The 1995 Attempted Derailing of the French TGV (High-Speed Train) and a Quantitative Analysis of 181 Rail Sabotage Attempts

MTI Report 09-12

MINETA
TRANSPORTATION INSTITUTE
Created by Congress in 1991

MINETA TRANSPORTATION INSTITUTE

The Norman Y. Mineta International Institute for Surface Transportation Policy Studies (MTI) was established by Congress as part of the Intermodal Surface Transportation Efficiency Act of 1991. Reauthorized in 1998, MTI was selected by the U.S. Department of Transportation through a competitive process in 2002 as a national "Center of Excellence." The Institute is funded by Congress through the United States Department of Transportation's Research and Innovative Technology Administration, the California Legislature through the Department of Transportation (Caltrans), and by private grants and donations.

The Institute receives oversight from an internationally respected Board of Trustees whose members represent all major surface transportation modes. MTI's focus on policy and management resulted from a Board assessment of the industry's unmet needs and led directly to the choice of the San José State University College of Business as the Institute's home. The Board provides policy direction, assists with needs assessment, and connects the Institute and its programs with the international transportation community.

MTI's transportation policy work is centered on three primary responsibilities:

Research

MTI works to provide policy-oriented research for all levels of government and the private sector to foster the development of optimum surface transportation systems. Research areas include: transportation security; planning and policy development; interrelationships among transportation, land use, and the environment; transportation finance; and collaborative labor-management relations. Certified Research Associates conduct the research. Certification requires an advanced degree, generally a Ph.D., a record of academic publications, and professional references. Research projects culminate in a peer-reviewed publication, available both in hardcopy and on TransWeb, the MTI website (http://transweb.sjsu.edu).

Education

The educational goal of the Institute is to provide graduate-level education to students seeking a career in the development and operation of surface transportation programs. MTI, through San José State University, offers an AACSB-accredited Master of Science in Transportation Management and a graduate Certificate in Transportation Management that serve to prepare the nation's transportation managers for the 21st century. The master's degree is the highest conferred by the California State University system. With the active assistance of the California Department of Transportation, MTI delivers its classes over a state-of-the-art videoconference network throughout the state of California and via webcasting beyond, allowing working transportation professionals to pursue an advanced degree regardless of their location. To meet the needs of employers seeking a diverse workforce, MTI's education program promotes enrollment to under-represented groups.

Information and Technology Transfer

MTI promotes the availability of completed research to professional organizations and journals and works to integrate the research findings into the graduate education program. In addition to publishing the studies, the Institute also sponsors symposia to disseminate research results to transportation professionals and encourages Research Associates to present their findings at conferences. The World in Motion, MTI's quarterly newsletter, covers innovation in the Institute's research and education programs. MTI's extensive collection of transportation-related publications is integrated into San José State University's world-class Martin Luther King, Jr. Library.

MTI Report 09-12

OFF THE RAILS: THE 1995 ATTEMPTED DERAILING OF THE FRENCH TGV (HIGH-SPEED TRAIN) AND A QUANTITATIVE ANALYSIS OF 181 RAIL SABOTAGE ATTEMPTS

March 2010

Brian Michael Jenkins
Bruce R. Butterworth
Jean-François Clair

a publication of the
Mineta Transportation Institute
College of Business
San José State University
San José, CA 95192-0219
Created by Congress in 1991

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. CA-MTI-10-2501	**2. Government Accession No.**	**3. Recipients Catalog No.**
4. Title and Subtitle Off the Rails: The 1995 Attempted Derailing of the French TGV (High-Speed Train) and a Quantitative Analysis of 181 Rail Sabotage Attempts		**5. Report Date** March 2010 **6. Performing Organization Code**
7. Authors Brian Michael Jenkins Bruce R. Butterworth Jean-François Clair		**8. Performing Organization Report No.** MTI Report 09-12
9. Performing Organization Name and Address Mineta Transportation Institute College of Business San José State University San Jose, CA 95192-0219		**10. Work Unit No.** **11. Contract or Grant No.** DTRT 07-G-0054 2008-ST-061-TS0004
12. Sponsoring Agency Name and Address California Department of Transportation Sacramento, CA 94273-0001 U.S. Department of Transportation Office of Research—MS42 Research & Special Programs Administration P.O. Box 942873 400 7th Street, SW Washington DC 20590-0001 U.S. Department of Homeland Security Science and Technology Dictorate Washington, DC 20528		**13. Type of Report and Period Covered** Final Report **14. Sponsoring Agency Code**

15. Supplementary Notes

16. Abstract

On August 26, 1995, the Saturday of the final and busiest weekend of France's summer holiday season, terrorists attempted to derail the TGV (Train à Grande Vitesse) between Lyon and Paris by planting a bomb. Fortunately, their crude triggering mechanism failed to detonate the bomb, and subsequent analysis indicates that even had the bomb gone off, the explosion would not have derailed the train.

The TGV episode, one of a continuing series of case studies by the Mineta Transportation Institute, points to a continuing problem: Since 1995, terrorists have attempted to derail trains on at least 144 occasions.

Because of the expansion of high-speed rail systems in Europe, Asia, and North America, where 15 high-speed rail projects are in preparation or under way in the United States alone, this case study has been expanded to include a chronology and statistical analysis of attempted derailments worldwide. This analysis examines the geographic distribution of the attempts, the methods used by the saboteurs, and the outcomes. Although based on a small universe of events, it underscores both the attractiveness to terrorists of attacking transportation systems—a successful attack can result in high body counts, significant disruption, dramatic images, and enormous publicity, all things sought by terrorists—and the difficulties of achieving success.

17. Key Words **18. Bombings; Bombs; Casualties; Terrorism; Trains**	**19. Distribution Statement** No restrictions. This document is available to the public through The National Technical Information Service, Springfield, VA 22161		
20. Security Classif. (of this report) Unclassified	**21. Security Classifi. (of this page)** Unclassified	**22. No. of Pages** **54**	**23. Price** $15.00

Form DOT F 1700.7 (8-72)

Library of Congress Catalog Card Number: 2010924156

To order this publication, please contact the following:
Mineta Transportation Institute
College of Business
San José State University
San José, CA 95192-0219
Tel (408) 924-7560
Fax (408) 924-7565

email: mti@mti.sjsu.edu
http://transweb.sjsu.edu

ACKNOWLEDGMENTS

The authors wish to express their appreciation to Anthony Tisdale, of the Federal Transit Administration of the U.S. Department of Transportation, and Deputy Chief Lewis Best and Ross Moir of the Metropolitan Boston Transportation Authority (MBTA) for their assistance in identifying incidents and providing additional information for the chronology.

The authors also wish to thank the Mineta Transportation Institute peer reviewers for their thoughtful and helpful reviews of this report. We thank MTI Research Director Dr. Karen Philbrick for her patient encouragement and guidance; Kristin Nwakobi, for her assistance in compiling the data; Research Support Manager Meg Fitts for relieving us of the unavoidable administrative burdens; and Janet DeLand, for her skillful editing.

The authors also thank MTI staff including Director of Communications and Special Projects Donna Maurillo, Student Research Support Assistant Chris O'Dell, Student Publications Assistant Sahil Rahimi, Student Graphic Artists JP Flores and Vince Alindogan, and Student Webmaster Ruchi Arya. Additional thanks are offered to to Editorial Associates Robyn Whitlock and Catherine Frazier.

TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

On August 26, 1995—the final Saturday and busiest weekend of France's summer holiday season—terrorists attempted to derail the TGV (Train à Grande Vitesse) between Lyon and Paris by planting a bomb. Fortunately, their crude triggering mechanism failed to detonate the bomb, and subsequent analysis indicates that even had the bomb gone off, the explosion would not have derailed the train. Nevertheless, the psychological effect of an explosion on the train would have been enormous. France's TGV was the first high-speed rail system in Europe and today remains a source of national pride. That gives the trains the iconic status, or "emotional value," typically sought by terrorists. Moreover, a successful attack on the TGV would have sent further shudders through a nation already rattled by a terrorist bombing campaign that had commenced a month before.

The perpetrators of the attempted derailment were members of the GIA (Groupe Islamique Armé), an Algerian terrorist organization that had extended its campaign to France. At the time of the attempt on the TGV, GIA terrorist teams had already carried out a series of attacks in Paris, most of them directed against accessible transportation targets. In response, the French government sent thousands of police and soldiers into metro and train stations, which may have compelled the terrorists to contemplate other venues and means of attack. The terrorist campaign ended in November 1995 with the death or capture of most of the terrorist network, although one more bombing occurred in 1996.

The TGV episode, one of a continuing series of case studies by the Mineta Transportation Institute (MTI), points to a continuing problem: Since 1995, terrorists have attempted to derail trains on at least 144 occasions.

Given the expansion of high-speed rail systems in Europe, Asia, and North America, where 15 high-speed rail projects are in preparation or under way in the United States alone, the TGV case study has been expanded to include a chronology and statistical analysis of attempted derailments worldwide. This analysis examines the geographic distribution of the attempts, the methods used by the saboteurs, and the outcomes. Although based on a small universe of events, it underscores both the attractiveness to terrorists of attacking transportation systems—a successful attack can result in high body counts, significant disruption, dramatic images, and enormous publicity, all things sought by terrorists—and the difficulties of achieving success. Ordinary bombings on trains and buses and in stations and depots give terrorists a higher return on investment per bomb than derailments.

The incidents included in the analysis take place outside of conventional wars, although many of them were part of guerrilla wars and broader terrorist campaigns. Wartime sabotage of rail transport is reviewed in a separate section. One such campaign, the Russian sabotage campaign against German invaders during World War II, resulted in an extraordinary volume of attacks, but it depended on a national effort that included training thousands of partisans and keeping them equipped with explosive devices. No contemporary guerrilla army or terrorist group can summon these kinds of resources.

A final section of the analysis, which appears just before the chronology of attacks, lists some of the security measures appropriate for preventing deliberate derailments, particularly in response to high-threat situations.

INTRODUCTION

Terrorists see public surface transportation as a killing field. Despite their continuing obsession with attacking commercial aviation, when it comes to wholesale killing, trains and buses offer easily accessible concentrations of people. Terrorists plant most of their bombs in crowded coaches or stations where they will cause direct casualties, but about ten percent of their attacks aim at derailing trains. A well-placed, perfectly timed bomb can send a speeding train plunging into a river or careening down a steep embankment, causing scores of casualties.

In October 1995, a still unidentified attacker sabotaged a remote section of the track in Arizona causing the Sunset Limited to derail. One person was killed and 65 were injured. The Mineta Transportation Institute published a detailed case study of this event.[1]

Two months prior to the Arizona event, terrorists in France attempted to derail the high-speed train between Lyon and Paris. That is the subject of the following case study.

In order to put these two events into a broader context, the second part of this report analyzes 181 events where guerrillas or terrorists attempted to derail trains, 144 of them since January 1996. Taking advantage of MTI's expanded and computerized database of attacks on surface transportation, the analysis looks at the distribution and modes of attack, the saboteurs' success or failure in derailing trains, and the consequences of their attacks in terms of casualties. (A chronology with brief descriptions of these events are included in Appendix A.)

Many of these attacks were part of ongoing guerrilla wars or terrorist campaigns—the perpetrators regarded themselves as being at war, even when government authorities rejected this assertion. Yet they differ from wartime sabotage when underground resistance fighters or commandos carried out systematic behind the front lines campaigns of sabotage intended primarily to interdict enemy supply lines. Wartime sabotage is the subject of Appendix B.

THE GROWTH OF HIGH-SPEED RAIL

The threat of attacks on rail lines is especially relevant today as Europe continues to expand its already extensive high-speed rail network, new high-speed projects are scheduled for Asia, and the United States begins work on a number of high-speed passenger rail projects.

The TGV began operations in 1981 with service between Paris and Lyon. Its success led to rapid expansion. By 1995, three additional lines were in operation, and further expansion took place in the late 1990s. In 2003, the TGV network carried its billionth passenger.[2]

High-speed rail service was introduced in the United Kingdom in 1976. In 1993, the Euro Star linked London with Paris and Brussels. What originally began as a service to accommodate heavy traffic between a pair of cities has grown to a network of connecting high-speed lines that covers much of Europe.

With its high volume of rail passengers, Japan was the first country to offer commercial high-speed service. The line between Tokyo and Osaka, which began operation in 1964, remains the most heavily traveled high-speed line in the world. South Korea, China, and Taiwan have also built high-speed rail systems, which continue to expand.[3]

The United States followed a different trajectory, placing greater emphasis on highway construction and air travel. For decades, rail passenger service declined. One by one, the grand passenger trains of the 1940s made their last runs. In recent years, traffic congestion, both on land and in the air, and rising fuel costs have led to the construction of new urban transit systems, but with the exception of Amtrak's Acela service, which runs higher-speed trains on existing conventional tracks, there has been no corresponding development of intercity high-speed rail.[4]

That situation may now change. Fifteen high-speed rail corridors have been identified in the United States, with projects in various stages of development. One of the most ambitious, California's high-speed rail system, eventually will connect San Diego with San Francisco and Sacramento.[5]

New construction will bring with it the opportunity to think about safety and security in advance, not as add-ons. Thus far, high-speed rail strategies have focused almost exclusively on safety, with security focused more on keeping bombs off trains than it is with keeping bombs from being placed under trains. Certainly, bombs on trains pose the most likely current threat, but as this report indicates, some attention should also be paid to protecting the rail lines themselves against sabotage. Security specialists are quick to point out the difficulties of protecting long lines. Traditional perimeter defenses would not be supportable, but now is the time to develop creative approaches to reducing risk. The first step is understanding the nature of the threat, which is the purpose of this analysis.

THE 1995 EVENT

On August 25, 1995, terrorists in France planted a bomb on the rail line used by the TGV (*Train à Grand Vitesse*) high-speed passenger service between Lyon and Paris. The bomb failed to detonate, and a suspected terrorist was soon identified and later killed in a shootout with French police.[6] Nonetheless, this episode, along with others, underscores the potential threat to high-speed passenger trains and the inherent difficulties of transportation-system security.

The violent derailment of a train traveling at speeds near 200 miles per hour, carrying hundreds of passengers, could cause serious casualties. In addition to the publicity, body count, and disruption sought by today's terrorists, high-speed rail is an icon of technological progress, thus adding the emotional value that terrorists seek in their targets. For these reasons, the attempted derailment, although fortunately a failure for the terrorists, takes on particular significance. The case study of this event, initiated as one of the Mineta Transportation Institute's continuing series of case studies of terrorist attacks on surface transportation, was therefore broadened to include a historical review and quantitative analysis of deliberate derailments of passenger trains. (Some derailments of freight trains are included in the database.)

MOTIVE

The attempted derailing of the TGV was part of a terrorist campaign directed against France by the Armed Islamic Group, or GIA (*Groupe Islamique Armé*). The GIA emerged in 1992, after the Algerian government voided the electoral victory of the Islamic Salvation Front (FIS). The GIA was more radical, more violent, and less discriminate in its terrorist campaign than the other Islamic groups and regularly engaged in massacres. In 1993, it broadened its campaign, attacking foreigners living in Algeria to punish them for having anything to do with the despised Algerian government.

The GIA received support from the Algerian community in France, particularly from young first- and second-generation immigrants. The Algerian government, in turn, urged France to destroy these underground networks. In the eyes of the GIA, France was an ally of the Algerian government, which made it the terrorists' enemy. GIA members in France killed Algerian expatriates they considered too moderate.[7]

In December 1994, GIA terrorists hijacked a French airliner, which they reportedly intended to crash in Paris. The plan was disrupted when French commandos stormed the plane.[8]

On July 25, 1995, GIA launched a campaign of terrorism in France itself, beginning with the explosion of a bomb at the Saint-Michel RER (commuter train) station in Paris. This was the first of a series of bombings. The bombs were initially directed at commuter rail and metro stations, but as security tightened, the campaign broadened to include other public places.[9] The GIA placed a total of seven bombs between July 25 and October 17, 1995:

- July 25—A bomb in the metro at the Saint Michel RER station killed eight people and injured more than 50.[10]
- August 17—A bomb detonated in a public trash bin in Paris, injuring 16 people.[11]
- August 26—A bomb was discovered on the Paris-Lyon TVG line near Cailloux sur Fontaine.[12]
- September 3—A bomb exploded at a market in Paris, injuring four people.[13]
- September 7—A bomb in the trunk of a car blew up in front of a Jewish school in Villeurbanna, a suburb of Lyon. The terrorists erred on the timing of the explosion, which was intended to go off just as the children were coming out of the school; eight people were injured.[14]
- October 6—A bomb was discovered in a trash bin in a public toilet in Paris; police quickly evacuated the area before the bomb detonated, and there were only a few injuries.[15]
- October 17—A bomb exploded on an RER commuter train in Paris, injuring 30 people.[16]

The six bombs that exploded killed a total of eight people and injured more than 108.

On November 1, 1995, French police arrested most of the members of the GIA network. At the time of the arrest, the terrorists were planning to detonate a bomb at the public market in Lille, in the north of France. That project was the subject of an earlier MTI case study.[17]

THE DEVICES USED

The devices used in the GIA attacks were all of similar design.[18] They contained a homemade mixture of sodium chlorate, sulfur, black powder, and sometimes charcoal. The percentages differed. The device used in the TGV derailment attempt contained 46.4 percent sodium chlorate, 35.1 percent black powder, and 26.4 percent sulfur. Some of the devices, including that bomb, also contained nails and bolts to make shrapnel. Seven of the bombs were packed in butane gas containers; the last one was packed in a pressure cooker.

The size of the bombs varied. Where concealment was not an issue (the TGV episode, Villeurbanna, and the October 6 bombing in Paris), the terrorists used large, 26-liter containers. The weights of these devices varied. The bomb intended to derail the TGV train weighted 19 kilograms (41.8 pounds); the other two weighed more—26 kilograms (57.2 pounds) because they contained more nails and bolts.

The devices used in the metro had to be easily carried and concealed under the seats. These four devices were packed into 6-liter containers and weighed from six to eight kilograms (13.2 to 17.6 pounds).

All but the TGV device used timers. The detonator of the TGV device was a mechanical system consisting of a 12-volt motorcycle battery connected to a light bulb filled with black powder. A small piece of wood separated two metal plates and prevented completion of the electrical circuit. The piece of wood was, in turn, connected to 30 meters of fishing wire, which was stretched across two sets of tracks. According to the plan, the train was to snag the fishing line, pulling out the wood separator. This would allow the two metal plates to touch, completing the circuit, and the bomb would detonate, sending shrapnel through the windows and sides of the coaches and derailing the train.

The bomb was placed at a point about 10 kilometers north of Lyon. At this point, TGV trains are usually traveling about 200 kilometers (125 miles) per hour, considerably less than its maximum speed. The first train to come by apparently did snag the fishing line, but the piece of wood did not completely slide out, thus preventing contact. Subsequent trains passed without incident. In fact, French authorities calculated that 15 trains passed the bomb before a train driver spotted it.

The bomb would not have achieved its intended result in any case. Although the explosion would have propelled shrapnel up to 150 meters, experiments conducted after the event indicated that the thick steel sides and double windows of the coach would have protected the passengers.

Nor would the explosion have derailed the train. The device was placed about 1.5 meters from the track and about 1 meter below the level of the rail. Much of the blast would therefore have been absorbed by the ballast, causing some local displacement but not enough to destabilize the track and derail the train. Analysis indicates that high explosives like Semtex or C-4 would have to be placed directly next to the track to sever the rail and derail the train. Nonetheless, an explosion would have had a spectacular psychological effect.

PROFILE OF THE PERPETRATORS

Fingerprints found on the tape around the explosive device belonged to Khaled Kelkal, a 24-year old Algerian immigrant who lived in Lyon and was known to the French police. He had recently completed a prison sentence for petty crime. While in prison, Kelkal came under the influence of religious fanatics, and upon his release he traveled to Algeria, ostensibly to visit his family, but possibly also as a further step along the path of radicalization. However, French authorities do not believe Kelkal was recruited into the GIA until just before the bombing campaign. This is a typical jihadist trajectory, beginning with self-identification, and ending in terrorism.[19]

Subsequent investigation revealed that GIA had two teams operating in France, one led by Ait Ali Belkacim and the other by Bouelem Ben Said. Both men were experienced terrorist operatives, extensively trained—Belkacim was trained in Afghanistan—and deployed to France to recruit and train young volunteers, one of whom was Kelkal.

French police believe that Kelkal was involved in the July 11, 1995, assassination of an imam in Paris who was considered by the terrorists to have been too moderate. According to one report, Kelkal escaped in a shootout with French gendarmes at a checkpoint in a suburb of Lyon on July 15, 1995.

On August 17, one of the two GIA terrorist teams detonated a bomb in Paris, while the team led by Ben Said, which included Kelkal and two other new recruits, prepared the attempt on the TGV. They chose August 26 for the attack, the Saturday of the last and busiest weekend of the French summer holiday season, when trains would run full.

With Kelkal clearly identified as a suspect in the failed attempt, the hunt was on. After some internal debate, the authorities decided to go public, broadcasting his identity and offering a reward for information leading to his arrest. Although some reports credit Kelkal with involvement in the car bombing outside the Jewish school in Lyon on September 7, others familiar with the case disagree, saying that Kelkal was clearly on the run at the time. Police tracked him down at a hideout in the mountains, and he was killed in the subsequent shootout. Police found a notebook on his body that enabled them to round up others in the terrorist network. [20]

WHY A DERAILMENT?

The December 1994 hijacking of an Air France Airbus by GIA extremists who, authorities believed, intended to crash it in Paris, provided warning that GIA would likely extend its terrorist campaign into France. Subsequent GIA propaganda denounced the arrests by French authorities of many young people in France for involvement in obtaining and shipping weapons to the Islamist guerrillas in Algeria.[21]

In a bombastic article in al Ansar (a magazine published in London), Rachid Ramda, GIA's representative in Europe, warned that an explosion was going to occur that "will shake and drive France crazy, and will push it into hell." Ramda went on to warn that "soon France will receive clear messages that will bring massive numbers of its citizens to their

television sets."[22] The rhetoric is typical hyperbole, but nonetheless, it does appear to be both a warning and a summons to action.

French authorities were unable to obtain a copy of this article until after the first bombing on July 25, and the article offers no clues as to what the terrorists' targets might be. Authorities previously were aware of lists circulating through GIA channels of Muslim religious leaders considered by the terrorists to be guilty of substandard zeal and therefore possible targets of extremist violence. The July 11 assassination of Abdelbaki Sahraoui (the co-founder of FIS) and his secretary in Paris underscored the threats.[23]

Local terrorist leaders had latitude in target selection and were no doubt guided by operational considerations. There were ample precedents for attacking public surface transportation. Operatives connected with Hezbollah had chosen public places and transportation targets during a previous terrorist campaign in France in the mid-1980s. In the early 1980s, the terrorist group led by the infamous Carlos (Ilych Ramirez Sanchez, known popularly as "Carlos the Jackal") planted bombs aboard France's passenger trains.[24] The GIA terrorists may have been aware of a spectacular derailing of a train in France during the Algerian War in 1961, although train derailings had not figured in the GIA's own campaign in Algeria, and apparently the group had no operational experience in this area.

The terrorists did see surface transportation as easily accessible targets where terrorist operatives could leave their bombs and easily escape. The first bombings, however, prompted a massive security response. Thousands of police and soldiers flooded the train and metro stations, forcing terrorists to seek other targets and attack scenarios. Tight security would have made it extremely risky to carry a bomb into the Lyon or Paris rail station, but the successful derailing of the TGV would have delivered the desired spectacular message to the French people. The lack of technical knowledge of how to derail a train and the failure of the triggering device, however, suggest improvisation. It was an ambitious idea. The terrorists simply did not know how to execute it.

CURRENT SECURITY AND RESPONSE

Such security measures are costly. French authorities, therefore, emphasize the importance of deploying limited resources in ways that terrorists cannot predict, persuading them that they face a high risk of being apprehended. The French also place great importance on intelligence operations to monitor the activities of groups and individuals engaged in terrorist radicalization and recruiting.

In contrast to the heavy security at rail and metro stations, the situation in Lyon posed little risk for the saboteurs. The TGV operated on a dedicated line, which, because of the high speed of the train, was protected by a fence. The fence did not prove to be much of a barrier—the terrorists merely cut their way through it. There were no alarms and few security cameras.

A "sweeper train" sent out at the beginning of each day checks the integrity of the track before passenger trains begin to operate. In this case, however, the inspection train

did not detect the device as it lay at the side of and below the rails. After the incident, inspection trains were double-manned, with a crewmember detailed to watch specifically for obstacles or devices.

The police and army had already been mobilized in response to the terrorist bombing campaign. Along with rail staff, large numbers of policemen and soldiers were deployed to inspect the entire rail system on foot.

A STATISTICAL ANALYSIS OF DERAILMENTS

In 1997, the Mineta Transportation Institute published its first chronology of terrorist (and other significant violent) attacks on surface transportation targets. That chronology of approximately 900 events has since grown to a database of more than 1,600 incidents and is in the process of being further computerized to facilitate increasingly detailed quantitative and trend analysis.

The database currently includes 181 derailment attempts, most of them by terrorists, but a few by environmental extremists, as well as other adversaries. (These episodes are listed in Appendix A.) The first attempt occurred in 1920, but 170 of them occurred after January 1, 1970. Given the small size of this sample, the following statistical analysis should be considered only as indicative. Nonetheless, the incidents provide information on perpetrators' techniques and the results they have achieved. The total number of cases will increase as we identify additional incidents.

Eleven of the derailment cases in the database occurred between 1920 and 1970. Undoubtedly, excluding wartime sabotage, there have been many others which the authors have not yet been able to document in detail. For example, the account of the May 16, 1942 incident indicates that there were 40 trains derailed in India in August 1942 alone. These have been included for historical interest.

The earlier derailment attacks account for 6 percent of all derailment attacks in the database, but account for 39 percent of all the fatalities from derailments and 31 percent of all injuries. Obviously, these were the most spectacular events measured in terms of fatalities, and therefore most easily captured in a historical search for incidents; the average number of deaths per derailment incident prior to 1970 was 34. Since 1970, the number of deaths per incident has averaged just 3.4. If the researchers had access to more information for this earlier period, the number of incidents, including the failed attempts covered in the later years, the average death toll per incident would decline.

One other point is worth mentioning. Derailment attacks overall account for 10.5 percent of all attacks on surface transportation, and 9.5 percent of all fatalities and 7.8 percent of all injuries resulting from these attacks. However. between 1920 through 1970, derailment attacks account for 73 percent of all attacks on surface transportation, and 70 and 92 percent of the injuries respectively. Part of this is artifice is likely a bias in the reporting. But in part, the smaller proportion of derailments in the later period reflects the rise of contemporary terrorism with its hallmark of bombs in public places. In the earlier period, guerrillas sabotaged trains. Today, terrorists kill passengers.

SOME WAYS TO DERAIL TRAINS

Terrorists and other adversaries may attempt to derail trains by placing improvised explosive devices (IEDs) next to the tracks or burying them beneath the rails. We refer to these devices in the database as "track bombs." Or saboteurs may attempt to derail trains by removing spikes, loosening or removing the bolts and plates that hold the rails in place, or removing portions of the track itself. In a few cases, saboteurs have attempted to

derail trains by placing concrete blocks or other objects on the rails. Other methods can be used. In one unique instance, a 14-year old derailed several trams in Lotz, Poland in January of 2008 by using an infrared remote control device. Twelve people were slightly injured in one derailment.

When there are no bombs, it is not always clearly established that a derailment is deliberate. In a few cases where operators have claimed or authorities have suspected sabotage, allegations also have been made that operators were trying to avoid responsibility for poor maintenance by blaming imaginary saboteurs.

The use of bombs was confirmed in 131 of the 181 events in the MTI database, or 72.4 percent of the cases. From the narrative accounts in the database, we suspect track bombs in an additional 18 cases, or 9.9 percent, for a total of 82.3 percent of the derailment events. (See Table 1. Tables do not always precisely total 100 percent due to rounding.)

Mechanical sabotage was confirmed in 21 cases, or 11.6 percent of the total, and was suspected in six cases, for a total of 27 cases, or 14.9 percent of the incidents. Five cases involved other means of sabotage.

Table 1 Derailment Methods

Distribution by Derailment Category

Derailment Type	#	%
Track Bomb Confirmed	131	72.4
Bolts/Track removed	21	11.6
Track Bomb Suspected	18	9.9
Other	5	2.8
Bolts/Track Remove Suspected	6	3.3
Total	**181**	**100.0**

GEOGRAPHIC DISTRIBUTION

The greatest proportion of incidents—33.1 percent—occurred in South Asia; 19.3 percent occurred in Western Europe, 17.1 percent occurred in Russia and the newly-independent states (NIS), and 10.5 percent occurred in the Middle East and North Africa (see Table 2).

Table 2 Distribution by Region

Region	#	%
South Asia	60	33.1
Western Europe	35	19.3
Russia and the NIS	31	17.1
Middle East and North Africa	19	10.5
Southeast Asia	14	7.7
South America	10	5.5
Sub-Saharan Africa	7	3.9
East Asia	2	1.1
North America	2	1.1
Eastern Europe	1	0.6
Total	**181**	**100.0**

India was the site of 42 of the 181 events, or 23.2 percent; the Russian Federation was the site of 27 events, or 14.9 percent; and 17 events, or 9.4 percent of the total occurred in Pakistan (See Table 3).

Table 3 Distribution by Country

Country	#	%
India	42	23.2
Russian Federation	27	14.9
Pakistan	17	9.4
United Kingdom	14	7.7
Thailand	9	5.0
Turkey	9	5.0
Colombia	8	4.4
Spain	7	3.9
France	7	3.9
Algeria	5	2.8
Georgia	3	1.7
Israel	3	1.7
Italy	3	1.7
South Africa	3	1.7
Bangladesh	2	1.1
Czech Republic	2	1.1
Indonesia	2	1.1
United States	2	1.1
Germany	1	0.6
Angola	1	0.6
Argentina	1	0.6
Cambodia	1	0.6

Country	#	%
China	1	0.6
Congo	1	0.6
Djibouti	1	0.6
Japan	1	0.6
Kosovo	1	0.6
Lithuania	1	0.6
Malaysia	1	0.6
Mozambique	1	0.6
Myanmar	1	0.6
Peru	1	0.6
Poland	1	0.6
Sri Lanka	1	0.6
Total	**181**	**100.0**

Terrorist campaigns are often a product of conflicts in the developing world, with seemingly less relevance for the kind of terrorist activity likely to be seen in the more developed world. If we divide the geographic distribution into developed and developing countries, we see that the most events—50.3 percent—have occurred in 10 developing countries, with India, Turkey, Thailand, and Pakistan leading the list; 36.5 percent occurred in 10 developed countries, with Russia, the United Kingdom, Spain, and France leading the list. Together, these 20 countries accounted for 86.8 percent of all events (see Table 4).

Table 4 Comparison of Events in Ten Developed and Ten Developing Countries

Developed Country				Developing Countries			
Rank	**Country**	**#**	**%**	**Rank**	**Country**	**#**	**%**
1	Russian Federation	27	14.9	1	India	42	23.2
2	United Kingdom	14	7.7	2	Pakistan	17	9.4
3	Spain	7	3.9	3	Turkey	9	5.0
4	France	7	3.9	4	Thailand	9	5.0
5	Israel	3	1.7	5	Colombia	8	4.4
6	Italy	3	1.7	6	Bangladesh	2	1.1
7	United States	2	1.1	7	Argentina	1	0.6
8	Germany	1	0.6	8	Cambodia	1	0.6
9	Japan	1	0.6	9	China	1	0.6
10	Lithuania	1	0.6	10	Congo	1	0.6
	Total	**66**	**36.5**		**Total**	**91**	**50.3**

The deadliest attacks have occurred in the developing countries. We can see this by comparing the 149 bombing attacks in the more developed world with those occurring in the developing world. In the more developed areas (North America, Western Europe, Russia and the NIS, Eastern Europe, and East Asia), there were a total of 62 track-bomb attacks, resulting in 141 fatalities, or 2.3 fatalities per attack. In the developing world

(South Asia, the Middle East and North Africa, Southeast Asia, Sub-Saharan Africa, and South America), there were 87 attacks, resulting in 406 fatalities, or 4.7 fatalities per attack (see Table 5).

If we include the fatalities resulting from mechanical sabotage (not shown in Table 5) and consider only those since the 1970s, we have a total of 70 incidents resulting in 33 fatalities in the developed world, or .47 fatalities per attack, and 100 incidents resulting in 545 fatalities in the developing world, or 5.4 fatalities per attack. However, one single event in the developing world resulted in 252 fatalities (the August 11, 2001 attack in Angola), which skews the average. Omitting this incident gives us a total of 99 incidents with 293 fatalities or 3.0 fatalities per incident, a lethality rate that is still more than eleven times that of the developed world.

Because of the one previously mentioned massacre, Angola leads the world with the most fatalities resulting from deliberate derailments. India follows with 147 fatalities, Mozambique with 58, Pakistan with 37, and Russia with 32.

Table 5 Casualties per Event (Bombings Only)

Region	Incidents	All Fatalities	All Injuries	Fatalities per Event	Injuries per Event
South Asia	48	52	224	1.08	4.67
Russia and the NIS	31	33	306	1.06	9.87
Western Europe	28	28	173	1.00	6.18
Middle East and North Africa	16	6	56	0.38	3.50
South America	9	0	0	0.00	0.00
Sub-Saharan Africa	7	323	362	46.14	51.71
Southeast Asia	7	25	130	3.57	18.57
East Asia	2	80	80	40.00	40.00
Eastern Europe	1	0	0	0.00	0.00
North America	0	0	0	0.00	0.00
TOTAL	**149**	**547**	**1331**	**3.67**	**8.93**

TARGETS

In most events, the target of the attack is a passenger train—97 of the incidents, or 53.6 percent of the total, involved passenger trains. Freight trains were struck in 22 cases. They are included because some were simply the first train to come along right after a rail line was blown up or they became inadvertent targets because of erroneous timing by the terrorists. In some cases, however, the freight train appears to have been the target. The tracks themselves were sabotaged in 51 cases—terrorists wanted to derail whatever train came along. One train was derailed by a bomb in a station, and one special tourist train was attacked (see Table 6).

Table 6 Targets

Target	#	%
Train, Passenger (Intercity or Commuter)	97	53.6
Railway Tracks	51	28.2
Train, Freight	22	12.2
Railway Bridge	5	2.8
Railway, Unspecified	1	0.6
Train Station, Unspecified	1	0.6
Train Station, Unspecified	1	0.6
Train, Tourist	1	0.6
Train, Trolley	1	0.6
Train, Troop	1	0.6
Total	**181**	**100.0**

SABOTAGE OR SLAUGHTER?

In 69 of the 181 cases in the chronology, the adversaries succeeded in derailing a train. In 40 more cases, they clearly attempted to derail a train. For example, the train passed over but failed to detonate the bomb, or the bomb detonated but failed to derail the train, or the train was able to stop in the nick of time. The intent in the remaining 72 cases is not clear. Clearly, some were attempted derailings, but authorities discovered the bomb or sabotage of the line well before a train was due to pass. In some cases, authorities were warned in advance—the terrorists were satisfied to demonstrate that they could derail trains if they chose to do so. In a few cases, the threat of derailment was connected with an extortion attempt or was intended merely to cause disruption and alarm.

SUCCESS IN DERAILING

When we think of derailments, we envision saboteurs plunging crowded passenger trains into deep ravines, killing hundreds. The data does not support this perception. Terrorists were able to actually derail all or a portion of the train in 67 of the 181 attacks in the database, or 37 percent. In 149 bomb attacks, terrorists derailed trains in 47 cases or 31.5 percent of the time. In 25 incidents involving mechanical sabotage, terrorists derailed 19 trains, or 76 percent of the cases. However, these figures include all bombings and all sabotage attempts. If we limit the cases to those where it was clearly the attempt of the adversaries to derail a train as opposed to sabotage the tracks, then in 81 attempted derailings with bombs, terrorists derailed 47 trains, a success rate of 58 percent. In 22 attempted derailings using mechanical means, the adversaries succeeded in 19 times for a success rate of 86.4 percent. While attempted derailings with explosives are almost four times more common than using mechanical means, mechanical sabotage is clearly more effective. One should, however, be wary of a reporting bias here as explosions or the discovery of explosives are more likely to be reported than incidents of mechanical sabotage when no derailing occurs (see Table 7).

Table 7 Success in Derailment

Type of Attack	#	%
Mechanical Sabotage/Derailment	19	10.5
Track Bombs/Derailment	47	26.0
Other Sabotage/Derailment	1	0.5
Mechanical Sabotage/No Derailment	6	3.3
Track Bombs/No Derailment	102	56.4
Other Sabotage/No Derailment	4	2.2
Undetermined	2	1.1
Total	**181**	**100.0**

A total of 955 persons were killed in the 181 events, an average of 5.28 persons per event. In 148 of the events, there were no fatalities at all. The median number of fatalities for the 33 events with fatalities (between 1920 and 2009) is 21. The median number of fatalities for the 11 events between 1920 and 1961 is 24. The median number of fatalities in events with fatalities in the period 1977 (the date of the first entry after 1961) to 2009 is six. A sample comparable to the 11 events between 1920 and 1961 would be the 11 deadliest events from the post-1961 period. The latter events have a median of 26 fatalities, close to that in the earlier period. The larger number of more recent low-level incidents reduces the average but not the median number of fatalities per incident These figures are provided in Table 8.

Table 8 Mean Lethality Comparison

Type of Event with Fatalities	# of Events	Median Lethality
All between 1920 and 2009	33	21
All between 1977 and 2009	22	6
All between 1920 and 1970	11	24
Most Lethal Events: 1961 to 2009	11	26

What can we make of this? Derailments with significant casualties continue to occur, along with numerous failed attempts and low-level events. As in all terrorism, our concern is driven not by the deadly statistics but by the worrisome spectaculars.

CASUALTIES BY TARGET

Not surprisingly, most of the fatalities in terrorist derailments have occurred on passenger trains. In the 181 attacks, 923 of the 955 fatalities (or 97.3 percent) occurred on passenger trains. Similarly, 95.6 percent of the 2,134 injuries occurred on passenger trains. Where terrorists blew up or sabotaged railway tracks, there were no fatalities or injuries, simply because the bomb or tampering was discovered before any train arrived (see Table 9).

Table 9 Casualties by Target

Target	Non-U.S. Victim Fatalities	% of Total	U.S. Fatalities	% of Total	Non-US Victim Injuries	% of Total	U.S. Injuries	% of Total
Train, Passenger (Intercity or Commuter)	923	97.7	6	60.0	1860	96.1	180	90.9
Train, Freight	12	1.3	0	0.0	32	1.7	0	0.0
Train Station, unspecified	8	0.8	0	0.0	0	0.0	0	0.0
Railway Tracks	1	0.1	3	30.0	1	0.1	18	9.1
Train, Tourist	1	0.1	1	10.0	9	0.5	0	0.0
Train, Trolley	0	0.0	0	0.0	12	0.6	0	0.0
Train, Troop	0	0.0	0	0.0	22	1.1	0	0.0
Total	**945**	**100.0**	**10**	**100.0**	**1936**	**100.0**	**198**	**100.0**

CASUALTIES BY MEANS OF SABOTAGE

Again with the caveat that the total number of cases is very small, it appears that terrorists have caused more casualties per incident by mechanical sabotage (for example, removing bolts or track) than by blowing up passing trains. As Table 9 shows, events involving confirmed IEDs resulted in an average of less than three fatalities per event, while suspected IEDs caused 10 fatalities per event. Combining the two gives us an average of four fatalities per event, or 57.3 percent of the total number of fatalities.

In contrast, cases of confirmed mechanical sabotage resulted in 12 fatalities per event, while suspected mechanical sabotage resulted in 26 fatalities per event, for a combined average of 15 fatalities per event.

Overall, bombs killed 547 persons and injured 1,331, while mechanical sabotage killed 408 persons and injured 791 (see Table 10).

Table 10 Casualties by Type of Attacks

Type of Attack	# of Events	All Victim Fatalities	Fatalities per Event	% of all fatalities	All Victim Injuries	Injuries per Event	% of All Injuries
Bolts/Track Remove Suspected	6	159	26.50	16.6	210	35.00	9.8
Bolts/Track Removed	21	249	11.86	26.1	581	27.67	27.2
Track Bomb Suspected	18	175	9.72	18.3	302	16.78	14.2
Track Bomb Confirmed	131	372	2.84	39.0	1029	7.85	48.2
Other	5	0	0.00	0.0	12	2.40	0.6
Total Attacks	**181**	**955**	**5.28**	**100.0**	**2134**	**11.79**	**100.0**
Total Bolts and Tracks	27	408	15.11	42.7	791	29.30	37.1
Total Bombs	149	547	3.67	57.3	1331	8.93	62.4

DISTRIBUTION OF BOMBING INCIDENTS

The distribution of the 149 track-bombing events presents only a slightly different picture. Again, most of the bombings occurred in South Asia—32.2 percent, Russia and the NIS—20.8 percent, Western Europe—18.8 percent, and the Middle East and North Africa—10.7 percent (see Table 11).

Table 11 Distribution of Bombing Incidents

Region	#	%
South Asia	48	32.2
Russia and the NIS	31	20.8
Western Europe	28	18.8
Middle East and North Africa	16	10.7
South America	9	6.0
Southeast Asia	7	4.7
Sub-Saharan Africa	7	4.7
East Asia	2	1.3
Eastern Europe	1	0.7
North America	0	0.0
Total	149	100.0

India was the site of the most bombing incidents with 30, followed by Russia with 27, Pakistan with 16, and United Kingdom with 13 (see Table 12).

Table 12 Distribution of Bombings by Country

Country	#	%
India	30	20.1
Russian Federation	27	18.1
Pakistan	16	10.7
United Kingdom	13	8.7
Colombia	8	5.4
Turkey	8	5.4
Spain	7	4.7
Algeria	5	3.4
France	5	3.4
Thailand	4	2.7
Georgia	3	2.0
Israel	3	2.0
South Africa	3	2.0
Italy	2	1.3
Angola	1	0.7
Argentina	1	0.7
Bangladesh	1	0.7
Cambodia	1	0.7
China	1	0.7
Congo	1	0.7
Czech Republic	1	0.7
Djibouti	1	0.7
Indonesia	1	0.7
Japan	1	0.7
Kosovo	1	0.7
Lithuania	1	0.7
Mozambique	1	0.7
Myanmar	1	0.7
Sri Lanka	1	0.7
Germany	0	0.0
Malaysia	0	0.0
Peru	0	0.0
Poland	0	0.0
United States	0	0.0
Total	149	100.0

**Note*: Countries with 0 bombing incidents are listed because they experienced track removal or other types of derailment attempts.

BOMB DERAILMENTS BY TARGET TYPE

Seventy-four of the 149 bomb derailment events, or 49.7 percent targeted passenger trains; freight trains were attacked in 22 events or 14.8 percent (see Table 13).

Table 13 Bomb Derailments by Target Type

Target	#	%
Train, Passenger (Intercity or Commuter)	74	49.7
Railway Tracks	44	29.5
Train, Freight	22	14.8
Railway Bridge	5	3.4
Railway-Unspecified	1	0.7
Train Station, Unspecified	1	0.7
Train Station, Unspecified	1	0.7
Train, Trolley	1	0.7
Train, Troop	1	0.7
Total	149	100.0

SINGLE- AND MULTIPLE-BOMB ATTACKS

One hundred of the confirmed bomb attacks and 18 of the suspected bomb attacks (79.2 percent) involved a single IED. Thirty-one of the confirmed bomb attacks (20.8 percent) and none of the suspected bomb attacks involved multiple devices. In the 149 events, terrorists planted 213 bombs (see Table 14).

Table 14 Single and Multiple Attacks

Type	#	% of All
Track Bomb Confirmed		
Single	100	67.1
Multiple	31	20.8
Track Bomb Suspected		
Single	18	12.1
Multiple	0	0.0
All Bombs		
All Single	118	79.2
All Multiple	31	20.8

OUTCOMES OF THE BOMBINGS

More than half of the IEDs (53 percent) detonated on target; 22 (10 percent) detonated early, away from the target, or otherwise malfunctioned; 73 (34 percent) were rendered

safe (see Table 15).

Table 15 Outcomes of Bomb Attacks

Detonation or Release of IED or IID	#	% of bombs
Detonated or Released on Target	112	53
EOD Successful—Rendered Safe	73	34
Detonated Early or Away from Target, or Malfunctioned	22	10
Failed to Detonate or Release	4	2
Unknown	2	1
Total	213	100

CASUALTIES BY BOMBING TARGET

Bomb derailments caused 523 deaths on passenger trains, or 95.6 percent of the total bomb-related fatalities, and 95.9 percent of the total bomb-related injuries (see Table 16).

Table 16 Casualties by Target

Derailment Type	All Victim Fatalities	% of All Total	All Victim Injuries	% of All Total
Train, Passenger (Intercity or Commuter)	523	95.6	1276	95.9
Train, Freight	12	2.2	32	2.4
Train Station, Unspecified	8	1.5	0	0.0
Railway Tracks	4	0.7	1	0.1
Train, Troop	0	0.0	22	1.7
Train, Trolley	0	0.0	0	0.0
Railway Bridge	0	0.0	0	0.0
Railway-Unspecified	0	0.0	0	0.0
Train, Tourist	0	0.0	0	0.0
Total	547	100.0	1331	100.0

Bombings killed an average of fewer than three persons per bomb detonated on target (see Table 17). MTI's data base currently indicates that b*ombs left in the passenger compartments of passenger trains themselves provide a higher return on investment—more than double the lethality—around seven persons per bomb detonated.*

Table 17 Casualties per Bomb

Fatalities and Injuries Per Bomb and Per Bomb Detonated On Target											
Derailment Type	**# of Events**	**# of Bombs**	**# of Bombs on Target**	**All Victim Fatalities**	**Fatalities per Bomb**	**Fatalities per bomb on target**	**% of All Fatalities**	**All Victim Injuries**	**Injuries per Bomb**	**Injuries per Bomb on Target**	**% of All Injuries**
Track Bomb Confirmed	131	195	98	372	1.91	3.80	68.0	1,029	5.28	10.50	77.3
Track Bomb Suspected	18	18	14	175	9.72	12.50	32.0	302	16.78	21.57	22.7
Total Bombs	**149**	**213**	**112**	**547**	**2.57**	**4.88**	**100.0**	**1,331**	**6.25**	**11.88**	**100.0**

POSSIBLE SECURITY MEASURES

A great deal of attention has, understandably, been devoted to the safety of high-speed rail systems; much less attention has been devoted to security. Most security measures address the challenge of keeping explosive devices off the trains. Rail security rarely appears in discussions of high-speed rail projects.

Security against sabotage of rail lines comprises physical barriers, surveillance, alarms that alert operators to tampering, and inspection. It should also involve cyber security to prevent tampering with electronic controls for switching of tracks.

High-speed trains usually require specially built rails on exclusive right-of-ways. These are protected by fences, which can be alarmed and linked to CCTV systems to identify possible intruders.

Seamless rails and other components can be designed to make mechanical sabotage more difficult. Low-voltage currents sent through the rails can alert operators to breaks and possibly to tamper attempts.

Surveillance of long lines over great distances is always difficult; however, high-speed rail operators can utilize camera coverage and also modern technology to maintain visual coverage and investigate suspicious events. It may even be possible to program small aerial drones to follow train routes and watch for intruders or evidence of tampering.

In addition, operators may enlist local communities along right-of-ways to report suspicious activity. Citizens' tips can be encouraged by instruction and special access numbers.

France and Japan have shown that sweeper trains can be used to verify the integrity of train lines before regular traffic starts. Research should explore the use of small robot inspection vehicles, which could be loaded with a variety of sensors, to identify sabotage attempts. Under high threat conditions, they could even precede each train by several miles, thus providing early warning.

Sabotage threats or attempts may require entire lines to be inspected manually, as is done in France. On 9/11, New York City shut down its entire subway system until staff and police could check every mile of tunnel. Such inspections require a great deal of manpower and can take a long time, disrupting operations. Operators might consider working with local police departments along right-of-ways to develop contingency plans that divide emergency inspections into local sectors. A 400-mile search could thus become 80 five-mile searches. Local personnel could be trained, and track vehicles could be pre-deployed to facilitate rapid inspection. Rail staff could concentrate on areas not convenient to local law enforcement. Preexisting contingency plans and exercises can facilitate efficient response in emergency conditions.

Coach design is well understood, and safety has improved. It is noteworthy that accidental derailments of high-speed trains have not resulted in many fatalities. Because of their rigid connection, derailed cars that have come off the tracks did not tip over. Nonetheless, emergency response plans should be in place to cover events along entire train routes.

CONCLUDING OBSERVATIONS

Rail lines are obviously vulnerable to sabotage. They are easily observable, accessible, and difficult to protect.

A small quantity of strategically placed explosives can cause a derailment that may result in significant casualties, although technical knowledge is required. More research is needed to determine the composition and quantity of explosives required to sever rails or derail heavy locomotives and rolling stock.

Derailments may also be attempted by mechanical means, such as removing spikes or plates, or even by switching tracks electronically. Some mechanically caused derailments have resulted in even greater casualties than those caused by explosives. A few derailments have been attempted by placing objects on the rails, but these have not resulted in casualties.

Despite the vulnerability of rail lines, terrorists have attempted far fewer derailments than attacks on train stations or on trains themselves. The events in MTI's statistical database indicate that terrorists obtain much higher average body counts per bomb on trains, and a somewhat higher body count per bomb left in stations, than they achieve with attempts to derail trains.

One advantage of a derailment over a bombing on a train is that only one device is required, and mechanical sabotage requires no explosive device at all. Guaranteeing high body counts with explosives on trains requires multiple devices.

Getting a bomb to go off at the right time is difficult. Timers are unreliable if the trains do not run precisely on time, and pressure triggers do not always work. Detonation on command is the most reliable method, but it poses the greatest risks to the saboteur.

Our chronology of derailments indicates that although terrorists are the majority of the perpetrators, they are not the only ones. In a few cases, environmental extremists also have attempted to derail trains, albeit without success, and there have also been random acts of vandalism.

APPENDIX A: A CHRONOLOGY OF DELIBERATE DERAILMENTS

The derailments listed in this chronology are in MTI's computerized database of terrorist and serious criminal attacks on public surface transportation. Brief narratives are included only to give the reader a feel for the events. The database continues to grow as more incidents are included. We invite readers to submit events that we have missed. Please submit incident information to mti@mti.sjsu.edu.

July 8, 1920: India—Rail sabotage by unknown adversaries derails a passenger train near Belur, killing 25 people, injuring 60 others.

October 7, 1920: India—Hostile workers sabotage the rails, causing the derailment of the Madras-Bangalore mail train; 13 are killed, 15 injured.

December 27, 1930: China—Bandits blow up the locomotive of a train in Manchuria in order to rob and kidnap passengers; 80 die in the attack.

January 12, 1939: India—Unidentified attackers sabotage the tracks causing derailment of the Dehra Dun Express; 21 die, and 21 are injured.

August 12, 1939: United States—Unidentified attackers sabotage the tracks, causing derailment of the Union Pacific's "City of San Francisco" as it passes through Nevada; 24 die, and 115 are injured.

May 16, 1942: India—A Sindh sect sabotages the tracks, causing the derailment of the Punjab mail train, then attacks passengers; 22 die, and 26 are injured. (Four days later, another train averts a similar attempt. In August 1942, 40 trains were derailed in India.)

December 3, 1947: France—Unidentified perpetrators, possibly hostile workers, sabotage the tracks, derailing a Paris-Lille train; 21 die.

May 8, 1959: Indonesia—Unidentified perpetrators sabotage the tracks, derailing an express train; 92 die, and 14 are injured.

March 26, 1961: Myanmar—A bomb planted under the tracks by Karen rebels derails the Mandalay-Rangoon train, killing 23 and injuring 100.

April 19, 1961: India—Unidentified assailants sabotage the tracks, derailing a train; 23 die, 77 are injured.

June 18, 1961: France—A passenger train is derailed, killing 28 people, injuring 170. Initially thought to be an accident, a subsequent investigation led to the conclusion that the track was sabotaged by a bomb.

December 7, 1977: Israel—Authorities arrest members of an Arab guerrilla group plotting to sabotage a rail line near Jerusalem.

March 4, 1979: Israel—Terrorists detonate a bomb, derailing a train; no casualties are reported. Authorities find a second bomb on the line.

July 18, 1981: India—Mechanical sabotage causes the derailment of a passenger train, killing 35 people.

August 2, 1985: Mozambique—A track bomb derails a train, killing 58 people, injuring 160 others.

May 15, 1986: Bangladesh—A track bomb derails a passenger train, killing 25 and injuring 45.

October 27, 1986: United Kingdom—A track bomb derails a freight train in Northern Ireland; there are no injuries.

December 1, 1988: Peru—Guerrillas mechanically sabotage a track, derailing a tourist train; 2 are killed, 9 injured.

April 19, 1989: India—Suspected track sabotage derails the Bangalore-Delhi express, killing 67 and injuring 137.

June 2, 1989: Thailand—A bomb on the tracks derails a passenger train, injuring 3.

August 2, 1989: United Kingdom—The Irish Republican Army (IRA) bombs the Belfast-Dublin line 2 minutes before the train is due to pass; no casualties.

November 26, 1990: Japan—Radicals detonate a bomb on the tracks of Japan's high-speed train; no casualties.

February 25, 1991: United Kingdom—The IRA bombs a British Rail line minutes before a high-speed intercity train is due to pass; no casualties.

August 4, 1991: Spain—The Basque ETA claims to have placed bombs on four rail lines; only two explode.

January 18, 1992: India—A bomb on the tracks derails a train, killing eight.

April 1, 1992: Malaysia—Saboteurs remove the pins on the tracks in an attempt to derail a passenger train, but the engineer stops the locomotive in time.

July 21, 1992: Argentina—Warned by an anonymous tip, police disarm explosives on a rail line 15 minutes before a train is scheduled to pass.

August 30, 1992: Turkey—Guerrillas mechanically sabotage the tracks, derailing a passenger train; 4 are injured.

October 21, 1992: United Kingdom—IRA terrorists detonate a bomb on the tracks north of London, damaging a passing train and injuring 3.

October 21, 1992: United Kingdom—An IRA bomb destroys tracks in North London.

October 25, 1992: Turkey—Kurdistan Workers' Party (PKK) guerrillas plant a mine that derails a passenger train, killing 3 and injuring 47.

August 15, 1993: Cambodia—Guerrillas detonate a bomb, derailing a train; 2 are killed, 5 injured.

October 16, 1993: Bangladesh—Armed attackers remove a section of track, derailing a train, which they then rob; no fatalities.

March 30, 1994: Thailand—Separatists detonate a bomb, derailing a train; no fatalities.

November 8, 1994: Lithuania—A bomb destroys a bridge near Vilnius, and bystanders warn an oncoming train to stop; no injuries.

August 26, 1995: France—Algerian terrorists plant a bomb on the tracks of the TGV between Paris and Lyon, but it fails to detonate.

October 10, 1995: United States—Unidentified saboteurs derail the Sunset Limited near Phoenix; 1 person is killed, and 65 are injured.

April 8, 1998: Spain—ETA separatists plant 10 bombs on the tracks near Pamplona; none explode.

June 25, 1998: India—Separatists detonate a bomb, derailing a train in Kashmir, injuring 23.

August 7, 1999: India—A bomb blast derails a train in Assam; hours later, authorities find and defuse a powerful bomb beneath a nearby bridge.

August 9, 1999: India—A bomb targeting a passenger train derails a freight train instead, injuring five. It appears that a passenger train was the intended target.

August 11, 1999: India—A bomb blast on a rail bridge halts rail traffic in Assam.

August 19, 1999: India—A train is damaged by a bomb on the railway track in Assam. One person injured.

February 11, 2000: India—A bomb destroys a rail line minutes before an express passenger train is due to arrive; 5 are killed, 11 injured.

May 25, 2000: India—Police find and defuse three live mortar rounds on a rail line.

June 30, 2000: United Kingdom—A bomb damages the Belfast-Dublin rail line; no injuries.

September 25, 2000: United Kingdom—Terrorists detonate a 50-lb explosive device closing a rail line in Northern Ireland. Terrorists alerted authorities prior to the blast.

February 7, 2001: United Kingdom—The IRA detonates a bomb on a rail line in Northern Ireland; no one is injured, but authorities close the line to search for more devices.

February 13, 2001: United Kingdom—A 100-lb bomb explodes, halting service on the Dublin to Belfast line. (The same line was targeted in June 2000.)

March 9, 2001: United Kingdom—Authorities defuse a 46-lb bomb on the Dublin to Belfast line. Authorities were warned by the terrorists of an attack 11 days earlier.

March 28, 2001: Russia—Chechen rebels detonate three bombs, derailing a passing train; no injuries.

April 12, 2001: Colombia—Guerrilla forces bomb railroad tracks near Magdalena.

April 25, 2001: United Kingdom—Police defuse a bomb on a rail line in Northern Ireland.

August 3, 2001: Spain—Basque separatists claim responsibility for an explosive attack on the Spanish high-speed rail line.

August 11, 2001: Angola – Guerrillas mine a rail line causing a train carrying refugees to derail, then attack the train; 252 are killed, 165 injured.

August 15, 2001: Spain—Basque separatists detonate two bombs on the Madrid to Seville high-speed rail line.

August 22, 2001: Russia—Authorities defuse five bombs on a railway in Chechnya.

August 26, 2001: Russia—Chechen guerrillas attempt to derail a freight train.

August 28, 2001: Colombia—Authorities defuse a bomb on the rail line near Lima, in Guajira Department.

August 30, 2001: Russia—Authorities defuse five bombs on a rail line in Chechnya.

September 21, 2001: India—Guerrillas in Assam detonate a bomb on the tracks and derail a train, injuring 100 persons.

October 11, 2001: Pakistan—Guerrillas detonate a bomb under a freight train.

October 26, 2001: Russia—Authorities defuse two bombs on a rail bridge in Chechnya.

November 12, 2001: India—Guerrillas blow up a railway line in Jharkhand.

December 3, 2001: Indonesia—A bomb explodes on a rail line in West Java as a train passes. Authorities discover a second device ten meters from the first.

December 4, 2001: United Kingdom—Authorities defuse an 80-lb bomb on the Dublin-Belfast rail line.

January 12, 2002: Russia—Authorities defuse a command-detonated bomb on a rail line in Chechnya.

February 20, 2002: India—Maoist guerrillas blow a rail line in Jharkhand derailing a train.

March 30, 2002: Russia—A bomb on the tracks damages a freight train in Chechnya.

May 2, 2002: Colombia—Guerrillas blow up a track derailing a freight train in Guajira.

May 7, 2002: India—In a continuing campaign of sabotage, Maoist guerrillas blow up tracks at two locations in Jharkhand.

May 13, 2002: India—Saboteurs pull bolts and remove track to derail a train near Jaunpur; 12 die, 100 are injured.

June 6, 2002: Colombia—Authorities defuse a bomb on the tracks in Magdalena Department.

June 6, 2002: Colombia—Guerrillas blow up tracks derailing a freight train in Guajira.

June 6, 2002: Colombia—Guerrillas blow up tracks derailing a freight train in Magdalena.

July 1, 2002: Colombia—Guerrillas blow up a rail line near Sevilla.

July 2, 2002: Israel—Terrorists detonate a bomb on the rail line near Rehovot, injuring the engineer.

August 25, 2002: Congo—A bomb on the track derails a freight train, killing 12 and injuring 30.

September 4, 2002: Russia—Authorities defuse a bomb on the rail line in Chechnya.

September 8, 2002: Italy—Authorities defuse four crude explosive devices on the rail line between Sorrento and Naples.

September 11, 2002: Italy—Authorities defuse another bomb on the rail line between Sorrento and Naples.

October 28, 2002: Russia—Guerrillas blow up the tracks derailing a freight train in Chechnya.

October 30, 2002: South Africa—A bomb explodes at a rail bridge at New Canada; two more devices explode on the rail line near New Canada.

October 30, 2002: South Africa—A bomb explodes the Soweto Midway Rail Station.

October 30, 2002: South Africa—A bomb destroys a rail line in Protea, killing 1 person, wounding another.

November 18, 2002: Czech Republic—A car was deliberately left on the tracks in front of a passenger train near Prague. The train smashed into the car, but there were no injuries.

November 19, 2002: Czech Republic—Authorities defuse a bomb on a rail line near Prague.

December 21, 2002: India—Saboteurs derail the Hyderabad-Bangalore Express, killing 20 and injuring 80.

April 12, 2003: Serbia—Terrorists detonate a bomb damaging a rail bridge in Kosovo.

April 26, 2003: India—A freight train is damaged by a bomb on the rail line in Sivasagar.

July 15, 2003: India—Maoist guerrillas remove tracks, causing a train to derail in Bihar State; no injuries.

July 15, 2003: India—Maoist guerrillas sabotage tracks by mechanical means, causing a train to derail in Bihar; no injuries.

July 15, 2003: India—Maoist guerrillas bomb the tracks in Bihar, but an approaching train is able to stop before derailing.

July 15, 2003: India—In one of four coordinated attacks, Maoist guerrillas blow up tracks in Bihar, causing a derailment; no injuries.

August 16, 2003: Pakistan—Two bombs explode on the tracks of Karachi's main commuter line minutes before two passenger trains were due to cross the locations.

August 19, 2003: India—A bomb explodes on the tracks near Muzaffarnagar, injuring 2 workers.

August 25, 2003: India—Extremists detonate a remote-controlled bomb on the rail line in Assam, hours before three passenger trains were due to cross the area.

September 3, 2003: Russia—Two remote-controlled bombs, five meters apart, explode derailing a commuter train near Kislovdosk; 5 people are killed, 91 injured.

October 2, 2003: Pakistan—A bomb damages a railway bridge near Quetta.

November 1, 2003: India—A bomb derails a train in Assam, injuring 2 persons.

December 18, 2003: Russia—A bomb detonates under a freight train in Chechnya.

December 26, 2003: Spain—Police disarm a bomb buried under the tracks of the Zaragoza-Barcelona line.

December 26, 2003: Pakistan—Two bombs explode under the tracks of the rail line in Karachi.

January 13, 2004 : Russia—Authorities disarm a powerful bomb at a railway junction near Shelkovskaya.

January 18, 2004: Djibouti—A mine planted under the tracks of the Ethiopia-Djibouti line damages a commuter train, injuring 6 persons.

February 8, 2004: Russia—Police find 44kg of explosives near the rail line in Ingushetia.

February 21, 2004: France—A bomb is found on the line between Paris and Basel. This is after a group calling itself AZF threatens to derail France's high-speed trains unless paid a ransom of $4 million.

March 1, 2004: Spain—Terrorists attempt to bomb the tracks and derail Spain's high-speed (AVE) train; no injuries.

March 16, 2004: Georgia—A bomb blast damages the rail line near Tbilisi, but an approaching train manages to stop before coming to the damaged section.

March 18, 2004: Georgia—A bomb, possibly on the tracks, blows up igniting an empty tank car near Tbilisi.

March 24, 2004: France—A rail employee finds a bomb on the rail line between Paris and Basel, Switzerland. It is the second bomb on the rail network in two months. The earlier device, found near Limoges on February 21, was planted by a group calling itself AZF, which warned of further bombs unless the group received $4 million in ransom. In all, the AZF planted 10 bombs, none of which detonated, on France's rail lines before announcing an end to its campaign on March 25. Thus far, none of the terrorists have been apprehended.

May 4, 2004: Germany—Saboteurs bolt metal plates to the tracks in an attempt to derail the German high-speed (ICE) train between Cologne and Berlin; the driver is able to slow the train and roll over the plates without mishap.

May 29, 2004: Russia—Unidentified attackers blow up a section of track, derailing a train and injuring 8 people. Authorities find and defuse a second device.

August 25, 2004: Pakistan—A time-fused bomb destroys the main railway track in the Northwest Territory. However, it misses derailing a passenger train, which is running late.

August 25, 2004: Algeria—Two bombs damage the track outside Ahnif train station, injuring 1 person.

August 26, 2004: India—Militants detonate a bomb on the tracks near an oil refinery, injuring seven persons. This is one of four blasts in a series of bomb attacks in the region.

August 26, 2004: Algeria—In a second attack in Ahnif, terrorists detonate a bomb intended for a passenger train. A flock of sheep crossing the tracks set the bomb off prematurely.

August 29, 2004: Turkey—A landmine planted under the tracks of the Tatvan-Elazig line derails an empty train, injuring 1 person.

September 24, 2004: United Kingdom—Authorities defuse a pipe bomb on the track of a rail line in Belfast.

November 16, 2004: Russia—A passenger train strikes a mine in Chechnya but does not derail.

January 24, 2005: Pakistan—Guerrillas detonate a bomb on the railroad tracks, injuring 5 persons.

February 1, 2005: Pakistan—Guerrillas bomb a railway line near Quetta. The bomb shatters the windows of a passing train, injuring 4 persons.

February 5, 2005: Pakistan—Guerrillas bomb the tracks near Quetta but miss the train.

February 7, 2005: Pakistan—Militants bomb the rail line to Afghanistan.

March 4, 2005: Pakistan—Militants bomb the rail line in Dera Ghzi Khan, but miss a passenger train.

March 9, 2005: Algeria—A bomb on the rail line narrowly misses a fuel train.

March 12, 2005: Russia—Authorities defuse a bomb on the Baku-Moscow rail line.

March 17, 2005: Pakistan—Two trains traveling opposite directions on the rail line near Lahore are attacked by two bombs. The second blast kills 1 and injures 5 persons.

March 22, 2005: Pakistan—Militants bomb the rail line between Baluchistan and the rest of Pakistan.

March 23, 2005: Pakistan—Militants place bombs on the tracks in three places near Quetta.

May 6, 2005: Thailand—Authorities discover that militants have removed the bolts on the rail line in Narathiwat Province.

May 27, 2005: Thailand—Separatists detonate two rail-side bombs that derail a maintenance train in Narathiwat Province. The separatists open fire on the derailed train; 22 persons are injured.

May 28, 2005: Turkey—PKK guerrillas blow up the track, derailing a freight train; no injuries.

June 12, 2005: Russia—Unidentified attackers blow up the track, derailing a Moscow-Grozny train; no injuries.

July 2, 2005: Turkey—Attackers blow up the track, derailing a train on its way to assist passengers on another train that had been bombed; 6 die, and 8 are injured.

July 6, 2005: Russia—Unidentified attackers blow up the track, damaging a freight train.

July 24, 2005: Russia—A bomb detonates on a rail line in Dagestan, killing 1 person, injuring 40.

July 24, 2005: Turkey—A remote-controlled bomb derails a postal train in Mus Province.

August 20, 2005: Russia—A bomb on the track derails a passenger train; no injuries.

August 21, 2005: Pakistan—A bomb on the tracks derails a freight train, injuring 2.

September 16, 2005: Russia—A bomb under the tracks derails a freight train; no injuries. The apparent target was a passenger train.

February 6, 2006: India—Maoist rebels in Jharkand State blow up rail tracks; no injuries.

February 27, 2006: Pakistan—Tribal militants detonate a bomb, derailing an express train; no injuries.

April 19, 2006: United Kingdom—Vandals lay cables across the Liverpool-London line, forcing the engineer to make an emergency stop.

April 19, 2006: France—Authorities defuse a bomb on the Paris-Nantes TGV line; no injuries.

May 25, 2007: Turkey—A bomb causes the derailment of a freight train in Eastern Turkey; no injuries.

June 4, 2007: Thailand—Islamic militants remove the bolts on a rail line in Southern Thailand, derailing a train; 18 are injured.

June 6, 2007: Thailand—An army patrol finds that bolts have been removed on a passenger line in Yala Province.

June 6, 2007: Sri Lanka—Tamil Tigers blow up tracks, derailing a passenger train. Authorities find two more devices in the vicinity. There are no reports of casualties.

June 6, 2007: Thailand—Authorities find and defuse two bombs beneath the tracks on the rail line in Pattani Province.

June 7, 2007: Thailand—Authorities find that separatists have removed 28 bolts from a rail line in Yala Province.

July 5, 2007: Thailand—Islamic militants remove 65 bolts in an attempted derailing; no casualties.

July 10, 2007: Turkey—PKK rebels detonate a bomb on the tracks to derail a freight train; no reports of casualties.

August 7, 2007: Russia—A bomb planted next to a railway bridge detonates, derailing the Nevsky Express to St. Petersburg, which was traveling at 191 kilometers per hour. Instead of slowing the train, the engineer maintained the high speed to cross the bridge before the train derailed; no fatalities.

August 15, 2007: Russia—A passenger train is derailed by a bomb on the tracks; 60 are injured.

August 24, 2007: India—Maoist guerrillas blow up tracks across the State of Jharkand.

September 14, 2007: Turkey—A passing train is derailed by a mine planted by PKK guerrillas in Eastern Turkey.

January 9, 2008: Poland—Police arrest a teenager who used a homemade device that enabled him to switch tram tracks and derail several trams in Lotz.

May 27, 2008: Colombia—Unidentified attackers plant a mine on the tracks, derailing a freight train; no reports of casualties.

June 3, 2008: Italy—Italian police discover a plot to sabotage a train line.

June 10, 2008: India—Maoist guerrillas remove tracks and derail a freight train; no reports of casualties.

August 9, 2008: Spain—ETA terrorists plant a bomb on the high-speed rail line near Ondres.

September 26, 2008: Pakistan—Unidentified attackers blow up the tracks, derailing a passenger train; 6 die, and 15 are injured.

November 9, 2008: France—Attackers place concrete blocks on a TGV line in Southern France; the driver manages to stop the train.

March 9, 2009: India—Unidentified terrorists blow up a railway track in Assam. In the following four days, two more devices are discovered.

March 19, 2009: India—An improvised explosive device destroyed rail tracks in Assam Province; several unexploded devices are discovered nearby.

March 23, 2009: India—An explosion destroys tracks in Assam only minutes before a super fast train from Delhi was due to pass through the area. Authorities find and defuse a second device nearby.

June 22, 2009: India—Employees find a small explosive device on the tracks in Northeastern India and halt trains despite being robbed of their radios by militants.

July 17, 2009: India—Unidentified attackers blow up railway tracks in West Bengal.

July 31, 2009: Pakistan—Saboteurs derail a passenger train traveling from Karachi to Lahore, killing 30 people.

September 6, 2009: Georgia—A bomb destroys a section of rail line near the Abkhazia region.

October 13, 2009: India—Maoist militants bomb the rail line in Jharkhand.

November 27, 2009: Russia—Terrorists bomb the rail line derailing the passenger train between Moscow and St. Petersburg; 26 people are killed, 100 are injured.

November 30, 2009: Russia—A bomb went off under a passing passenger train in Daghestan. There were no injuries.

January 6, 2010: Russia—Authorities discover an explosive device on the railway near a bridge in Dagestan.

January 7, 2010: India—A bomb explodes on a railway in Janpur, injuring a child. Police find several more devices in the area.

January 18, 2010: India—Maoist militants blow up railway tracks in Gaya Patna.

January 24, 2010: India—A bomb destroys rail tracks in Assam Province minutes before an express passenger train is to pass the area.

January 28, 2010: Algeria—An explosion on the rail line destroys a freight train in Bejaia Province.

January 30, 2010: Algeria—Authorities discover a second bomb on the same line in Bejaia Province.

February 2, 2010: Russia—A bomb explodes on a rail line in St. Petersburg, injuring 1 person.

APPENDIX B: WARTIME SABOTAGE

Our inquiry focused on peacetime attacks by terrorists, although it includes derailment attempts by extortionists, environmental extremists, and other saboteurs, including vandals. We also looked at what lessons might be derived from wartime sabotage.

Many terrorists consider themselves at war, and some of the attacks in MTI's database take place in conflict zones and are part of ongoing low-level guerrilla campaigns. So what do we mean by "wartime?" It is a matter of degree. "Wartime" in this study is intended to mean all-out armed hostilities involving two armies, including civil wars and large-scale guerrilla formations. The context of expectations and security is different in wartime than in peacetime.

The objective of most wartime sabotage is to impede the shipment of military supplies and strategic materiel and the transport of enemy soldiers on troop trains. Numerous attacks on rail lines and dramatic derailments occurred in World War I—for example, attacks by Arab raiders on the Turkish rail line in the Middle East. World War II saw attacks on rail lines by the resistance fighters in German-occupied Western Europe and most extensively in German-occupied Russia; and during the Korean war and the First Indochina War commando attacks were made on North Korea's coastal rail line and tunnels.

As a young officer during the Vietnam War, I (Brian Jenkins) stood on the front platform of a small diesel locomotive that was pulling a train load of peasants, farm animals, and nervous soldiers while pushing two flat cars loaded with heavy rails ahead of itself to set off any mines. We were struggling in a slow climb over the Col des Nuages, the mountain pass between Hue and Danang, and the scene of past Viet Minh attacks during the First Indochina War. The hulks of derailed locomotives and rolling stock lay rusting in the ravines below us, testament to past disasters. It was here in 1953 that Viet Minh rebels blew up a viaduct, sending two locomotives and 18 cars down the mountainside, killing 100 or more passengers and trainmen. (This event and other examples of wartime sabotage are not included in the chronology in this report, because they would distort the quantitative analysis.)

Sabotage of rail systems in German-occupied countries during World War II was meant to replace or supplement allied strategic bombing. The sabotage attacks in occupied Western Europe involved limited quantities of explosives and were of limited effectiveness. The largest campaigns took place in German-occupied Russia, where poor roads made German forces heavily dependent on rail systems. Sabotage by trained Soviet partisans built slowly to a crescendo of hundreds of attacks carried out by thousands of operatives behind the lines whose actions were supported and coordinated by the Soviet military command. Partisans used bombs with long-term delays (several months), pressure- or vibration-triggered devices, command detonation to destroy gasoline-filled tank cars, and magnetic mines with time delay fuses, all supplied by the Soviet Army.

By 1943, German forces were struggling to deal with more than 1,000 rail sabotage incidents a month. In just two nights in 1944, partisans cut the rails in 8,422 places. Those running the trains had to remove an additional 2,478 mines. A single night later in the war

saw more than 10,000 demolition actions. Partisans also destroyed bridges and fired anti-tank weapons at locomotives, and German rail repair crews were regularly attacked.

The veterans of these sabotage campaigns are by now very old men or long gone, but their legacies may live on. It is interesting to note that among the developed countries, Russia has suffered the most derailments by modern terrorists.

Wartime saboteurs concerned themselves more with disrupting supply lines than with causing casualties. Effective disruption required sustained campaigns, central direction, a large supply of demolition equipment, and large numbers of operatives. Terrorist groups are clearly not able to replicate the magnitude of wartime sabotage or match its sophistication, so they seek one-off spectaculars. Those charged with security have the same problems—long distances and manpower constraints. However, these might be mitigated by new technology.

ENDNOTES

1. Brian M. Jenkins and Bruce Butterworth, *Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks,* San José, CA: Mineta Transportation Institute, November 1997.

2. "Early TGV History," TVGWeb.org, http:www.trainweb.org/tgvpages/history.html, accessed February 25, 2010.

3. Justin McCurry, "High-speed rail in Japan: From bullets to magic leviathan," *The Guardian (UK)*. August 5, 2009.

4. Randy James, "A Brief History of High-Speed Rail," *Time,* April 20, 2009, http://www.time.com/time/nation/article/0,8599,1892463,00.html.

5. California High-Speed Rail Authority. http://www.cahighspeedrail.ca.gov/, accessed March 2, 2010.

6. "Potential terrorist attack targets French high-speed train," Agence France Presse. August 27, 1995.

7. "Six suspected Moslem extremists remanded in custody." Agence France Presse. September 15, 1995.

8. "Hijacked plane 'was meant to explode over Eiffel Tower,'" BBC Monitoring Newsfile February 18, 2001.

9. Nicolas Vaux-Montagny, "Algerian to spend life in prison for 1995 Paris attacks," Associated Press, October 15, 2009.

10. "Militant held over Paris bombings," *The Herald* (Glasgow), August 22, 1995.

11. Marlise Simmons, "Bomb Near Arc de Triomphe Wounds 17," *New York Times*, August 18, 1995, Section A, page 3.

12. Mary Dejevsky, "Bomb found on TGV line in France," *The Independent* (London), August 28, 1995.

13. "Explosion Injures 4 in Paris Market," *St. Louis Post-Dispatch* (Missouri). September 4, 1995, 3A.

14. "'Miracle' spares lives in French school bombing," *Houston Chronicle*, September 8, 1995, A-18.

15. Alister Doyle, "New Blast Follows Burial Of Paris Bombing Suspect," *Chicago Sun-Times*, October 7, 1995, 13.

16. Christopher Burns, “28 Hurt in Paris Bombing; Eighth Attack Since July,” *Chicago Sun-Times*, October 17, 1995, 3.

17. Jenkins and Butterworth.

18. The description of the device and other details of the 1995 attack are derived from contemporary media sources and supplemted by the personal recollections of Jean-François Clair, who was an official of the French Directorate of Territorial Security (DST), part of France’s intelligence system responsible for internal security, similar to the FBI in the United States or MI-5 in the United Kingdom.

19. Stéphanie Giry, “France and Its Muslims,” *Foreign Affairs*, Vol. 85, No. 5 (September–October 2006), 87–104.

20. Marlise Simons, “French Police Kill Algerian Suspected In Bombings,” *New York Times*, September 30, 1995, Section 1, p. 5.

21. William F. Shugart II, “An Analytical History of Terrorism, 1945–2000,” *Public Choice*, Vol. 128, No. 1/2, The Political Economy or Terrorism (July 2006): 7–39.

22. This bombastic rhetoric reflected a shift in GIA’s strategy toward Europe from one of restraint in order to maintain its sanctuary and protect its support networks to one of viewing the European countries as enemies to be attacked. A GIA communique issued in January 1995 announced that GIA operatives would “consider anyone aiding the oppressive regime [Algeria] an enemy of Allah [...] and as a result he/she becomes a military target.” GIA Communique, January 11, 1995 cited in Lia Brynjar and Kiok Ashild, “Islamist Insurgencies, Diasporic Support Networks, and Their Host States: The Case of the Algerian GIA in Europe 1993-2000,” FFI/RAPPORT 2001/03789, Kjeller, Norway: Norwegian Defence Research Establishment, 2001.

23. “Official of FIS abroad accuses GIA of assassinating imam in Paris,” BBC Summary of World Broadcasts, July 15, 1995.

24. Doreen Carvajal, “Carlos the Jackal to Be Tried for Role in 4 Bombing Attacks in ‘80s,” *New York Times*, May 5, 2007, Sec. A.

25. Jenkins and Butterworth.

ABBREVIATIONS AND ACRONYMS

DST	Directorate of Territorial Security, Part of France's Internal Security System Comparable to the Fbi or MI-5
FIS	Islamic Salvation Front
GIA	Groupe Islamic Armé
IED	Improvised Explosive Device
IID	Improvised Incendiary Device
MTI	Mineta Transportation Institute
NIS	Newly Independent States
RER	Paris Commuter Train Line
TGV	Train À Grande Vitesse

BIBLIOGRAPHY

"Algerian FIS Armed Wing Says War Against France 'Legal Duty.'" AFX News. December 30, 1994.

Burns, Christopher. "28 Hurt in Paris Bombing; Eighth Attack Since July." *Chicago Sun-Times*. October 17, 1995.

Carvajal, Doreen. "Carlos the Jackal to Be Tried for Role in 4 Bombing Attacks in '80s." *New York Times*. May 5, 2007, Sec. A.

Dejevsky, Mary. "Bomb found on TGV line in France." *The Independent* (London). August 28, 1995.

"Early TGV History," TVGWeb.org. http://www.trainweb.org/tgvpages/history.html, accessed February 25, 2010.

"Explosion Injures 4 in Paris Market." *St. Louis Post-Dispatch* (Missouri). September 4, 1995.

Giry, Stéphanie. "France and Its Muslims." *Foreign Affairs*, Vol. 85, No. 5 (September–October 2006): 87–104.

James, Randy. "A Brief History of High-Speed Rail." *Time.* April 20, 2009. http://www.time.com/time/nation/article/0,8599,1892463,00.htm.

Jenkins, Brian M. and Bruce Butterworth. *Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks.* San José, CA: Mineta Transportation Institute, November 1997.

McCurry, Justin. "High-speed rail in Japan: From bullets to magic leviathan." *The Guardian (UK)*. August 5, 2009.

"Militant held over Paris bombings." *The Herald* (Glasgow). August 22, 1995.

"'Miracle' spares lives in French school bombing." *Houston Chronicle*. September 8, 1995, A-18.

"Official of FIS abroad accuses GIA of assassinating imam in Paris." BBC Summary of World Broadcasts. July 15, 1995.

"Potential terrorist attack targets French high-speed train." Agence France Presse. August 27, 1995.

Shugart, William F. II. “An Analytical History of Terrorism, 1945–2000.” *Public Choice*, Vol. 128, No. 1/2, The Political Economy or Terrorism (July 2006): 7–39.

Simons, Marlise. “French Police Kill Algerian Suspected in Bombings.” *New York Times*. September 30, 1995.

————. “Dead Bomb’s Suspect’s Ties Still a Mystery in France.” *New York Times*. October 1, 1995.

“Six suspected Moslem extremists remanded in custody.” Agence France Presse. September 15, 1995.

Vaux-Montagny, Nicolas. “Hijacked plane ‘was meant to explode over Eiffel Tower.’” BBC Monitoring Newsfile. February 18, 2001.

ABOUT THE AUTHORS

BRIAN MICHAEL JENKINS

Mr. Jenkins has a B.A. in fine arts and a masters degree in history, both from UCLA. He studied at the University of Guanajuato, Mexico and in the Department of Humanities at the University of San Carlos, Guatemala where he was a Fulbright Fellow and received a second fellowship from the Organization of American States.

Commissioned in the infantry at the age of 19, Mr. Jenkins became a paratrooper and ultimately a captain in the Green Berets. He is a decorated combat veteran having served in the Seventh Special Forces Group in the Dominican Republic during the American intervention, and later as a member of the Fifth Special Forces Group in Vietnam (1966–1967). He returned to Vietnam on a special assignment in 1968 to serve as a member of the Long Range Planning Task Group; he remained with the group until the end of 1969, receiving the Department of the Army's highest award for his service. Mr. Jenkins returned to Vietnam on third special assignment in 1971.

In 1983, Mr. Jenkins served as an advisor to the Long Commission, convened to examine the circumstances and response to the bombing of the U.S. Marine Barracks in Lebanon. In 1984, he assisted the Inman Panel in examining the security of American diplomatic facilities abroad. In 1985–1986, he served as a member of the Committee of the Embassy of the Future, which established new guidelines for the construction of U.S. diplomatic posts. In 1989, Mr. Jenkins served as an advisor to the national commission established to review terrorist threats following the bombing of Pan Am 103. In 1993, Mr. Jenkins served as a member of the team contracted by the New Jersey-New York Port Authority to review threats and develop new security measures for the World Trade Center following the February bombing.

In 1996, President Clinton appointed Mr. Jenkins to be a member of the White House Commission on Aviation Safety and Security. From 1999–2000, he served as an advisor to the National Commission on Terrorism and since 2000, he has served as a member of the U.S. Comptroller General's Advisory Board. Mr. Jenkins also is the Director of the National Transportation Security Center at the Mineta Transportation Institute, and since 1997 has directed the institute's continuing research on protecting surface transportation against terrorist attacks.

Mr. Jenkins serves as a Special Advisor to the International Chamber of Commerce and a member of the advisory board of the ICC's investigative arm, the Commercial Crime Services. Over the years, Mr. Jenkins also has served as a consultant to or carried out assignments for a number of government agencies including the Department of Homeland Security. As part of its international project to create a global strategy to combat terrorism, the Club of Madrid in 2004 appointed Mr. Jenkins to lead the international working group on the role of intelligence.

Mr. Jenkins is the author of *International Terrorism: A New Mode of Conflict*, the editor and co-author of *Terrorism and Personal Protection*, co-editor and co-author of *Aviation*

Terrorism and Security, and a co-author of *The Fall of South Vietnam*. His latest books are *Unconquerable Nation: Knowing Our Enemy, Strengthening Ourselves* and *Will Terrorists Go Nuclear?* He is also the author of numerous articles, book chapters, and published research reports on conflict and crime.

BRUCE ROBERT BUTTERWORTH

Bruce Butterworth has had a distinguished government career working at congressional, senior policy and operational levels. Between 1975 and 1980, as a professional staff member for the House Government Operations Committee, he ran investigations and hearings on many transportation safety issues, particularly in aviation. He spent 11 years in the Department of Transportation, 8 of them in the Office of the Secretary. He managed negotiations on air and maritime services in the GATT (now WTO), chaired U.S. delegations to UN Committees, dealt with transport issues related to border inspections, and was part of the U.S. Lockerbie response.

Mr. Butterworth held two executive posts in aviation security and in both worked closely with Congress as the informal but primary liaison. He was Director of Policy and Planning (l991–1995), establishing strategic, long-term and contingency plans, and federal rules. As Director of Operations (l995–2000) he was responsible for federal air marshals, hijacking response, and 900 field agents; he worked to improve security and the performance of security measures by U.S. airports here and by U.S. airlines globally. He ran the FAA's aviation command center, successfully managing the resolution of hijackings and security emergencies. He launched a successful program of dangerous goods regulation and cargo security after the 1995 ValuJet crash, oversaw the conversion of the air marshal program to a full-time program with high standards, was a key player in the response to the ValuJet and TWA 800 accidents, and was a frequent media spokesperson. He worked closely with the Congress, the National Security Council staff, the intelligence community, law enforcement agencies, and authorities of other nations.

Mr. Butterworth was an associate director at the U.S. Holocaust Memorial Museum (2000–January 2003), responsible for security and building operations. He designed and implemented a "best practice" procedure to deal with mail possibly containing anthrax powder; and developed and conducted new, comprehensive emergency planning and exercises. Between January of 2003 and September of 2007, he was one of two deputy directors in a 1,300 person Engineering Directorate at NASA's Goddard Space Flight Center, managing workforce planning, budgeting, and human capital management for complex robotics space missions, substantially reducing overhead and improving workplace safety there. Besides having helped DHS in information sharing, he is a research associate with the Mineta Transportation Institute. He wrote a peer reviewed report on security risks created by highway-borne hazardous materials for the State of California, is updating prior work on selective screening in the rail environment and is, along with Brian Michael Jenkins, constructing an IED-focused data base of surface transport attacks.

He also co-authored a May 2007 study with P.J. Crowley, senior fellow and director of Homeland Security at the Center for American Progress titled *Keeping Bombs off Planes: Securing Air Cargo, Aviation's Soft Underbelly*. In February of 2009 he published with Mr. Jenkins an opinion piece on information sharing entitled: "A Campaign the Secretary Must

Win."

Mr. Butterworth co-authored reports published by the Mineta Transportation Institute including *Selective Screening of Rail Passengers*, along with a supplement that will be published early in 2010; *Implementation and Development of Vehicle Tracking and Immobilization Technologies*; and a companion report, *Supplement to MTI Study on Selective Passenger Screening in the Mass Transit Rail Environment*.

Mr. Butterworth was awarded a Master of Science degree from the London School of Economics in 1974 and a Bachelor of Arts degree from the University of the Pacific in 1972 (Magna cum Laude). He was a California State Scholar and a Rotary Foundation Fellow. He received numerous special achievement and performance awards.

JEAN-FRANÇOIS CLAIR

Jean-François Clair is a former Inspector General of Police. He served 35 years in France's Security Service, the Directorate of Territorial Security or *Direction de la Surveillance du Territoire* (DST). The DST is France's internal intelligence system, with responsibilities similar to the FBI in the United States or MI-5 in the United Kingdom. From 1983 to 1997, he was the head of the DST's Anti-Terrorist Branch. In 1998 he was promoted to become the Deputy Director of the Service, a position he held until his retirement in 2007.

Dr. Clair received his Ph.D. in Public Law from the University of Paris in 1969, and graduated from the Institute for Higher Studies for National Defense or *Institut des haute études de defense nationale* (IHEDN) in 1993.

Dr. Clair currently teaches in the Graduate School of International Affairs at the *institut d'Études Politiques de Paris* (Sciences-Po) and at the Institute for International and Strategic Research (IRIS). He is a frequent lecturer at he George Marshall Center in Garmisch, Germany, and he participates in international symposia on terrorism and security issues (Singapore 2007 and 2008; Berlin 2008, and; Oslo 2009). He is also in charge of research for the French Administration.

PEER REVIEW

San José State University, of the California State University system, and the MTI Board of Trustees have agreed upon a peer review process required for all research published by MTI. The purpose of the review process is 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 Research Associated 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.

MTI FOUNDER

Hon. Norman Y. Mineta

MTI BOARD OF TRUSTEES

Honorary Co-Chair
Hon. James Oberstar **
Chair
House Transportation and
Infrastructure Committee
House of Representatives
Washington, DC

Honorary Co-Chair
Hon. John L. Mica **
Ranking Member
House Transportation and
Infrastructure Committee
House of Representatives
Washington, DC

David L. Turney *
Chair/President/CEO
Digital Recorders, Inc.
Dallas, TX

William W. Millar ^
Vice Chair/President
American Public Transportation
Association (APTA)
Washington, DC

Hon. Rod Diridon, Sr. #
Executive Director
Mineta Transportation Institute
San Jose, CA

Ronald Barnes
General Manager
Veolia Transportation/East
Valley RPTA
Mesa, AZ

Rebecca Brewster
President/COO
American Transportation
Research Institute
Smyrna, GA

Donald H. Camph
President
California Institute for
Technology Exchange
Los Angeles, CA

Anne P. Canby
President
Surface Transportation
Policy Project
Washington, DC

Jane Chmielinski
President
DMJM Harris
New York, NY

William Dorey
President/CEO
Granite Construction, Inc.
Watsonville, CA

Mortimer Downey
Chairman
PB Consult Inc.
Washington, DC

Nuria Fernandez
Commissioner
City of Chicago,
Department of Aviation,
Chicago, IL

Steve Heminger
Executive Director
Metropolitan Transportation
Commission
Oakland, CA

Hon. John Horsley #
Executive Director
American Association of State
Highway & Transportation
Officials (AASHTO)
Washington, DC

Joseph Boardman
President/CEO
Amtrak
60 Massachusetts Ave., N.E.
Washington, DC 20002

Will Kempton
Director
California Department of
Transportation
Sacramento, CA

Brian Macleod
Senior Vice President
Gillig Corporation
Hayward, CA

Dr. Bruce Magid
Dean
College of Business
San José State University
San José, CA

Stephanie Pinson
President/COO
Gilbert Tweed Associates, Inc.
New York, NY

Hans Rat
Secretary General
Union Internationale des
Transports Publics
Bruxelles, Belgium

Vickie Shaffer
General Manager
Tri-State Transit Authority
Huntington, WV

Paul Toliver #
President
New Age Industries
Seattle, WA

Michael S. Townes #
President/CEO
Transportation District
Commission of Hampton Roads
Hampton, VA

Edward Wytkind
President
Transportation Trades
Department, AFL-CIO
Washington, DC

** Honorary
* Chair
^ Vice Chair
# Past Chair

Directors

Hon. Rod Diridon, Sr.
Executive Director

Karen E. Philbrick, Ph.D.
Research Director

Peter Haas, Ph.D.
Education Director

Donna Maurillo
Communications Director

Brian Michael Jenkins
National Transportation Security Center

Asha Weinstein Agrawal, Ph.D.
National Transportation Finance Center

Research Associates Policy Oversight Committee

Asha Weinstein Agrawal, Ph.D.
Urban and Regional Planning
San José State University

Jan Botha, Ph.D.
Civil & Environmental Engineering
San José State University

Katherine Kao Cushing, Ph.D.
Enviromental Science
San José State University

Dave Czerwinski, Ph.D.
Marketing and Decision Science
San José State University

Frances Edwards, Ph.D.
Political Science
San José State University

Taeho Park, Ph.D.
Organization and Management
San José State University

Diana Wu
Martin Luther King, Jr. Library
San José State University

MINETA
TRANSPORTATION INSTITUTE
Created by Congress in 1991

SAN JOSÉ STATE
UNIVERSITY

Funded by U.S. Department of Transportation and California Department of Transportation