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**A Literature Review of Rail
Trespassing and Suicide
Prevention Research**

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A Literature Review of Rail Trespassing and Suicide Prevention Research

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PUBLISHER’S NOTE

The views expressed in this e-circular paper are those of the committee and do not necessarily represent the views of all participants, the Transportation Research Board, or the National Academies of Science, Engineering, and Medicine. This publication has not been subjected to the formal TRB peer review process.

Introduction

This report reviews and summarizes available research reports and data sources related to the issues of railroad trespassing and suicide, focusing on research from 2013 onwards. According to the Federal Railroad Administration's (FRA) Office of Safety Analysis, approximately 70% of all railroad-related deaths in the United States, are the result of trespassing and suicide (FRA, 2017). In the European Union (EU), the comparable number is 89% (ERA, 2016).

DEFINITIONS AND NOTES

According to the FRA's Guide for Preparing Accident/Incident Reports, a trespasser is defined as someone "who is on the part of railroad property used in railroad operation and whose presence is prohibited, forbidden, or unlawful" (FRA, 2011). Trespassers in this sense do not include highway users involved in a collision with on-track equipment at a highway-rail or a pedestrian pathway crossing denoted with a U.S. Department of Transportation (DOT)/Association of American Railroads (AAR) Inventory Number (e.g., 372133T). Trespassing incidents resulting in a casualty are required to be reported to the FRA using FRA Form 6180.55a.

Likewise, verified suicides are required to be reported to the FRA on the FRA 6180.55a reporting form. "Suicide data is data regarding the death of an individual due to that individual's commission of suicide as determined by a coroner, public police officer or other public authority; or injury to an individual due to that individual's attempted commission of suicide as determined by a public police officer or other public authority." Suicides may occur at highway-rail crossings, as well as away from crossings. The FRA database contains a "flag" in the data field FRA57 to denote whether the suicide occurred at a crossing or not. FRA suicide data is only available to the public in an aggregated format, in contrast to FRA's trespassing data which is available to the public on an incident basis via the FRA's Safety Data website: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/on_the_fly_download.aspx.

ORGANIZATION OF THE REPORT

The organization of the report starts with an explanation of how documents and data sources were chosen for inclusion in the report. Four categories of documents and data are reviewed:

1. Reports dealing with trespass and suicide epidemiology,
2. Reports dealing with potential countermeasures,
3. Available data sources, and
4. FRA Research needs workshops.

STUDY SELECTION PROCESS

The following available databases were searched: Science Direct, Research Gate, and Google Scholar. Studies found there and on the FRA's website were supplemented by suggestions from a panel of rail safety experts. Studies focused on rail suicide and/or trespassing were selected, with an emphasis on studies published in 2013 or later, with a further emphasis on studies conducted in the United States. Some studies were eliminated after a cursory review revealed them to be off point. Additional studies were added by a search of Mendeley.com and by checking the reference lists of reviewed literature. Some of the studies that were reviewed were not referenced in the report, because their content was similar or derivative of another study, they were relatively old, or they pertained principally to foreign data, particularly Europe.

Unlike many of the literature reviews covered in this report, sources are not restricted to peer-reviewed journal articles. Some of the sources of this report are FRA reports, case studies, or rail safety conference presentations. A total of 102 documents were reviewed; of these, 46 were deemed relevant. Table 1 provides a summary of the primary topics covered in the 46 documents included in the Literature Review.

TABLE 1 Characteristics of Reviewed and Cited Literature

Primary Subject of Study	Reviewed	Cited
Suicide Causation and Risk Factors	31	13
Suicide Countermeasures	27	11
Suicide Statistics	3	3
Trespassing Causation and Risk Factors	10	8
Trespassing Countermeasures	16	8
Trespassing Statistics	2	2
Economic Impacts	4	1
Regulation and Law	3	1
Rejected	7	0
Total	102	46
Primary Location Studied		
United States	39	28
Foreign (EU as a whole, Canada, individual EU nations, Japan, Australia)	47	15
Global	9	3
Rejected	7	0
Total	102	46

Selected Epidemiologic Findings

INCIDENCE OF RAIL-RELATED TRESPASSING AND SUICIDE

Worldwide railroad suicide rates (proportion of all suicides that are railroad related) range from 1.3% in Canada (Mishara 2013) to more than 12% in the Netherlands (Van Houwelingen, Baumert, Kerkhof, Beersma, and Ladwig 2013). Based on the FRA reported number of 309 rail suicides for 2013 and the total number of suicides of 41,149 (Heron 2013), rail-related suicide accounted for less than 1% of all suicides in the United States.

Over half of all suicides in the United States are the result of firearms (Kochanek, Murphy, Xu, and Tejada-Vera 2014). The rate of suicide due to firearms in the United States is more than eight times that of other wealthy countries. Overall, the relative share of death due to suicide is equal among the countries (Grinshteyn and Hemenway 2016). Conversely, railroad trespassing is a much larger problem in the United States than in Europe. In the United States, 43% of railroad-related deaths are due to trespassing, but only 17% of deaths in the EU are due to trespassing (ERA 2016).

LETHALITY

Nationwide, statistics are not kept on railroad suicide attempts (without injury), nor on instances where pedestrians trespass but are not injured. Therefore, it is not possible to derive a lethality statistic for rail suicide and trespassing actions. However, the FRA does track trespassing and suicide attempt incidents that involve a casualty, either injury or death. For the past 5 years, about 50% of trespassers were fatally injured and about 90% of those involved in suicide attempts were fatally injured. Trespassing and suicide incidents are far more likely to result in death in comparison to highway–rail crossing incidents where a fatality results in about 20% of all collisions.¹

AGE OF VICTIMS

The mean age of railroad suicide victims is somewhat consistent over several studies with the mean age ranging between 39 and 45 years of age (Mishara and Bardon, 2016). The mean age of railroad-related suicides tend to be younger than the overall suicide mean age (R. 13–36 FRA_Report, 2013). The FRA Rail Trespasser Fatalities: Demographic and Behavior Profiles analysis reports a mean age for trespassers of 38.

GENDER

Male-to-female rail suicide ratios are between 3:1 and 3.5:1, which closely parallels the gender ratios in the overall suicide statistics. The FRA Rail Trespasser Fatalities: Demographic and Behavior Profiles analysis indicates 82% of trespassers were male, which equates to 4.6:1.

RISK FACTORS FOR RAIL SUICIDE IN THE UNITED STATES

In the United States, 15% of railroad suicide victims were married compared with 38% for all methods of suicide (Berman, Sundararaman, Price, and Au, 2014). The Berman study is an in-depth, epidemiological study with information from next of kin of completed suicides. However, because of the intrusiveness of the “psychological autopsy” method employed with this study, only 55 cases were included in the final report, providing a limited sample size from which to draw conclusions. Berman also concluded that 96% of incidents occurred on areas of track that did not have a barrier to restrict access to the right-of-way (ROW): 55% of incidents occurred in suburban areas, 25% in downtown/urban areas, and 20% in rural areas (Berman et al., 2014).

While psychiatric disturbance and comorbidity (mostly with alcohol) is expected in suicide cases, Berman reported that of the 37% of decedents who had been drinking at the time of death; a very large percentage (94%) of all suicide decedents in the United States had blood alcohol levels above 0.08 blood alcohol content (BAC) (compared to 64.5% >.08 BAC). Mental health disorders were identified in 96% of the study decedents and 47% had been prescribed medications, but only 19% were adherent to the medication (Berman et al., 2014).

Trespassing incidents resulting in a confirmed suicide, where the trespasser was wearing earphones or earbuds, or where the trespasser is talking on a mobile phone are more likely to result in fatal injuries (Wali, Khattak, and Zhang, 2017).

There was some variability of temporal and spatial peak of suicide (Lukaschek, Baumert, Erazo, and Ladwig, 2014; Savage, 2016; Botha, Neighbour, and Kaur, 2014). Most studies indicated a weekday afternoon and evening peak, with higher incidence roughly corresponding with peak railroad operations times. European studies indicate many more station suicides than the local studies in the United States (one from the San Francisco area and one from the Chicago area) (Mineta Report, 2010; Savage, 2016). The relative lack of access to a gun and the availability of railroad tracks to the victim’s residence were the major factors in the choice of rail suicide (DOT/FRA/ORD-13/25 FRA_Report, 2013).

A study on the potential impact that gun availability might have on railroad suicide suggested that legislation that decreased the availability of firearms in Switzerland may have reduced firearm-related suicides, but increased railway suicides (Reisch, Steffen, Habenstein, and Tschacher, 2013). The Swiss Army is a militia and its militia members must store their guns at home. Somewhat unique to Europe, Switzerland’s firearm suicide rate was 39% of all suicides, more similar to the United States than the rest of Europe. In 2003, a number of changes were made to the army, some of which reduced the availability of firearms, although that was not the reason for the changes. The number of militia members was halved, the discharge age was lowered, the fee to purchase the military firearm (after discharge) was raised, and a license was required to keep possession of the military weapon. As the authors expected, the rate of firearm suicide in Switzerland decreased, as did the overall suicide rate, for the affected demographic (males, ages 18–43). The authors did, however, note that there was a partial method–substitution effect in which some selective substitution occurred, specifically with railway suicides. In other words, while reduced availability of firearms resulted in a lower overall suicide rate (most prominently firearm suicides), railway suicides increased more than expected. That increase is likely the result of a substitution of method for roughly 22% of those that didn’t die by firearm suicide. The authors quantified the number of lives saved as 30 per year.

A study from Belgium compared the geographical distribution between rates of general suicide and railway suicide at the district level for 43 cases (Strale, Krysinska, Overmeiren, and

Andriessen, 2016). In general, greater wealth and older age tends to increase railway suicide, but decrease the general suicide rate. Rail suicide per capita is highest in suburbs and lower in central cities and rural areas. The authors concede that effects could be due to confounding factors, such as lower rail density in poorer areas. This study is consistent with the Savage Chicago study (Savage, 2016) and the Berman study (DOT/FRA/ORD-13/25 FRA_Report, 2013).

RISK FACTORS FOR RAIL TRESPASSING IN THE UNITED STATES

“The most typical rail trespasser fatality involves White males who are possibly intoxicated, with a mean age of 38, and with low socioeconomic status” (FRA, Rail Trespasser Fatalities: Demographic and Behavior Profiles, June 2013). This study found that two-thirds of railroad trespassing fatalities occur between the ages of 20 and 49. In the market analysis of income, family and life stages of the decedents, findings suggested that the two highest-risk “markets” that trespassing prevention efforts should focus on are (1) younger, lower income, urban renters in second-tier cities with railroads; and (2) lower income, rural homeowners who are likely to be empty nesters or couples without children. Finally, toxicology reports from coroners determined that drugs and/or alcohol were associated with approximately half of all trespasser fatalities.

Distraction and sensory deprivation resulting from the rising popularity of auditory technologies with headphones or earbuds poses a very high risk for railroad trespassers. A study of published reports of pedestrian fatalities from crashes involving trains or motor vehicles from 2004 to 2011 found that the use of headphones/earbuds with handheld devices poses a safety risk to pedestrians in environments with moving vehicles. Of the 116 pedestrian fatalities investigated 55% of the fatalities involved trespassers on railroad property (Lichenstein, Smith, Ambrose, and Moody, 2012). The number of pedestrian fatalities may be higher now because mobile phone ownership has increased from 35% of Americans in 2011 to 77% in 2016.² These results are further supported by the 2017 trespassing injury severity study from the Southeastern Transportation Center at the University of Tennessee, which found that 55% of incidents where the trespasser was reported to be wearing headphones or talking on a mobile phone resulted in fatal injuries (Wali, Khattak, and Zhang, 2017).

In this research literature review, there were very few studies that systematically measured trespassing incidents that did not result in casualties. One report, Trespass Prevention Research Study—West Palm Beach (DOT/FRA/ORD-16/03 FRA_Report, 2016), collected and analyzed trespass violation data reported by law enforcement, locomotive crew observations, and video recording of specific locations along two stretches of freight and commuter rail track within the city limits of West Palm Beach, Florida. Such detailed studies can help determine where trespassing “hot spots” exist.

Epidemiology studies comprise one category of FRA trespassing literature. Cadle Creek Consulting prepared the Rail-Trespasser Fatalities: Developing Demographic Profiles report for FRA in 2008 that was updated by North American Management in 2013 (Cadle Creek Consulting, 2008). Both reports concluded that the compared demographics and drug use of decedents were remarkably similar. The Stanchak and daSilva Trespass Event Risk Factors study expanded on these results, including many other risk factors (other than demographics) (DOT/FRA/ORD-14/32, 2014). Each of the epidemiological studies dealt in different ways with the potentially confounding effects of suicides in the trespassing data. As Stanchak asserts

“Several transportation safety researchers have investigated risk factors that could potentially lead to railroad trespassing casualties, but much of the academic literature is inconclusive. Many past researchers, including those studying this issue within the last decade, encountered challenges caused by limited data resources and uncertain data quality; the same problems were faced during this research effort. The vast majority of available data is of trespassing casualties, which are events resulting in a casualty, and not of incidents, which are trespass events that may or may not result in an accident. More data on incidents that do not result in casualties would be valuable to railroad safety researchers. While the accident/incident reports submitted to FRA by railroads have proven to be extremely helpful to railroad researchers, there are many updates to the reporting system that could make research into trespass incidents more efficient. Some of these improvements may include a way to easily filter motor vehicle operating trespassers from pedestrian trespassers and fields to mark intoxication, bicycle use, or use of potentially distracting electronic devices. In future studies, researchers could also look for information gathered through transportation agencies’ growing efforts to collect their own data and establish trespass prevention programs.”

Notes

1. <http://safetydata.fra.dot.gov/OfficeofSafety/default.aspx>
2. <http://www.pewresearch.org/fact-tank/2017/01/12/evolution-of-technology/>

Selected Rail Trespassing and Suicide Countermeasure Findings

Probably the most comprehensive list of preventative measures can be found in the RESTRAIL toolbox at www.restrail.eu/toolbox/. This paper uses the RESTRAIL countermeasure family groupings to describe some of the countermeasures below, including: (1) organizational and procedural measures; (2) physical and technological measures; and (3) public awareness and educational measures. For this summary, law enforcement measures are included with public awareness and education. Some of the findings from the literature in these areas is summarized below.

ORGANIZATIONAL AND PROCEDURAL MEASURES

Speed Restrictions

At certain times and locations, speed restrictions may work (DOT/FRA/ORD-14/36 FRA_Report, 2014), but the effects would need to be studied, because of the operational and profit effects to the railroad (Berman et al., 2014).

Track Surveillance

Track surveillance may work, but subsequent actions taken after identification of potential victim, presumably by the train crew, train police, or local police are key to the effectiveness of this measure. “Track surveillance may allow railroads to identify individuals who are trespassing. However, if this countermeasure is going to be effective at reducing suicides the railroads and/or law enforcement must be committed to dealing with individuals once they are identified” (DOT/FRA/ORD-14/36 FRA_Report, 2014). This measure could be labor-intensive and expensive, so probably must be implemented in known hot spots or at known risk times. Detection may be done remotely, potentially reducing the need for human monitors.

PHYSICAL AND TECHNOLOGICAL MEASURES

Platform Screen Doors

Platform screen doors deter access to trains (or tracks) from the station platform. Full height doors provide a total floor to ceiling barrier, whereas half-height doors do not. Where applicable, platform screen doors, especially full height, are very effective in deterring both suicide and trespassing (Barker, Kolves, and De Leo, 2016; DOT/FRA/ORD-14/36 FRA_Report, 2014). However, their application is limited to areas where access is tightly controlled and usually not at street level. Also, they are quite expensive to install. Use of platform screen doors is rare in the United States, principally confined to people mover systems at airports. However, a recent news story indicated that the Metropolitan Transit Authority in New York is reconsidering them in the wake of recent events (<http://www.insurancejournal.com/news/east/2016/11/17/432489.htm>).

Suicide Pits

A suicide pit is a term used to refer to trenches below the rails of a train line, often used in stations for drainage purposes. These trenches may provide a space where a person on the tracks can avoid contact with the approaching train. There was conflicting evidence of effectiveness for this countermeasure (Barker et al., 2016). The pits were dug as drainage, not for voids to potentially save lives. Also, their application is limited to locations where the conditions allow for them.

Blue Lights

In Japan and the United Kingdom, rail operators have installed blue LED lights on train platforms. The light is described as “soothing” or “like daylight.” There is conflicting evidence of their effectiveness (Matsubayashi, Sawada, and Ueda, 2016; Barker et al., 2016). Earlier studies indicated a very favorable decrease in suicide activity with little substitution effects to other locations, but subsequent studies indicated that the effectiveness was overstated and applications were not generalizable.

Fencing

Fencing at hot spots may work (Havârneanu, Burkhardt, and Paran, 2015). However, because of the cost of installation and maintenance, this solution must be implemented where incursion is most likely. In the general suicide literature, means restriction is one of the only countermeasures proven effective (Cox et al., 2013). However, means restriction is multifaceted in the rail arena (fencing, berms, antitrespassing grids, level separation) and difficult to accomplish. One study indicated that one of the strongest characteristics of completed rail suicides was track availability (DOT/FRA/ORD-13/25 FRA_Report, 2013). Of 55 cases studied, 80% of completed train suicides occurred in urban and suburban locations with 76% of decedents living within 1 mi of the site of their death.

The 2015 FRA study, High-Security Fencing for Rail Right-of-Way Applications (DOT/FRA/ORD-15/38 FRA_Report, 2015), examined current uses of high-security fencing on several commuter railroad properties and recommended best practices for effective ROW fencing. The study states that to effectively prevent trespassing, fencing should address access from all sides (over, under, around, and through). The fencing should be strategically located, based on a robust hazard analysis. Stakeholder and community support key to its effectiveness. The installing railroad should have a policy regarding fencing and strongly support it.

Automatic Detection and Warning

One of the RESTRAIL pilot tests was an automatic detection and alarm system that was installed at two illegal footpaths in Finland (Kallberg and Silla, 2016). Trespassers were detected by an infrared sensor which triggered a prerecorded voice message to leave the area immediately. At one site, there was a 44% decrease in trespassing behavior over a 60-day post-installation period and an 18% decrease at the other location. This system was similar to the FRA Pittsford, New York, study (D.-06/03-1 FRA_Report, 2012).

Air Bags on Locomotives

The FRA has a conceptual framework study on the use of locomotive air bags to mitigate the effects of level crossing and trespassing accidents on vehicles and pedestrians (DOT/FRA/ORD-16/22 FRA_Report, 2016). Air bag use has been conceptualized, but not engineered or implemented.

PUBLIC AWARENESS AND EDUCATIONAL MEASURES

Media Guidelines on Reporting Rail Suicide Events

Media reporting regarding rail suicide that include specific descriptions of locations and images can lead to copycat behavior (Barker et al., 2016; Havârneanu et al., 2015). One study implied that any reporting (not just sensational or specific) could increase incidence (Mishara and Bardon, 2016). A recent FRA study compared media reporting with guidelines established by suicide prevention groups (from the 17/02 study (DOT/FRA/ORD-17/02 FRA_Report, 2017):

Media attention following a suicide death has the potential to result in copycat suicide attempts, an effect that has been demonstrated for many methods of suicide, including those that occur on the railway system. Suicide prevention groups are aware of this issue and have developed specific recommendations to minimize the risk of suicide contagion through the media. These recommendations range from high-level ones, such as not including the term “suicide” in the headline, to more content-specific recommendations, such as not oversimplifying suicide or glamorizing the victim involved. These recommendations aim to reduce sensationalistic portrayals of suicide, decrease the likelihood of vulnerable individuals identifying or admiring suicide victims or acts of suicide, and increase the inclusion of information on seeking help.

Also from the 17/02 study:

The findings in this report indicate that railway suicide incidents are often reported in a similar way to trespass incidents. In other words, the reportage provides details about or photos of the location, includes details about what happened just before the collision, and does not provide help-seeking information. These are aspects typically absent from reportage about suicide by other means, but consistent with how trespass incidents are typically reported. This may be because suicide incidents on the rail system tend to be more visible to the public than many other types of suicide and therefore, reporters feel compelled to provide more details; or, reporters who typically focus on transportation issues may not be aware of suicide reporting recommendations. In either case, there may be benefits to developing railway-specific recommendations for how to report on suicide incidents and disseminating such recommendations to both media outlets as well as individuals who interface with the media following rail-related incidents.

The authors point out why reporting rail suicides in a similar way to trespassing coverage is not optimal: “a detailed description of how a trespass fatality came to be may help others avoid similar errors, while a similarly detailed description of a suicide may simply inform the reader of a means to accomplish such an act.”

Law Enforcement

Law enforcement strategies to prevent and mitigate the impacts of rail trespassing used in the United States include educational blitzes; removal of high-risk/high-offender populations from the rail rights-of-way; officer-on-a-train programs to identify and report trespasser violations; use of closed-circuit television, remote monitoring, and remote patrol by aircraft to identify trespasser violations; posted signs at high-risk/high-use areas; and a variety of legal penalties in accordance with relevant state law, including citations, fines, arrest, community service, and offender education. According to the March 2016 Volpe Center report, Law Enforcement Strategies for Preventing Rail Trespassing Risk Factors, when law enforcement personnel participate in rail safety, the number of risky behaviors along the ROW, including trespassing, is reduced. However, the report also cited that empirical data on the effectiveness of law enforcement initiatives for preventing rail trespassing is not readily available and scientifically designed experiments are necessary to prove the long-term effects of law enforcement activities on curbing rail trespassing. Additional findings were that local communities lack the resources to comprehensively patrol railroad rights-of-way and that identifying trespasser hot spots to appropriately target enforcement activities is critically important (DOT/FRA/ORD-16/03 FRA_Report, 2016).

Community-Based Collaboration

An FRA case study of a community-based collaboration was performed in West Palm Beach, Florida (DOT/FRA/ORD-14/19 FRA_Report, 2014). Lessons were learned about how to improve the FRA's Community, Analysis, Response and Evaluation model, which included the affected municipalities, local police, Volpe, and the railroads. A principal observation was that local involvement and leadership was not sustained. The authors recommend a follow-up study to evaluate measures installed, sustainability of community involvement, and building on a hazard analysis process initiated with this study.

Signage

Signage is a relatively low-cost measure that can be taken almost immediately. Station signage can be effective, but must be paired with other countermeasures to maximize its potential. Signage is likely not to be effective unless the would-be trespasser perceives a real chance of being detected and prosecuted (Havârneanu, 2016).

For suicide prevention, help-seeking signage ("call or text for help") may be an easy, cost-effective way of showing the public that the railroad is taking rail suicide seriously, but it has several drawbacks. First, in the Berman study only one of the 29 individuals (whose possessions were known) were reported to have had a cell phone in their possession at the time of the incident, which indicates that a dedicated phone would probably need to be present at the sign site in order to be effective (Berman et al., 2014). The reader should note that this finding was for 29 individuals in a data set from 2011, so the sample is small and prior to cell phone ubiquity. On the other hand, ownership of a cell phone does not automatically imply that the vulnerable individual is currently carrying it or that it is fully functional. Second, public telephones are vanishing and are subject to vandalism (Mishara, 2013). Also, quoting from the Preventing Suicides in Public Places: A Practical Guide (Public Health England, 2015):

A disadvantage of signage is that it may advertise the lethal potential of a site to vulnerable individuals. It also relies on the suicidal individual to make the call. In isolated locations, mobile phone signals may not be reliable. Distressed individuals, especially those with mental health problems or leading chaotic lives, may also find themselves without enough battery power or credit to make a call.

Detection

A substantial number of trespassers and suicide victims are likely imperiled for at least a short while before impact, based on the proportion who were engaged in stationary events, like lying down and sitting (Wang et al., 2016). This implies that detection has the potential to save lives, if it happens in time for remedial action to take place. Current developments in the rail use of detection technology, either in-ground detectors installed under the tracks (Catalano, Bruno, Pisco, Cutolo, and Cusano, 2014), drone detector technology used by BNSF Railway (<http://insideunmannedsystems.com/flying-the-rails/>), or other technology, could be tested to determine effectiveness.

A less-sophisticated technology was tested by the FRA in 2004 (D.-06/03-1 FRA_Report, 2012):

...commercial-off-the-shelf technology system was installed at a bridge in Pittsford, New York, where trespassing is commonplace and fatalities have occurred. This video-based trespass monitoring and deterrent system had the capability of detecting trespass events when an intrusion on the railroad right-of-way occurred. The interactive system comprised video cameras, motion detectors, infrared illuminators, speakers, and central processing units. Once a trespass event occurred, the in-situ system sent audible and visual signals to the monitoring workstation at the local security company where an attendant validated the alarm by viewing the live images from the scene. The attendant then issued a real-time warning to the trespasser(s) via pole-mounted speakers near the bridge, called the local police, and then the railroad police, if necessary. All alarm images were stored on a wayside computer for evaluation. The system was installed in August 2001 and evaluated over a 3-year period ending in August 2004.

While there were several issues with the use of this technology (mainly false positives), the study showed that lives could be saved. The 06/03-1 study alerted the trespassers and instructed them to remove themselves from the area. Using a statistical value of a life of \$3 million, the authors suggested that the investment was justified. With the improvement in related technologies in the last decade, it is likely that solutions would be even more reliable and cost-effective.

Trespass and Suicide Data

The FRA and the Federal Transit Administration (FTA) both provide data quantifying the extent and nature of rail-related trespassing and suicide. The principal FRA data set is the FRA 6180.55a casualty database. (FRA, 2018) This database provides incident-level descriptions of the location and nature of specific incidents. Incident-level suicide data is not available to the public, only summary counts can be obtained from the FRA's Safety Data website. The trespassing data is available for download from the FRA Safety Data website: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/on_the_fly_download.aspx.

FTA, on the other hand, provides safety data in a different format in the National Transit Database, the principal reservoir of transit related system data (FTA, 2018). FTA includes safety data for approximately 70 light rail, streetcar, cable car, and hybrid rail systems. FTA data can be downloaded from the National Transit Database at <https://www.transit.dot.gov/ntd/ntd-data>.

FRA data includes data for 827 railroads as of December 2017. FRA data encompasses approximately 30 commuter rail systems. In order to quantify the true number of rail-related trespassing and suicide incidents, it is necessary to combine data from both FRA and FTA. For example, New Jersey Transit operates one commuter rail line that reports to FRA and two light rail lines and one hybrid rail line that report to FTA so quantifying the exact number of incidents can be challenging. Both FRA and FTA also provide exposure data to calculate rates of incidents by number of unlinked passenger trips, passenger train-miles of operation, and employee hours worked.

FRA Research Needs Workshops

Most rail trespassing research is conducted and published under the auspices of the FRA through the Volpe National Transportation Systems Center. FRA has conducted Research Needs Workshops in 2008, 2012, and most recently, in 2015 (DOT-VNTSC-FRA-09-02, 2009) (DOT/FRA/ORD-13/18, 2013). The purpose of these workshops is twofold:

- Provide FRA and key stakeholders with an update of current and future activities in the areas of ROW fatality and trespass prevention.
- Solicit new ideas from the workshop attendees on prospective new or expanded initiatives, strategies, programs, and research projects.

These goals were achieved by bringing together subject matter experts to share information, collaborate, identify, and prioritize specific recommended actions related to education, engineering, and enforcement (Three Es) to facilitate the reduction of railroad ROW trespass incidents and fatalities. After the 2015 workshop, the participants developed more than 110 ideas during five breakout sessions. Each group brainstormed many potential project ideas for each topic area. Each group was then tasked with identifying its top three to five project proposals out of the many that were posited during the sessions. This vetting process resulted in the identification of the top 24 recommended actions across the five topic areas: Pedestrian Safety Issues, Community Outreach and Education, Design, Technology, and Infrastructure, Enforcement, and Intentional Deaths/Acts.

The 2015 Research Needs Workshop resulted in FRA leading research in several of the identified areas. The following projects are currently underway or recently completed:

TRESPASS PREVENTION TRAINING AIDS

To develop and disseminate highway-rail grade crossing safety and trespass outreach materials. FRA and its contractor will develop enhanced grade crossing safety & trespass materials for distribution by the safety partners. It is envisioned that the bulk of the materials will be video/web-based products. This project is on-going.

RAILS-WITH-TRAILS

To produce a comprehensive report which accurately documents and synthesizes relevant state and local laws and regulations, policies, plans, designs, and operational procedures for the establishment of Rails-with-Trails (RWTs). The report will provide examples of widely accepted practices which may be adopted in other locations where RWTs exist or are proposed. The report will also provide examples of practices which should be avoided. This project is on-going.

LAW ENFORCEMENT GRANT PROGRAM

This project involves conducting a law enforcement research study focused on rail ROW trespass prevention. It will be composed of research to develop selection criteria, distribute funding to selected local law enforcement agencies to enforce railroad specific violations, and evaluate effectiveness of enforcement activities. This project is on-going.

LAW ENFORCEMENT STRATEGIES

To identify communities and organizations implementing successful initiatives that are focused on the enforcement of traffic safety laws and precautions at highway–rail grade crossings and trespassing. This project report in draft form and under review at FRA.

PHOTO ENFORCEMENT AT CROSSINGS

FRA partnered with the city of Orlando and the Volpe Center to study the effectiveness of advancing technologies to detect, detour, and enforce highway–rail grade crossing violations. City officials in Orlando, Florida, funded the installation of cameras at one to three grade crossings and FRA contractor will collect and analyze vehicle data before and after the cameras are installed. This project is on-going.

VEHICLE RIGHT-OF-WAY INCURSION PREVENTION

FRA will analyze incursion prevention by using basic obstacles to block the ROW. This will be done through a comprehensive literature review of relevant research and implementation studies of interventions to prevent vehicle incursions into railroad ROWs. In the same time, researchers will perform an in-depth analysis of recent relevant incidents and attempt to characterize the typical incident, if possible. There may be an opportunity to partner with a state DOT, major transit agency, and/or other DOT modal administrations to implement and evaluate a specific intervention. FRA has partnered with SunRail and the City of Orlando, Florida. This project is on-going.

LAW ENFORCEMENT TRAINING AIDS

FRA through its contractor will identify and research current best practices and effective initiatives used by law enforcement organizations in areas where there exists a high degree of public awareness and compliance with railway trespassing laws. This study will identify areas where public compliance with rail safety laws is high and research enforcement factors that may have contributed to the success. The results will be disseminated to rail safety stakeholders. This project is on-going.

PEDESTRIAN OVERPASS EVALUATION

FRA through its contractor will evaluate a grade separation at a highway–rail intersection, and determine what effects, if any, it has on pedestrian trespass activity at the crossing. This project is on-going.

ENGINEERING DESIGN FOR PEDESTRIAN SAFETY

FRA through its contractor will research on practical and cost-effective engineering design solutions such as pedestrian channelization techniques currently employed on the rail system that will enable railroads to mitigate pedestrian crossing hazards. This project is on-going.

TRESPASS PREVENTION RESEARCH STUDY

FRA through its contractor will research the effectiveness of the Community Trespass Prevention Program. This program has a goal to create safer communities by fostering the development of long-term trespass prevention strategies through community problem-solving partnerships. This study will build on the lessons learned from TPRS I and avoid any deficiencies previously encountered, aim to get national buy-in on the proposed trespass prevention guidance. Currently FRA has partnered with the City of Worcester, Massachusetts, and several area railroads. This project is on-going.

TRESPASS DETECTION AND WARNING

This study will conduct field research on trespass detection and deterrent technologies. The research will consist of designing, installing, operating, and evaluating a large-scale trespass detection and deterrent system in collaboration with the Brunswick, Maine, Police Department to mitigate trespassing issues along several high-risk areas along the rail line in the Brunswick area. FRA has installed a variety of camera systems and is currently conducting further evaluations.

TRESPASS INNOVATIVE TECHNOLOGIES

FRA through its contractor will look at new technologies such as sound and other devices to alert trespassers. Additionally, looking at a way to mount a device on a locomotive that will send a signal that breaks into headphones. This project is on-going.

ANTI-TRESPASS GUARDS EVALUATION

To review, select, and evaluate emerging technologies and application for railroad ROW trespass application, specifically anti-trespass guards or landscaping rock treatments. New technologies or approach to mitigate the trespass problems, such as anti-trespass guards currently operational

in Europe and the use of rock ballast at the ends of platform and at grade crossings, will be investigated for possible demonstration at trespass prone locations. FRA has installed one set of anti-trespassing guards and is currently reviewing their effectiveness.

HIGH-SECURITY FENCING STRATEGIES FOR RIGHT-OF-WAY

Review of both high-security fencing and normal fencing to determine cost-benefit. FRA will produce a report that outlines its findings and recommendations. FRA has developed and published the report FRA_Report, D.-15/38 (2015), High-Security Fencing for Rail Right-of-way Applications.

Conclusion

This report provides a summary of approximately 50 reports dealing with railroad trespass and suicide prevention. The major findings are listed below.

GENERAL CONCLUSIONS

- In the United States, about 70% of all railroad-related deaths are the result of trespassing and suicide (FRA, 2017). In the European Union (EU), the comparable number is 89% (ERA, 2016).
- A total of 102 documents were reviewed. Of these, 46 were relevant and are discussed.
- Rail suicide rates vary widely amongst countries: 1.3% in Canada (Mishara, 2013); 12% in the Netherlands (Van Houwelingen et al., 2013); and less than 1% in the United States (FRA, 2013).
- In the United States, trespassing is a larger cause of rail fatalities than suicide, as opposed to the EU where suicide causes more fatalities (ERA, 2016).
- Suicide attempts (with casualty) result in a fatality in over 90% of cases, in contrast to trespassing incidents (with casualty) that results in a fatality in about 50% of instances (FRA, 2016).

RISK FACTORS

- The mean age of suicide fatalities runs between 39 and 45 (Mishara and Bardon, 2016).
- Males represent 7% to 82% of fatalities (Cadle Creek, 2008; FRA, 2013).
- Fifteen percent of railroad suicide victims were married, compared with 38% for all methods of suicide (Berman et al., 2014).
- Alcohol was involved in 37% of suicide incidents with as many as 94% of those cases having a BAC of .08 or greater (Berman et al., 2014).
- Trespassers wearing earbuds or headphones are more likely to result in a fatality (Wali et al., 2017).
- Suicides peak in the afternoon and evening (Savage, 2016).
- The lack of access to firearms leads to an increase in the proportion of rail suicides of overall suicides. In the Reisch study, restricted access of firearms led to lower firearms suicides, lower overall suicides, but a partial substitution to rail suicides (DOT/FRA/ORD-13/25, 2013) (Reisch et al., 2013).
- Geographic areas of greater wealth and older age tend to have higher rates of railway suicide, but lower general suicide rates (Strale et al., 2016).
- The most typical rail trespasser fatality involves white males who are possibly intoxicated, with a mean age of 38, and with low socioeconomic status (FRA, 2013).

COUNTERMEASURES

- Probably the most comprehensive list of preventative measures can be found in the RESTRAIL toolbox (RESTRAIL, 2018).
- Restricting train speeds and track surveillance may have some influence on reducing the frequency of incidents (DOT/FRA/ORD-14/36, 2014).
- Suicide pits may have some influence in reducing the occurrence of incidents (Barker et al., 2016).
- Research trials of blue lights in Japan and the United Kingdom have shown mixed results in reducing the frequency of incidents (Matsubayashi et al., 2016).
- Fencing and other access control methods show a definite ability to reduce occurrences (DOT/FRA/ORD-13/25, 2013).
- Fencing, when used, should fully seal an area, should be strategically targeted, should be supported by all stakeholders and should be the outcome of a policy decision (DOT/FRA/ORD-15/38, 2015).
- Automated detection systems can effectively reduce the occurrence of trespassing (DOT/FRA/ORD-07/06, 2007) (Kallberg & Silla, 2016).
- Media reporting can negatively impact the occurrence of incidents and can lead to copycat occurrences when mis-reported (Barker et al., 2016) (Havârneanu, 2015) (Mishara & Bardon, 2016) (DOT/FRA/ORD-17/02, 2017).
- Law enforcement efforts can lead to reductions in the occurrence of incidents (DOT/FRA/ORD-16/03, 2016).
- Community based collaborations can lead to reductions in the occurrence of incidents, but require sustained leadership (DOT/FRA/ORD-14/19, 2014).
- Passive signage is likely not to be effective unless the would-be trespasser perceives a real chance of being detected and prosecuted (Havârneanu, 2016).
- A substantial number of trespassers and suicide victims are likely imperiled for at least a short while before impact, suggesting they can be detected (Wang et al., 2016).
- Commercial-off-the-shelf technology can be applied to effectively reduce the number of incidents (DOT/FRA-ORD-06/03, 2012).

DATA

- Both the FRA and FTA provide trespass and suicide data, as well as operational data needed to determine rates of occurrence by number of unlinked passenger trips, passenger train-miles and employee hours. FRA data is incident specific covering the general railroad system of railroads operating in the United States. FTA data is provided at a transit system level for approximately 70 transit systems offering light rail, streetcar, cable car and hybrid rail transit in the United States (FRA, 2018) (FTA, 2018).

FRA RESEARCH NEEDS WORKSHOPS

- FRA held Research Needs Workshops in 2008, 2012 and 2015 providing many potential research needs (DOT-VNTSC-FRA-09-02, 2009) (DOT/FRA/ORD-13/18, 2013).

In conclusion, this report has reviewed and summarized a wide variety of recent research pertaining to the epidemiology of trespassing and rail related suicide. In addition, a number of specific countermeasures have been detailed for future exploration and implementation to reduce the occurrence of rail trespassing and rail suicide.

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