) Other (please specify below)
- (**n**) Don't know/Not sure

If you chose "Other", please explain:

[Q26B appears IF Q26A = a]

- **Q26B**. Which department in your agency led the development of these guidelines?

(**n**) Don't know/Not sure

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[This page is rail/agencies with multi-modal transfer facility only]

This next section asks about past incidents experienced on your system and perceived threats.

Start Finish

Logout

- **Q27.** To your knowledge, has your rail system ever experienced any of the following incidents?

  - [ ] (**a**) Identification of explosive device on system
  - [ ] (**b**) Detonation of explosive device on system
  - [ ] (**c**) Use of arson/incendiary devices on system
  - [ ] (**d**) Identification of chemical or biological contaminants on system
  - [ ] (**e**) Identification of nuclear device or radiological contaminants on system
  - [ ] (**f**) Vehicle hijacking
  - [ ] (**g**) Hostage/barricade situation
  - [ ] (**h**) Employee sabotage
  - [ ] (**i**) Breach of essential computer/software systems
  - [ ] (**j**) Shooting incident with multiple victims
  - [ ] (**l**) Other (please specify)
  - [ ] (**k**) None of the above
  - [ ] (**n**) Don’t know/Not sure

  If you indicated "Other", please specify:

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The last set of strategies we would like to ask you about are the environmental design strategies your agency uses.

Start Finish

Logout

[Q27x_A thru Q27x_D appears for each incident indicated in Q27 (a-l) and only for Rail/Agencies with multi-modal transfer facility]

- You indicated the following incidents. For each incident, please answer the following questions.

Identification of explosive device on system

1. How many times has this type of incident occurred in the last decade? ☐ **Q27A** (**a**) Don't know/Not sure
2. What was the year of the most recent incident? ☐ **Q27A** (**b**)Don't know/Not sure
3. **Q27A_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   - ☐ (**a**) At a station
   - ☐ (**b**) On a vehicle
   - ☐ (**c**) On the tracks
   - ☐ (**d**) Other
   - ☐ **Q27A (c)** Don't know/Not sure
4. Briefly describe the incident: ☐ **Q27A** (**d**)Don't know/Not sure

Detonation of explosive device on system

1. How many times has this type of incident occurred in the last decade? ☐ **Q27B** (**a**) Don't know/Not sure
2. What was the year of the most recent incident? ☐ **Q27B** (**b**) Don't know/Not sure
3. **Q27B_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   - ☐ (**a**) At a station

- (**b**) On a vehicle
- (**c**) On the tracks
- (**d**) Other

- **Q27B** (**c**) Don't know/Not sure

4. Briefly describe the incident:

   Q27B (d) Don't know/Not sure

Use of arson/incendiary devices on system

1. How many times has this type of incident occurred in the last decade? **Q27C** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   - **Q27C** (**b**) Don't know/Not sure
3. **Q27C_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   - (**a**) At a station
   - (**b**) On a vehicle
   - (**c**) On the tracks
   - (**d**) Other
   - **Q27C** (**c**) Don't know/Not sure
4. Briefly describe the incident:

   Q27C (**d**) Don't know/Not sure

Identification of chemical or biological contaminants on system

1. How many times has this type of incident occurred in the last decade? **Q27D** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   - **Q27D** (**b**) Don't know/Not sure

3. **Q27D_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   - (**a**) At a station
   - (**b**) On a vehicle
   - (**c**) On the tracks
   - (**d**) Other
   - **Q27D** (**c**) Don't know/Not sure
4. Briefly describe the incident:
   Q27D (**d**) Don't know/Not sure

Identification of nuclear device or radiological contaminants on system

1. How many times has this type of incident occurred in the last decade? **Q27E** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   Q27E (**b**) Don't know/Not sure
3. **Q27E_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   - (**a**) At a station
   - (**b**) On a vehicle
   - (**c**) On the tracks
   - (**d**) Other
   - **Q27E** (c) Don't know/Not sure
4. Briefly describe the incident:
   Q27E (**d**) Don't know/Not sure

Vehicle hijacking

1. How many times has this type of incident occurred in the last decade? **Q27F** (**a**) Don't know/Not sure

2. What was the year of the most recent incident?
   - **Q27F** (**b**) Don't know/Not sure
3. **Q27F_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   - (**a**) At a station
   - (**b**) On a vehicle
   - (**c**) On the tracks
   - (**d**) Other
   - **Q27F** (**c**) Don't know/Not sure
4. Briefly describe the incident:
   Q27F (**d**) Don't know/Not sure

Hostage/barricade situation

1. How many times has this type of incident occurred in the last decade? **Q27G** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   - **Q27G** (**b**) Don't know/Not sure
3. **Q27G_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   - (**a**) At a station
   - (**b**) On a vehicle
   - (**c**) On the tracks
   - (**d**) Other
   - **Q27G** (**c**) Don't know/Not sure
4. Briefly describe the incident:
   Q27G (**d**) Don't know/Not sure

Employee sabotage

1. How many times has this type of incident occurred in the last decade? ☐ **Q27H** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   ☐ **Q27H** (**b**) Don't know/Not sure
3. **Q27H_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   ☐ (**a**) At a station
   ☐ (**b**) On a vehicle
   ☐ (**c**) On the tracks
   ☐ (**d**) Other
   ☐ **Q27H** (**c**) Don't know/Not sure
4. Briefly describe the incident:
   ☐ **Q27H** (**d**) Don't know/Not sure

Breach of essential computer/software systems

1. How many times has this type of incident occurred in the last decade? ☐ **Q27I** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   ☐ **Q27I** (**b**) Don't know/Not sure
3. **Q27I_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   ☐ (**a**) At a station
   ☐ (**b**) On a vehicle
   ☐ (**c**) On the tracks
   ☐ (**d**) Other
   ☐ **Q27I** (**c**) Don't know/Not sure
4. Briefly describe the incident:
   ☐ **Q27I** (**d**) Don't know/Not sure

Shooting incident with multiple victims

1. How many times has this type of incident occurred in the last decade? ☐ **Q27J** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   ☐ **Q27J** (**b**) Don't know/Not sure
3. **Q27J_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   ☐ (**a**) At a station
   ☐ (**b**) On a vehicle
   ☐ (**c**) On the tracks
   ☐ (**d**) Other
   ☐ **Q27J** (**c**) Don't know/Not sure
4. Briefly describe the incident:
   ☐ **Q27J** (**d**) Don't know/Not sure

Other

1. How many times has this type of incident occurred in the last decade? ☐ **Q27K** (**a**) Don't know/Not sure
2. What was the year of the most recent incident?
   ☐ **Q27K** (**b**) Don't know/Not sure
3. **Q27K_C.** Where did this incident occur on your rail system? (Please check ALL that apply)
   ☐ (**a**) At a station
   ☐ (**b**) On a vehicle
   ☐ (**c**) On the tracks
   ☐ (**d**) Other
   ☐ **Q27K** (**c**) Don't know/Not sure
4. Briefly describe the incident:
   ☐ **Q27K** (**d**) Don't know/Not sure

[End Rail/Agencies with multi-modal transfer facilities question block]

- **Q27_bomb.** How many credible threats (e.g. bomb, chemical, biological, fire attacks, etc) has your agency had in the last year?

  (**n**) Don't know/Not sure

[Q28x appears for each option selected in Q1 (a-g)]

- In your view, how vulnerable to terrorist attack is each of the modes in your system?

Not vulnerable at all — Very vulnerable
1 <--> 5

	(**a**) 1	(**b**) 2	(**c**) 3	(**d**) 4	(**e**) 5	(**n**) Don't know/Not sure
Q28A. Commuter rail						
Q28B. Heavy rail						
Q28C. Light rail						
Q28D. Bus						
Q28E. Ferry						
Q28F. Paratransit						
Q28G. [OTHER]						

- In your view, how vulnerable to terrorist attack is each of these rail system components in your system?

Not vulnerable at all — Very vulnerable
1 <--> 5

	(**0**) Does not apply	(**a**) 1	(**b**) 2	(**c**) 3	(**d**) 4	(**e**) 5	(**n**) Don't know/Not sure
Q29A. Rail stations							
Q29B. Multi-modal terminals (e.g. bus and rail stations)							
Q29C. Bridges/tunnels							
Q29D. Tracks and rail lines							
Q29E. Vehicles							

Thank you for completing the survey!

You now have three ways to proceed:

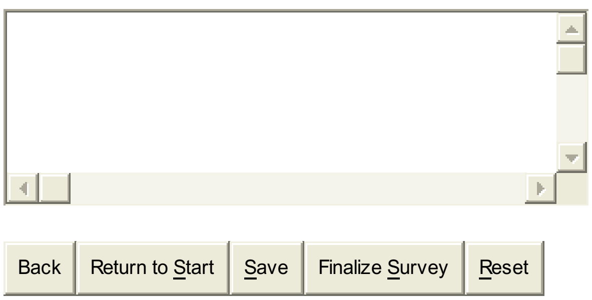
1. You can check over your answers by clicking on "**Return to Start**."

2. You can save what you have entered so far and return later to complete and submit the survey by clicking on "**Save**."

3. Or you can finalize and submit the survey by clicking on "**Finalize Survey**." (When you click on "Finalize Survey" your responses will be recorded and you will no longer be able to change your answers.)

If you indicated "Don't know/Not sure" for any of the questions or you think that someone else in your organization could add additional information to this nearly completed survey, please indicate their name(s) and contact information below and click on "Save" or "Finalize Survey."

Thanks again for your time and attention.



TRANSIT SECURITY SURVEY NEW USER REGISTRATION FORM

Transit Agency Information

Transit Agency Name
AGENCY

Agency City	Agency State
AGENCYCITY	**AGENCYSTATE**

Mailing Address
MAILING1
MAILING2

City	State
CITY	**STATE**

Zip
ZIP

Personal Information

(Individual filling out the survey)

First Name	Last Name
FIRSTNAME	**LASTNAME**

Title
TITLE

Email
EMAIL

Telephone Number (xxx-xxx-xxxx)
PHONE

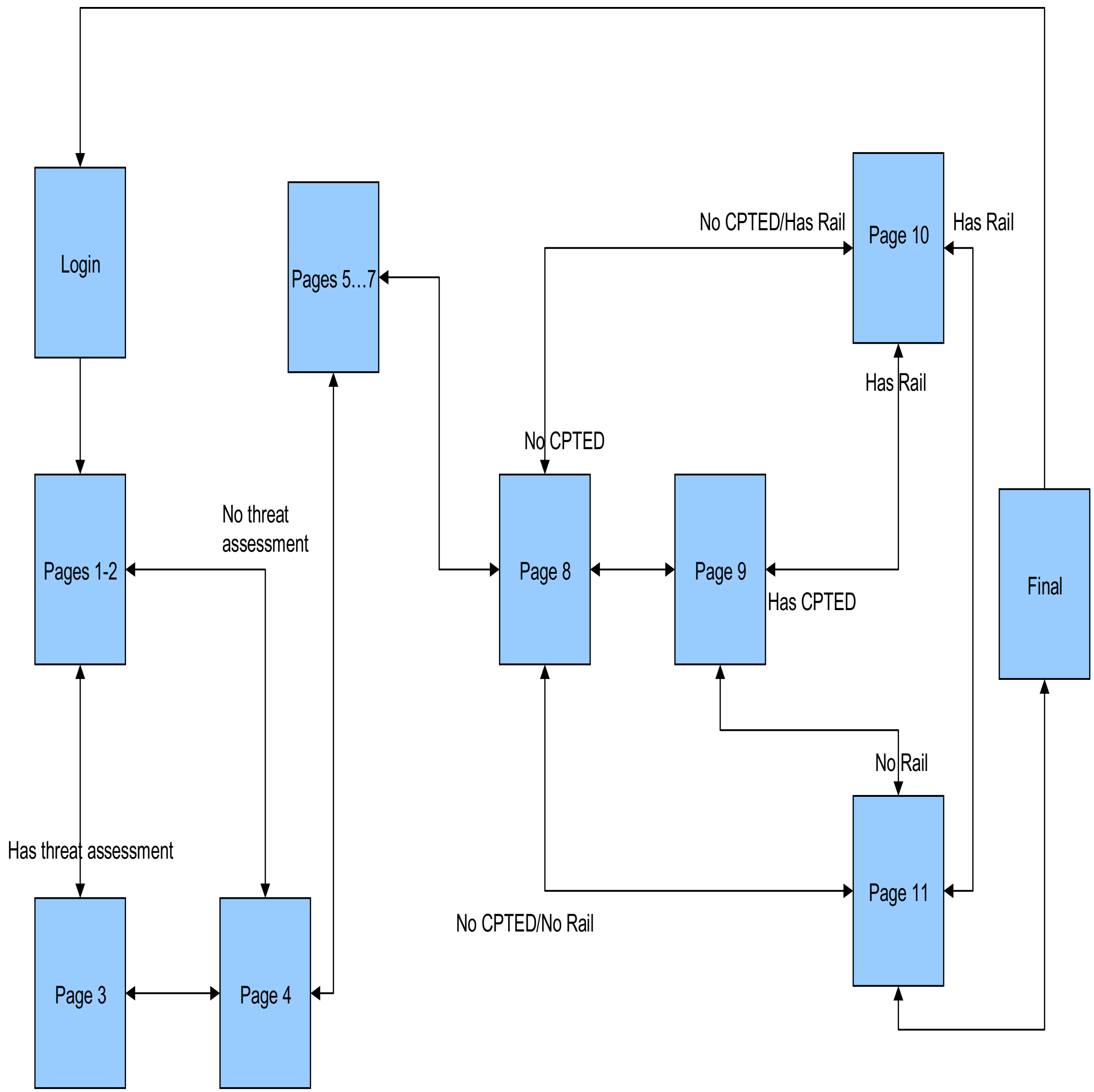
Choose a username (10 characters or less)
USERNAME

Choose a password (10 characters or less)
PASSWORD

Confirm password
PASSWORD

Data Dictionary for Misc. Fields

USERID:	Primary key internal to Access Db
TOTALLOGINS:	Total number of logins to survey
LASTIP:	Last IP address of User
LASTBROWSER:	Identifies browser of user
LASTLOGIN:	Date/time of last login
HASRAIL:	Checkbox specifies whether transit agency indicated rail
LASTPAGE:	Last page user was on before logging out
DONE:	Checkbox specifies whether user clicked “Finalize Survey”


Login
Pages 5...7
No CPTED/Has Rail
Page 10
Has Rail
Has Rail
No CPTED
No threat
assessment
Pages 1-2
Page 8
Page 9
Has CPTED
Final
No Rail
Has threat assessment
Page 11
No CPTED/No Rail
Page 3
Page 4

ENDNOTES

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3. United States General Accounting Office 2002 (b).

4. Boyd and Sullivan 1997.

5. Policastro and Gordon 1999; and *Alternative Technologies* 1993.

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6. Balog, Boyd, and Caton 2003.

7. Jenkins 1997.

8. Jenkins 1997; United States General Accounting Office 2002 (a).

9. Balog 2003; Balog, Boyd, and Caton 2003; Boyd and Sullivan 2000.

10. Jenkins 1997; United States General Accounting Office 1988.

11. The White House, *Securing the Homeland*, 2003 (b).

12. Flynn 2000.

13. Jenkins 1997.

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15. Federal Bureau of Investigation 1999, ii.

16. Ibid.

17. Boyd and Sullivan 1997.

18. Jenkins 2001; Jenkins and Gerston 2001; Jenkins 1997.

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22. Whent 1999, 9.

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26. Mauri, Cooney, and Prowe 1983.
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28. Balog et al., 1994, xxix.
29. Balog et al., 2003.
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31. Adduci, Boyd, and Caton 2002.
32. Federal Emergency Management Agency 2003 (b); National Capital Planning Commission 2001; United States General Services Administration 1999.
33. United States General Accounting Office 1988, 3.
34. Jenkins 1997, 40.
35. Savage 1996.
36. Gaier 2004.
37. Jenkins 1997; United States General Services Administration 1999.
38. American Institute of Architects 2003; Federal Emergency Management Agency 2003 (c); Federal Transit Administration 2003 (a); Gaier 2004.
39. Whent 1999.
40. Federal Emergency Management Agency 2003 (b), 2003 (c); United States General Services Administration 1999, 2003.
41. American Institute of Architects 2003.
42. Atlas 2002.
43. Jenkins 1997, Jenkins and Gerston 2001.
44. Felson 1996; LaVigne 1996, 1997; Loukaitou-Sideris et al., 2002, 135–151; Loukaitou-Sideris et al., 2001, 255-280.
45. Felson 1996; LaVigne 1996, 1997.
46. Crowe and Zahm 1994, 22–27; Newman 1972.
47. Clarke 1983; Crowe 1991.
48. Clarke 1983, 1995.
49. LaVigne 1996, 1997; Clarke 1983, 1995; Felson 1996.

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51. LaVigne 1996, 163-198.
52. Federal Emergency Management Agency 2003 (b), 2–61.
53. Ibid.
54. Boyd 1998; LaVigne 1996.
55. Jenkins 1997.
56. Ibid.
57. Felson 1996; LaVigne 1996; Myhre and Rosso 1996.
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59. Myhre and Rosso 1996.
60. American Institute of Architects 2003.
61. Crowe and Zahm 1994.
62. Federal Emergency Management Agency 2003 (a), 3–4.
63. Federal Emergency Management Agency 2003 (c).
64. Balog, Boyd, and Caton 2003.
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77. DeBlasio et al., 2002, 48.
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81. United States General Accounting Office 2002 (b).
82. Weinstock 2003.
83. Gaier 2004; United States General Accounting Office 1988.
84. Boyd, Maier, and Kenney 1996.
85. Federal Emergency Management Agency 2003 (c), 3–6.
86. Weidner 1996.
87. Ridership actually boomed in the late 1990s as a result of the city's growing economy and the introduction of automated reduced farecards.
88. National Capital Planning Commission 2001, i.
89. United States General Services Administration 1999.
90. Jenkins 1997, 2.
91. Federal Emergency Management Agency 2003 (b), 2003 (c).
92. Randall Atlas, "Is There a Difference in Designing for Crime or Terrorism?" CPTED Training Convention, 1999.
93. Balog, Boyd, and Caton 2003, 112.

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94. Yin 2003.
95. Singleton et al., 1988.
96. United States General Accounting Office 2002 (b).
97. While there were 119 individual responses to the survey, six agencies had multiple respondents. Since the agency was considered our unit of analysis for this study, only one completed response per agency was included, for a total sample size of 113.
98. This includes the Minneapolis Metro Transit system, which opened its first light rail line in July 2004.
99. Only respondents from systems with a rail mode were asked to rate its vulnerability, giving sample sizes of n = 5, 8, and 15 respectively for the three modes.

100. Difference is significant at the 0.0005 level.
101. Difference is significant at the 0.05 level
102. The 2002 GAO survey asked, "Who provides security for your transit property? (Check all that apply)," while our survey asked respondents to differentiate exclusive reliance on a strategy from the use of multiple strategies.
103. Jacobs 1961; Newman 1972.
104. United States General Accounting Office 2002 (b).
105. This represents 20 percent of the 113 agency respondents who completed the survey; however, only a total of 52 answered this question.
106. "Transit Agency Data," APTA 2004, available http://www.apta.com/research/stats.

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107. American Public Transportation Association 2004.

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108. Jenkins 1997; Jenkins and Gerston 2001.
109. Jenkins and Gerston 2001.
110. Schmidt 1992.
111. O'Connor 1991; Schmidt 1991.
112. Schmidt 1991, 1992; O'Connor 1991.
113. Jenkins and Gerston 2001.
114. Schmidt 1991, 1992.
115. Jenkins and Gerston 2001.
116. Dwyer 2003; *The Appleton Inquiry Report* 1992.
117. Barron, December 22, 1994; Hevesi, December 23, 1994; McFadden, December 25, 1994; Richard Perez-Pena, December 26, 1995, January 2, 1994.
118. Pangi 2002.
119. *R & D for Defence Canada,* Defence Canada, accessed March 12, 2003, http://www.suffield.drdc-rddc.gc.ca/Meeetings/FirstResponders/3%20-%%20Aum%20Shinrikyo_final.pdf, undated.

120. Okumura et al., 1998.

121. Tokyo has two main subway systems—the Tokyo Metro and the Toei Subway. See endnote 134 for additional information.

122. Normally, windows are expected to be kept shut because the trains are air conditioned.

123. During the sarin attack, the Hibiya Line was stopped and all passengers were evacuated. However, the Marunouchi Line was not stopped.

124. Tu 2002.

125. Jenkins 1997, Jenkins and Gerston 2001.

126. Riding, July 26, 1995; Simons, July 27, 1995, July 30, 1995; Ibrahim, September 7, 1995; Whitney, October 18, 1995, October 19, 1995; Jenkins 1997.

127. While most ETA bombs had not targeted the Spanish railway system, one particular incident had put the police and railway authorities on the alert. In December 2003, a bomb exploded on a railroad track in the Zaragoza province, about 300 kilometers from Madrid. The next day the police detained suspects belonging to ETA, but not before they had already placed another backpack loaded with explosives on a train from Irhun to Madrid. The police, in coordination with the transit operator, successfully intervened and aborted the second attack, disembarking all passengers and recovering the bomb before it exploded. According to the officials, this type of attack had never happened in Spain.

128. Jenkins 1997.

129. Some X-ray and scanning machines were already in place in some Madrid stations before 3/11.

Transit Security Strategies of International Agencies

130. Local representatives of government.

131. RATP, for example, has marked 150 million Euros for the next 10 years for transit security.

132. The project is led by an international team of public transport organizations, local authorities, research centers, and transport consultants, including UITP, RATP, Polis, Socialdata, CERTU, TIS.PT, Rupprech Consult, AMT Genoa, Bureau Zuidema, Babtie, and UWE.

133. This is the focus of a European research project called PRISMATICA.

134. The Toei Subway system is operated by the Transportation Bureau of the Tokyo Metropolitan Government, and has four lines with a total length of 109 kilometers. The

Tokyo Metro is operated by a private company, and has eight subway lines with a total length of 183.2 kilometers. The system moves an average of 5.59 million passengers per day.

135. According to an official, General Affairs Section, General Affairs Division, Transportation Bureau of Tokyo Metropolitan Government, until 2003 the Toei Subway only had earthquake drills.
136. These divisions are Safety Affairs Division, Transport and Business Division, Rolling Stock Division, Electrical Facilities Division, and Infrastructure Maintenance Division.
137. These divisions are General Affairs Division, Subway and Streetcar Service Division, Rolling Stock and Electricity Division, and Construction and Maintenance Division.
138. Part of this response now includes a rule of shutting down all lines in the system if a chemical attack happens. After the safety of the trains is confirmed, operations of each line can resume.
139. After the sarin attack in 1995, Toei Subway officials removed all trashcans from stations. Trashcans were moved back in 1997, but were placed in visible locations
140. To protect individuals from unfair scrutiny, Great Britain has a data protection act. An individual can pay 10 pounds and ask to see what data an organization such as the London Underground has on him or her. If they pay and they have a justification for the request, they can be supplied with the CCTV images. The Freedom of Information Act 2000 will further extend these rights.
141. This will change in the near future. A new European Union law coming into effect will allow the separation of infrastructure (which is public in Spain) from transit operations. Tracks and stations are going to be one company and the trains another company. From 2005 onward, private companies can form to operate merchandise trains, and in 2010 passenger trains can also be operated by private companies.
142. http://www.UITP.com/transits.

What Have We Learned, Where Are We Headed?

143. Boyd and Sullivan 1997.
144. While some intercity and commuter rail systems, because they handle fewer, longer-distance passengers, have instituted airport-like screening of passengers and their baggage, such efforts could not be extended to local transit operations serving dozens, hundreds, and even thousands of stops.

145. American Public Transportation Association 2004.

146. Said one Spanish official we interviewed: "…a station in the Basque country is not the same as a station in Andalusia in South Spain."

147. Federal Transit Administration, "Transit Safety and Security Statistics," (2005), available at http://transit-safety.volpe.dot.gov/Data/Samis.asp.

148. Hartgen, Ingalls, and Owens 1993; Lynch and Atkins 1998, 255–277.

ABBREVIATIONS AND ACRONYMS

AIA	American Institute of Architects
ALAMYS	Latin American Association of Underground Networks and Subways
ALARP	As low as reasonably practical
APTA	American Public Transportation Association
ATM	Automated teller machine
AVE	Alta Velocidad Española (Spain's high-speed rail system)
BART	Bay Area Rapid Transit
BTP	British Transport Police
Caltrans	California Department of Transportation
CBNR	Chemical, biological, nuclear, or radiological agents
CCTV	Closed-circuit television
CD-ROM	Compact disc read-only memory
CERTU	Centre d'Études sur les Reseaux de Transport et l'Urbanisme (France's Ministry of Transportation)
CODATU	Cooperation for the Continuing Development of Urban and Suburban Transportation
CPTED	Crime prevention through environmental design
CRTM	Consorcio Regional de Transportes de Madrid
CTAA	Community Transportation Association of America
DOT	Department of Transportation
DHS	Department of Homeland Security
Eole	Est-Ouest Liaison Express. A rail line that will link the east and west suburbs of Paris.
ETA	Euskadi Ta Askatasuna, a Basque paramilitary terrorist group. Initials translate to "Basque Country and Liberty."

EU	European Union
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GAO	Government Accountability Office; previously called General Accounting Office
GIA	Armed Islamic Group (responsible for bombings in Paris)
GSA	General Services Administration
IED	Improvised explosive device
ISAC	Information Sharing Analysis Center
IRA	Irish Republican Army
IRT	Interborough Rapid Transit
IT	Information Technology
MARC	Maryland Rail Commuter
MARTA	Metropolitan Atlanta Rapid Transit Authority
MBTA	Massachusetts Bay Transportation Authority
Météor	Métro Est-Ouest Rapide, a new subway line in Paris
MTA	Metropolitan Transportation Authority (New York City)
NCPC	National Capital Planning Commission
New Jersey Barrier	A tapered concrete barrier that is used in many narrow highway medians to prevent vehicle crossovers into oncoming traffic.
NRSP	National Railway Security Program
NYCTA	New York City Transit Authority
NYPD	New York Police Department
OSS	Office of Safety and Security

PATH	Port Authority Trans-Hudson (a subsidiary of the Port Authority of New York and New Jersey)
PIRA	Provincial Irish Republican Army
PRESS	Passenger Rail Equipment Safety Standards
PROTECT	Program for Response Options and Technology Enhancements for Chemical/ Biological Terrorism in Subways
PTS	Public transit security
RATP	Régie Autonome des Transports Parisiens, Paris' transit system
RENFE	La Red Nacional de los Ferrocarriles Españoles (National Network of the Spanish Railways)
RER	Réseau Express Régional, a part of Paris' transit system
RTP	Regional Transport Police
SCP	Situational crime prevention
SEPP	Security and Emergency Preparedness Program
SEPTA	Southeastern Pennsylvania Transportation Agency
SNCF	Societe National des Chemins de Fer Francais (French Railways)
SPIE	International Society of Optical Engineering
ST-ISAC	Surface Transportation Information Sharing and Analysis Center
TfL	Transport for London
TRANSEC	Transportation Security (part of the United Kingdom's Department for Transport)
TSA	Transportation Security Administration
UCR	Uniform Crime Reporting
UITP	International Union of Public Transport
VTA	Valley Transportation Authority
WMATA	Washington Metropolitan Area Transit Authority

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Dr. Wachs is the author or editor of four books, and has written over 130 published articles on transportation planning and policy, including the transportation needs of elderly and handicapped people, fare and subsidy policies in urban transportation, the problem of crime in public transit systems, and methods for the evaluation of alternative transportation projects. He has also performed historical studies of the relationship between transportation investments and urban form in the early part of the twentieth century, and on ethics in planning and forecasting. Recently, his writings have dealt with the relationship between transportation, air quality and land use, and transportation finance, as well as transit labor and contracting issues.

Dr. Wachs served as chairman of the executive committee of the Transportation Research Board during the year 2000, and was a member of the California Commission on Transportation Investment, to which he was appointed by Governor Pete Wilson. He is currently a member of the advisory committee on research and development for Caltrans, and was the first chair of the advisory panel for the Travel Model Improvement Program of the United States Department of Transportation.

ELLEN CAVANAGH

Ellen Cavanagh is a graduate student researcher in city and regional planning at the University of California, Berkeley. As senior advocate at Transportation Alternatives in New York City, Cavanagh participated in a number of post-9/11 community and interagency reconstruction task forces. Her research and advocacy in this area centered on the design of perimeter security for critical infrastructure in locations with heavy pedestrian flows.

CHRISTOPHER CHERRY

Christopher Cherry is a Ph.D. student in the Department of Civil and Environmental Engineering at the University of California, Berkeley. His research interests include transportation security, transportation policy and planning, transportation in developing countries, and intelligent transportation systems. He has a B.S. and M.S. in civil engineering, with an emphasis in transportation, from the University of Arizona. He has worked for several transportation engineering design consultants throughout his studies.

PETER HAAS, PH.D.

Peter J. Haas is currently education director for the Mineta Transportation Institute (MTI), a research and education organization located at San José State University (SJSU). Haas earned his doctorate in the field of public policy and public administration from the University of North Carolina at Chapel Hill in 1985, and has taught at the University of North Carolina, Virginia Tech, and SJSU, where he is also a member of the political science and public administration program faculty.

Dr. Haas is the author of many publications, including a coauthored textbook on policy analysis and program evaluation, and a host of professional and scholarly journal articles. He has directed several research projects on transportation for MTI, including a series of studies of local transportation tax initiative campaigns that have attracted national attention. He frequently serves as a panelist at the annual Transportation Cooperative Research Board program, and has made several presentations at the annual Transportation Research Board conference in Washington, D.C.

He was recently awarded a senior specialist grant from the Fulbright Foundation to teach and study in Latvia. As education director for MTI, Dr. Haas administers a statewide program that prepares transportation professionals for upper-level management and executive positions throughout the transportation industry.

PUBLICATION PEER REVIEW

San José State University, of the California State University system, and the MTI Board of Trustees have agreed upon a peer view process to ensure that the results presented are based upon a professionally acceptable research protocol.

Research projects begin with the approval of a scope of work by the sponsoring entities, with in-process reviews by the MTI Research Director and the project sponsor. Periodic progress reports are provided to the MTI Research Director and the Research Associates Policy Oversight Committee (RAPOC). Review of the draft research product is conducted by the Research Committee of the Board of Trustees and may include invited critiques from other professionals in the subject field. The review is based on the professional propriety of the research methodology.

Funded by
U.S. Department of
Transportation and
California Department
of Transportation

San José State
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