

# TRANSIT ADVISORY COMMITTEE FOR SAFETY (TRACS)

## 2018-2020 Charter

Trespass and Suicide Prevention Final Report

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## **Introduction**

### **FTA's Tasking to TRACS and Overview of the Safety Focus Areas**

The Transit Advisory Committee for Safety (TRACS) supports the United States Department of Transportation's (DOT) Federal Transit Administration (FTA) by providing information, advice, and recommendations on transit safety. TRACS is comprised of a diverse panel of professionals representing a variety of stakeholders and interests who cooperatively address safety and other transit issues that are determined by the Secretary of Transportation and the FTA Administrator.

Under the 2018-2020 TRACS Charter, the FTA tasked TRACS with the following: "Review emerging technologies and recommend public transportation innovations in safety that FTA can implement in support of the public transportation sector." To assist the transit industry's shift towards the principles of Safety Management Systems (SMS), FTA encouraged TRACS to make recommendations using an SMS framework.

The recommendations in this report focus on Trespass and Suicide Prevention (TSP). Other reports developed under the 2018-2020 TRACS Charter focused on Employee Safety Reporting (ESR) and Roadway Worker Protections (RWP). Previous TRACS reports and recommendations can be found in the [TRACS Archive](#).

### **Statement Regarding Resources for the 2018-2020 TRACS Charter**

There are several important differences between the 2018-2020 TRACS Charter and previous TRACS committees. The deliberations and written reports of prior TRACS committees were supported by the Volpe Center as subject matter experts and technical writers to guarantee a high-quality product for the FTA. The Volpe Center also facilitated knowledge exchange among TRACS members and public participants, conducted scientific literature reviews, supported the drafting of feature rich advisory reports, and helped finalize evidence-based recommendations to the FTA and the transit industry. This invaluable support from the Volpe Center was not made available to the 2018-2020 TRACS Charter, although FTA did provide consultant support to schedule and facilitate TRACS meetings, take notes, organize research materials, and develop templates for the three subcommittees' reports.

Another major difference between prior TRACS committees and the 2018-2020 Charter is the reduction of TRACS committee members from 30 to 15. This has left the current TRACS with less capacity to create a report of the same thoroughness and quality as reports under previous charters. Additionally, the current TRACS was given three tasks to complete, as well as the development of new technology safety criteria, in contrast to the two tasks usually given to the previous committees. Finally, in March 2020, the United States was struck by the novel coronavirus COVID-19, a worldwide pandemic. The members of this charter's smaller TRACS committee have faced extreme time conflicts as they work to manage safe public transportation operations under pandemic conditions.

In the past, TRACS reports have been very important to agencies, regulators, and other transit industry stakeholders as guidance documents to address safety improvement opportunities and were of significant influence in the conceptualization and development of FTA's Safety Management System's (SMS) framework in the Public Transportation Agency Safety Plan (PTASP) final rule (49 C.F.R. Part 673). The U.S. transit community values the TRACS Committee's best practice guidance and safety leadership. In order to provide these benefits in a robust and effective manner, the TRACS Committee needs an appropriately sized membership and requires substantial technical and subject matter expert support.

## **Executive Summary**

Trespassing and suicides are the leading causes of rail-related deaths. It is therefore critical to understand how emerging technologies and innovative solutions may help prevent or mitigate occurrences.

The National Transit Database (NTD) defines trespassing as "the unauthorized entry of transit owned land, structure, or other real property not intended for public use" (NTD, 2020). NTD defines suicide as "self-inflicted harm where the intention of the person was to cause a fatal outcome and death occurs. The intent can be determined by any reasonable method, including police reports and eyewitness account" (NTD, 2020). The Committee agrees it is important to distinguish trespassing and suicide as two separate issues because each presents its own unique risk factors that require distinct solutions.

Trespassing is the number one cause of death on U.S. passenger and freight railroad systems regulated by the Federal Railroad Administration (FRA), with more than 2,700 deaths documented between 2012 and 2017 (FRA, 2020). During that same time period, 1,701 people died by suicide on U.S. rail systems, according to FRA data. While this represents less than one percent of the total annual suicide deaths in the U.S., rail trespassing and suicides together account for more than 70 percent of all rail fatalities, making these behaviors a central safety concern.

The numbers of fatalities and injuries related to trespassing and suicide on U.S. rail transit systems (Subway/Metro, Light Rail, and Streetcar systems) are much lower in total than those on FRA-regulated rail carriers, but still represent a considerable level of risk, with more than 1,200 fatalities between 2007 and 2015. The majority of these fatalities (78 percent, or 973) were members of the public—not transit workers, patrons, or passengers. On rail transit systems, the highest risk of fatality is associated with incidents involving members of the public who trespass on the rail system or who attempt suicide, either in a station environment or on the right-of-way (FTA, 2018).

The FTA and FRA have participated in joint research workshops to explore rail trespassing and suicide prevention (TSP) initiatives and technologies, although the FTA has not strongly focused

on TSP issues until recently (Right-of-Way Fatality, 2008). The FRA has mounted a more robust response to TSP challenges through the work sponsored by its Office of Railroad Safety (RSS) and Office of Research, Development, and Technology (RD&T), particularly research conducted under contract by the Volpe Center. FRA maintains multiple website pages that include information about rail trespass and suicide, including: accident and incident reporting by rail carriers<sup>1</sup>; a Trespass and Suicide Statistics Dashboard<sup>2</sup>; and an eLibrary with areas devoted to research reports focused on rail trespass and suicide countermeasures. These websites provide rail carriers, regulators, safety professionals, and other stakeholders with up-to-date, standardized information regarding rail trespass and suicide on the general railway system. FTA does not have the same depth of data on the problems of trespass and suicide on rail transit systems. The recommendations in this report will help increase FTA's body of research on these issues and support risk-based prevention and mitigation countermeasures by rail transit agencies.

## Summary of Recommendations

The TRACS TSP subcommittee believes that FTA should focus on rail trespassing and suicide prevention, prioritize resources to further research in these areas, and take positive steps to support technologies and innovative practices that reduce or mitigate trespass and suicide events. The TSP subcommittee makes the following recommendations:

- 1) FTA and FRA should cooperatively work to align how they define and report trespass and suicide incident data.
- 2) FTA should provide targeted funding to develop and pilot test a comprehensive transit-specific Critical Incident Program (CIP) for preventing, mitigating, and reducing the effects of traumatic exposure (suicides, deaths, assaults, etc.) on safety critical transit employees, including resilience training, post-event screening and assessment, and treatment.
- 3) FTA should develop standard signage for rail stations that includes information on suicide hotlines and the dangers of trespassing.
- 4) FTA should support research and funding on the use of detection technologies, such as aerial photography, to identify trespassing hotspots and cross-reference that with suicide hotspots.
- 5) FTA should support the building of low-cost barriers—such as landscaping, anti-trespass panels, fencing and other barriers—and signage, around the railroad rights-of-way to reduce chronic trespassing and potential suicides.

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<sup>1</sup> <https://railroads.dot.gov/accident-and-incident-reporting/overview-reports>

<sup>2</sup> <https://explore.dot.gov/t/FRA/views/TrespassandSuicideDashboard>

- 6) FTA should research artificial intelligence (AI) technologies used for trespass and suicide detection and prevention such as those outlined in best practices documents from FTA or the American Public Transportation Association (APTA).
- 7) FTA should support additional research to develop a proof of concept for the following emerging technologies that may prevent rail trespassing and suicide: (1) systems that detect intrusions on or at rail rights-of-way, station platforms, and grade crossings; (2) systems that communicate and integrate rail trespasser intrusion alerts with train controls; and (3) trespasser and suicide detection systems that can integrate with train control systems and existing protection systems.

## Conclusion

Trespassing and suicide are the leading causes of death on our country's rails. Gathering, sharing, and standardizing data across agencies will provide valuable information with which to make decisions on safety expenditures. Signage and barriers implementation has been proven to reduce trespassing and suicides in some areas, and the examples cited in this report could be replicated and/or standardized across the country. Funding for additional research on detection technologies to better understand the exposure of the public at risk, and the use of artificial intelligence to improve the quantification and automated analysis of that data, will expand and enhance our existing knowledge base on trespassing and suicide prevention methods, delivering evidence that transit leaders can utilize for future planning. The Committee believes that the recommendations in this report offer both low- and high-tech solutions that create real options for moving the entire rail industry forward toward safer operations. Funding for additional research on detection technologies and the use of artificial intelligence will expand and enhance our existing knowledge base on trespassing and suicide prevention methods, delivering evidence that transit leaders can utilize for future planning.



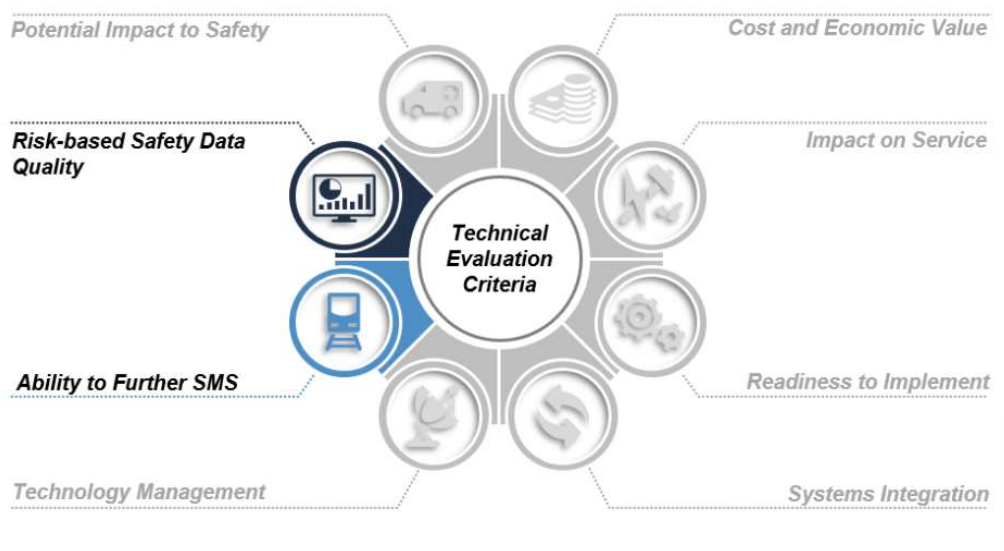
## Recommendations

### **TSP Recommendation #1 – Align FTA and FRA Trespass and Suicide Data Definitions and Reporting**

#### *Recommendation*

The Committee recommends that FTA and FRA cooperatively work to align how they define and report trespass and suicide incident data. Additionally, FTA and FRA should seek to develop a standardized definition and methodology for tracking and reporting a “near miss.”

#### *Technical Evaluation Criteria/Methodology*



Criteria used to evaluate this recommendation include: **Risk-Based Safety Data Quality** and **Ability to Further SMS Framework**.

**a. Risk-Based Safety Data Quality:** There is a well-established gap between how trespass- and suicide-related incidents are reported by rail transit systems to the FTA’s National Transit Database (NTD) and how the same incidents are reported by commuter rail systems to FRA’s Rail Accident/Incident Reporting System (RAIRS). A June 13, 2019 presentation “Trespasser and Suicides” made to the TSP subcommittee by Lisa Staes, Center for Urban Transportation Research (CUTR), University of South Florida, described the different trespass and suicide data reporting requirements for rail operators, depending on whether the information will be reported to FTA or FRA.

- FTA classifies **accidental collisions between a train and a person as a Safety Event**, but **suicides and attempted suicides are reported as Security Events**. Additionally, commuter railroads report security events to FTA, but report safety events to FRA.

- **FTA does not have a separate “Trespasser” incident report.** In the reporting of injuries, a transit property can check that an individual was injured while trespassing (an individual who is in an area of the transit property not intended for public use). But there is no specific reporting category for a person who is walking along or across rail transit tracks, either along the right-of-way or in a station environment. Separate from the “trespasser” checklist box under the Injuries reporting category, there are also checklist boxes for pedestrians and bicyclists. Therefore, a pedestrian or bicyclist who is struck on rail transit tracks may be categorized as a pedestrian or bicyclist injury, but not necessarily as a trespasser injury.
- FTA requires that suicide injuries and fatalities be reported if there is a collision. However, **if a suicide attempt does not result in a collision or the individual being taken to the hospital** (even if the person is transported off-scene for a mental health evaluation), **the event currently does not need to be reported** except as a “non-major incident.”
- FRA requires that a suicide or attempted suicide can be reported as such **only if confirmed by a coroner or other medical authority to be suicide/attempted suicide.** If the coroner reports that the cause of rail fatality is undetermined, it is recorded as a trespass death and not a suicide. The FRA’s safety data is more up to date than FTA’s, but the numbers are constantly shifting between trespasser and suicide casualties as the coroner reports are finalized and added to the incident reporting forms.

Also, the two DOT agencies have different definitions for these incidents:

	FTA Definition	FRA Definition
<b>Trespassing</b>	Unauthorized entry of transit owned land, structure, or other real property not intended for public use (National Transit Database 2020)	A trespasser is someone who is on the part of railroad property used in railroad operation and whose presence is prohibited, forbidden, or unlawful (FRA Guide for Preparing Incident/Accident Reports, 2011)
<b>Suicide</b>	Self-inflicted harm where the intention of the person was to cause a fatal outcome and death occurs. The intent can be determined by any reasonable method, including police reports and eyewitness account (National Transit Database 2020)	Death of an individual due to that individual’s commission of suicide as determined by a coroner, public police officer or other public authority (FRA Safety Reporting Form 6180.55a)

These differences between FTA and FRA's reporting elements, labels, and definitions make it all-but-impossible to compile a holistic understanding of the extent and nature of trespassing and suicide throughout all U.S. rail systems. The lack of common metrics also diminishes U.S. DOT's ability to meaningfully compare information regarding the circumstances of rail trespass and suicide events or the effectiveness of countermeasures to prevent or reduce the severity of incidents. Better alignment of FTA and FRA trespassing and suicide data, beginning with how events are labeled, defined, and reported, can help support more accurate and consistent data reporting that is comparable and can be freely interchanged between FTA- and FRA-regulated rail systems.

**b. Ability to Further SMS:** The FTA has defined SMS as "the formal, top-down, data-driven, organization-wide approach to managing safety risk and assuring effectiveness of safety risk mitigations." Having access to safety data that is consistently defined and collected at the Federal level will contribute to greater data accuracy throughout the transit industry and support informed safety decision-making by FTA. Establishing a closer working relationship between FTA and FRA and aligning the definitions and reporting requirements for the high-risk areas of rail trespassing and suicide will allow U.S. DOT, the National Transportation Safety Board (NTSB), and other Federal policy stakeholders to have a more complete and accurate understanding of these safety problems. At the local transit agency level, having a clear and consistent understanding of how rail trespass and suicide data is defined and reported will help build a more robust and effective SMS, giving all rail transit properties better tools with which to conduct risk assessments, track incident trends, and determine whether mitigations are effective and performance targets are being met.

**c. Defining "Near-Miss":** A major focus for FTA's SMS framework required for transit agency safety programs under the Public Transportation Agency Safety Plan (PTASP) regulation (49 CFR Part 673) is to ensure that transit agency employees can report safety concerns or near-misses to senior management under an Employee Safety Reporting Program (ESRP) that clearly describes which employee behaviors are protected and which may result in disciplinary action when reporting. The FTA has stressed the value of leading indicators, such as near misses, as safety data that can help transit agencies better define and mitigate hazards. However, the term "near-miss" is not defined by FTA or formally tracked as a safety data point by NTD. Each transit agency has had to develop its own definition and procedures for monitoring and reporting near miss incidents.

The FRA has a more established program for near misses, which are termed "close calls." The FRA defines a close call event as, "a specific situation or event that has a potential for more serious consequences that was observed by a railroad employee." As previously discussed, it is critically important to have clear definitions and consistent procedures for collecting data and reporting near misses.

***A possible definition for “near-miss”:***

*“An incident where no property was damaged and no personal injury was sustained but, where given a slight shift in time or position, damage and/or injury easily could have occurred.”*

FTA and FRA could utilize a think tank like the Volpe Center to work towards aligning their definitions of a “near miss” and other related criteria. They could also look at other organizations (perhaps even at the international level) to establish clearer definitions. For instance, the Occupational Safety and Health Administration’s (OSHA) National Safety Council

defines a “near miss” as “an unplanned event that did not result in injury, illness, or damage – but had the potential to do so” (OSHA, 2013).

### *Key Takeaways*

Differing data reporting requirements between FTA and FRA create obstacles to effective safety management at the national and local level. The following lists some of the obstacles created by FTA and FRA having different definitions and reporting requirements for rail trespassing and suicide incidents.

- 1. Safety data regarding rail trespassing and suicide cannot be consolidated or compared between FTA- and FRA-regulated rail systems.** As noted by NTSB Chairman Robert Sumwalt at a March 2015 two-day public forum on Rail Trespassing, it is frustrating that there is no way to accurately consolidate or compare the trespassing- and suicide-related safety data for U.S. rail systems since intercity passenger rail, freight rail, and commuter rail systems report to FRA and rail transit systems (subway, light rail, and streetcar) report to FTA and the two agencies use differing definitions and data elements in reporting these incidents.
- 2. Transit agencies often operate both rail transit and commuter rail systems.** Data reporting processes for these multimodal agencies would be streamlined and strengthened if the definitions and data elements for tracking and reporting rail trespassing and suicide were better aligned.
- 3. Different data definitions and reporting requirements create a roadblock to inter-agency collaboration.** FTA and FRA could conduct more meaningful safety research in the areas of trespass and suicide prevention if the two agencies “spoke the same language” in defining and quantifying the problems of rail trespassing and suicide.

### *Information Gaps*

Better alignment of trespassing and suicide data between FTA and FRA will help build a clear and consistent understanding of such incidents and will support outcome based data on the effectiveness of implemented mitigations and countermeasures. This recommendation, if implemented, will strengthen and improve SMS of rail transit properties and railroads throughout the United States.

## Conclusion

This recommendation should be implemented jointly by FTA and FRA to help improve the quality and reliability of safety data collected by both agencies at the national level regarding the highest-risk types of incidents on rail systems: trespassing and suicides. More consistent and more accurate data reporting will give transit agencies, including agencies that operate rail transit and/or commuter rail, better data for risk assessment, tracking safety trends, and determining whether mitigations are effective and performance targets are being met.

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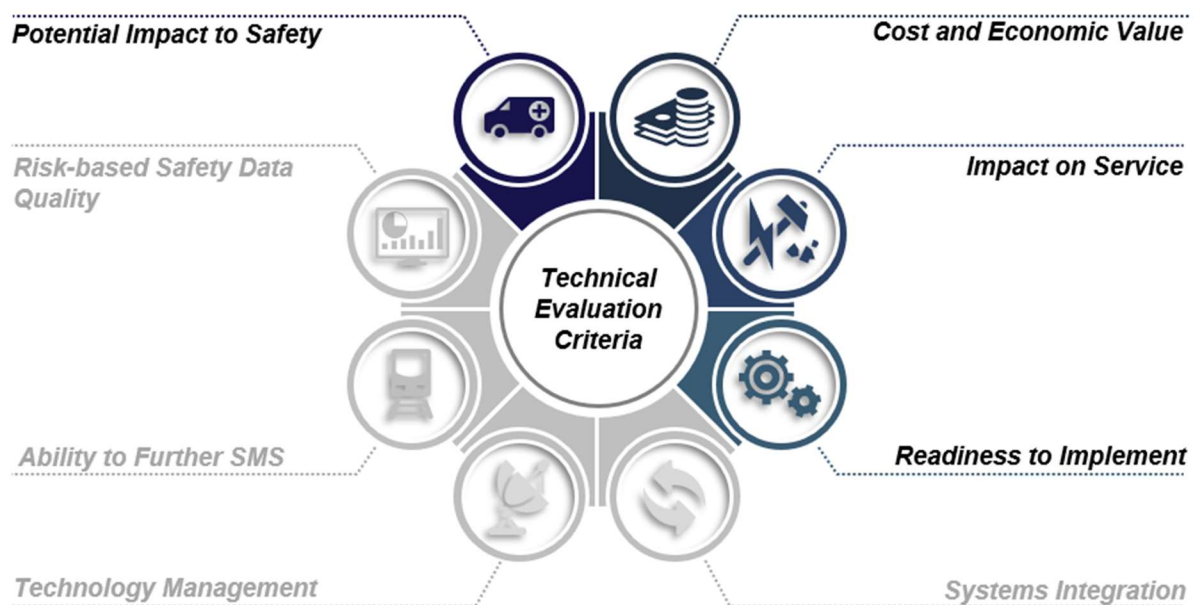
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## TSP Recommendation #2 – Provide Targeted Funding Support for Comprehensive Post-Fatality Support Programs

### *Recommendation*

The Committee recommends that FTA provide targeted funding to develop and pilot test a comprehensive transit-specific Critical Incident Program (CIP) for preventing, mitigating, and reducing the effects of traumatic exposure (suicides, deaths, assaults, etc.) on safety critical transit employees, including resilience training, post-event screening and assessment, and treatment.

### *Technical Evaluation Criteria/Methodology*



Criteria used to evaluate this recommendation include: **Potential Impact to Safety, Cost and Economic Value, Impact on Service, and Readiness to Implement.**

Scientific literature over the past decade has evolved to a better understanding of the nature, extent and response to exposure to traumatic critical incidents in the workplace (Attridge & van de Pol, 2010; van de Pol, Gist, Braverman, & Labardee, 2006). Existing programs focus on industry specific incidents and response for employees involved in these incidents (Bardon & Mishara, 2015b; Clarner et al., 2015). Pilot testing/demonstration programs have provided some data on utilization and acceptance in several industries, including rail (Bardon & Mishara, 2015a; Gist, 2017; Pinarowicz, Sherry, & Bodanza, 2013). Although there have been mixed but promising results regarding the prevention and alleviation of the deleterious effects of traumatic exposure, researchers suggest continued research is needed to demonstrate an

improvement to employee health and well-being, job performance, productivity, work satisfaction, and safety adherence (Gist, 2016).

The subcommittee identified the following TEC for consideration and justification in developing this recommendation: cost/benefits, potential impact on safety, potential impact on employee health and well-being, potential impact on service and on-the-job performance, and readiness to implement.

**Cost/benefits:** Many publicly available templates exist on how to implement assistance programs. These can be readily adapted to the transit environment, resulting in a favorable cost/benefit ratio.

**Potential impact on safety:** The effects of well-designed programs used in the military and other settings on traumatic incident exposure have been positive, supporting anticipated favorable impacts on workplace safety in the rail industry. The negative impacts on workplace safety of leaving traumatic experiences unaddressed are well documented as well, and include absenteeism and increased turnover.

**Potential impact on employee health and well-being:** Given the documented incidence of fatal incursions in transit systems, and especially given the predominance of suicides among these events, and given the documented impact of such events on employees, preparation and processes to address that impact clearly warrant action as a matter of occupational health and safety. Hillary Konczal, Chief Safety Officer (CSO) of the Metra's transit system in Chicago, highlighted in a recent presentation to TRACS that approximately 60 percent of Metra's fatalities are suicide related; prior FTA research indicates that operators have a greater than 50 percent likelihood of experiencing at least one such event in the course of their career and many will experience more than one (Sherry, 2011).

The freight rail industry has adopted well-designed programs that identify individuals needing assistance and treatment after such events. Appropriate and effective treatments by trained mental health professionals exist to reduce symptoms of exposure to traumatic workplace events. At the same time, additional efforts to adopt assessment and intervention programs for the entire rail industry are warranted, and additional research to identify effective prevention programs is also needed.

**Potential impact on service and on-the-job performance:** Appropriate treatment for individuals exposed to workplace trauma can have a positive impact on time lost to recuperation, employee engagement on return, and job satisfaction. In addition to the cost savings from lower turnover (some individuals leave their jobs after a traumatic exposure) and decreased absenteeism, the benefits obtained from traumatic exposure

intervention programs are linked to improvements in job performance (Attridge & van de Pol, 2010).

**Readiness to implement:** Technology Readiness Level (TRL) is a metric used to assess the maturity level of a specific technology (Heder, 2017). It is the capability of a technology, or its readiness level, to be implemented as part of a larger system to impact a desired change. The TRL 1 represents the lowest level of readiness while TRL 9 is the highest, where the technology has been demonstrated, implemented and proven useful or effective in an operational environment. The subcommittee has determined that the readiness level of a transit-specific critical incident program is high, probably around TRL 8-9.

The FRA's Office of Research and Development has already conducted a review of the literature on evidence-based best practices with respect to prevention, mitigation, intervention, and evidence-based treatment of occupational exposure to potentially traumatic events (PTEs). This foundational study led to the development of FRA's Critical Incident Rule (49 CFR Part 272). The same unit of FRA also sponsored a pilot program and an implementation assessment to establish the foundation for putting an evidence informed program in place and to assess requirements for and impediments to launching such a program in the carrier environment. This work provides a possible foundation for adaptation to the transit environment, reducing the potential cost of development and allowing focus to be placed on the most efficient mechanisms for dissemination and delivery.

Subsequent presentations to TRACS by Dr. Gist, Hillary Konczal, and Dr. Scott Gabree all attested to the value of such interventions in the rail environment, their direct and immediate applicability to transit operations, and the inherent alignment and integration of a critical incident intervention program within a systems-based approach for TSP in transit operations.

### *Key Takeaways*

1. The following are suggested definitions for clarity and understanding of the proposed recommendation:
  - Traumatic exposure: Traumatic exposures include workplace events that place an employee in a position of exaggerated helplessness, anxiety, and/or fear when confronted with situations beyond the usual scope of their duties and life experiences, and which present persisting difficulties in adjustment and resolution.
  - Critical incident: A critical incident is an event that results in a fatality, loss of limb, or a similarly serious bodily injury or a catastrophic accident, either witnessed or inflicted upon an individual employee (i.e. assault), which could be reasonably expected to impair a directly involved employee's ability to safely



perform job duties. This definition mirrors the definition from the FRA Critical Incident Rule, which allows the program to also include employees who are assault victims (except for operator assaults, which are not within scope of FRA-defined “critical incidents”).

- Directly involved employee: A directly involved employee means a transit employee whose actions or involvement are closely connected to the critical incident, who witnessed or was a victim of assault from the critical incident, or who was charged to directly intervene/respond to the critical incident. This definition mirrors the definition in the FRA Critical Incident Rule, but also the program to assist employees who are assault victims.
2. Exposure to trauma at the workplace, specifically for those in safety critical positions, is relatively common, with half or more of operators likely to be exposed to at least one and often more such events. Some occupations, such as transit operators, are at a much higher risk of traumatic exposure than others due to the increasing frequency and often grotesque consequences of workplace fatalities, particularly suicides (Gabree, Scott H. et al. 2019).
  3. Traumatic exposure, as documented in the research literature, increases the likelihood and severity of functional impairments in one or more of the following: emotional health, cognitive functioning (e.g. distraction, judgment, and decision-making), and overall physical health and well-being.
  4. The extent of emotional, psychological, long-term health, and job-related performance consequences of traumatic exposure for individuals will vary, depending on individual resiliency characteristics (e.g. coping style), degree and duration of exposure, and family or work-place social support systems.
  5. These impairments in emotional and cognitive function, as well as physical health and well-being often lead to decrements in on-the-job performance such as increased distractibility, absenteeism, and job turnover.

### *Information Gaps*

The following gaps in information remain to be addressed:

- Current programs, if any, existing in the transit sector: Many rail carriers covered under the FRA Critical Incident Rule (49 CFR Part 272) have existing programs, typically as an offshoot of an established Employee Assistance Program (EAP), which were designed to address some segments of the domain covered under the rule. While most of these required updating and adaptation to conform to current evidence and comply with the overall requirements of the Rule, the design was to facilitate building upon (rather than replacing) established programs wherever possible.

- Integration with current EAP and Occupational Health programs: These programs are most efficient and have the best penetration when integrated into existing help-seeking and health care delivery systems known to and utilized by target employees. Information regarding the nature and extent of such programs within the transit sector is needed to inform integration strategies (van de Pol et al 2006).
- Training delivery systems: Training is typically needed at several levels. Much can be delivered as additions to existing health and safety training, but integration into those systems must be informed by understanding the structure and mechanisms of said systems. Much training can potentially be delivered through remote learning where the infrastructure exists to support it; that, too, must rely on understanding of existing technological readiness at the end user level.
- Labor Management Cooperation: Programs tend to see better utilization and outcomes when developed and operated as a cooperative project among labor, management and the Federal Government. Understanding the involvement and interest of key labor organizations in the sector can also help inform the most efficient and effective pathways for implementation.
- Evidence of successful implementation: While many organizations are quick to design and implement safety interventions, there is often a paucity of information as to the effectiveness and impact of those interventions. The design and implementation of the CIP for the transit industry should include not only an implementation evaluation to document effective implementation strategies for future guidance documents, but measures of utilization, impact and effectiveness for accountability purposes. Rigorous implementation and impact evaluations will provide an evidence-based approach for policy and decision-making, ensuring appropriate business decisions for both the government and industry decision makers.

### *Additional Justification*

In its PTASP Final Rule, 49 CFR Part 670, FTA adopted the principles and methods of SMS as the foundation for the development, implementation, oversight and enforcement of the Safety Program. An integral and key element of FTA's Safety Program is the identification and mitigation of inherent hazards in the system, with hazard defined as "any real or potential condition that can cause injury, illness, or death; damage to or loss of the facilities, equipment, rolling stock, or infrastructure of a recipient's public transportation system; or damage to the environment" (Bardon & Mishara, 2015b; Clarner et al., 2015; Sherry, 2011). All too often, people consider a hazard as existing only in the external environment. Yet, a hazard can also occur internally. Fatigue and distraction are common hazards in the transit industry, with NTSB investigations documenting fatigue and distraction as a primary contributing factor in numerous catastrophic accidents. Thus, adequate funding and resources should be devoted to their prevention and mitigation, including the often-debilitating distraction and accompanying

fatigue caused by traumatic exposure (Bardon & Mishara, 2015b; Clarner et al., 2015; Sherry, 2011).

### *Conclusion*

Workplace trauma has been associated with a number of negative consequences including attendance, performance, productivity, and safety issues. The frequency of such events in the transit sector is well documented, with half or more of operators likely to be exposed to at least one and often more such events during the course of their work history. Programs for mitigation of these impacts and for treatment when required have been developed and can be readily adapted to the transit environment with favorable cost benefit. The Committee recommends that FTA fund a pilot project to facilitate such an adaptation and promote its dissemination among transit systems.

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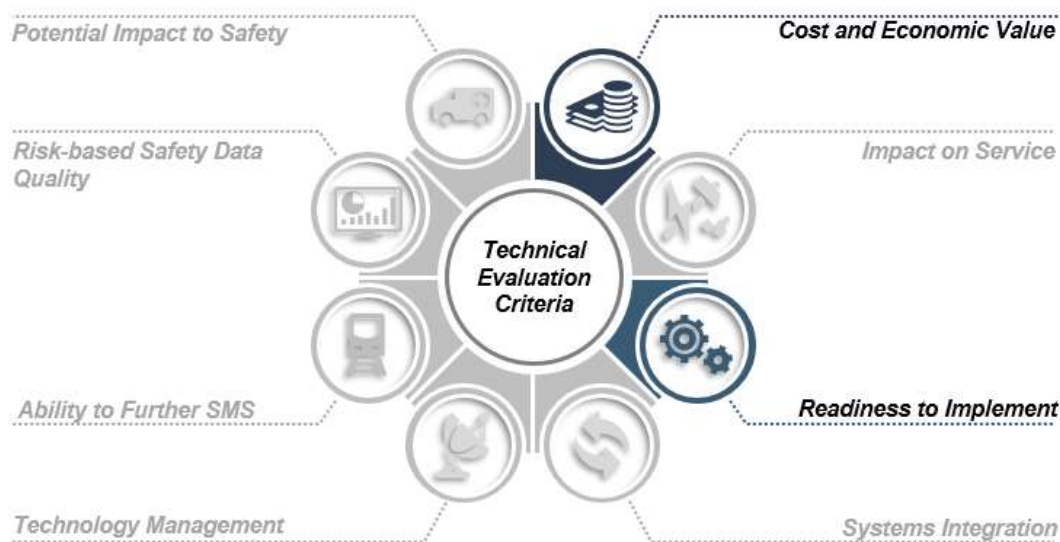
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## TSP Recommendation #3 – Develop Standard Suicide & Trespassing Prevention Signage

### *Recommendation*

The Committee recommends that FTA develop standard signage for rail stations that includes information on suicide hotlines and the dangers of trespassing.

### *Criteria/Methodology*



Criteria used to evaluate this recommendation include **Cost** and **Implementation Readiness**. Signage is a low-cost intervention when compared to building fences, walls, and other types of barriers. While fencing has been shown to be an effective countermeasure to reduce trespassing, it can also come with expensive installation and maintenance costs, depending on type. High-security fencing, while less susceptible to damage, requires higher upfront costs due to the superior materials and potential for additional installation work. Regular fencing, while potentially having lower installation costs, may be more susceptible to damage or vandalism, resulting in frequent and expensive repairs. Landscaping may also require frequent upkeep depending on the type of vegetation used. Signage, on the other hand, would likely call for very low installation and maintenance costs since it would require no construction and little to no upkeep.

Signage is used primarily for two purposes—to warn of trespassing dangers or to provide information on help with depression or suicidal ideation. Such signs are already being used by agencies across the country (Gabree, Scott H. et al. 2019; King and Frost 2005; Lobb et al. 2001; Silla and Luoma 2011). Examples of verbiage currently used (listed in alphabetical order by carrier) include:

- “Suicide is not the route” (BART, Long Island Railroad)
- “There is help” (Caltrain)
- “Speak Up, Save a Life. Suicide is Preventable. Most people who experience suicidal thoughts are in a temporary serious crisis. Suicide can be prevented with your help. It’s up to us.” (Caltrain)
- “If you or someone you know needs someone to listen, Samaritans is there.” (MBTA)
- “If you need to talk, we’re here to listen. Let us help” (Metra)
- “Need help? Feeling hopeless? Call the suicide prevention hotline at 877-727-4747” (Metrolink)
- “Suicide is NOT the answer.” (New Jersey Transit)
- “You talk, we listen. Together we survive.” (WMATA)

Some agencies have also partnered with local and national suicide helplines on signage campaigns to help prevent trespassing and suicide. Information reported by the San Francisco Bay Area Rapid Transit (BART) revealed that partnering with the National Suicide Prevention Lifeline on a signage campaign resulted in the helpline receiving 20 to 50 calls per year since the campaign began (Gabree, et al. 2019). Correlational patterns revealing suicide reductions were also documented at other properties (Gabree et al. 2019).

### *Key Takeaways*

Signage is an important low-cost prevention and intervention effort and can be used as part of public awareness campaigns to educate people on the dangers of trespassing. Signage may also prevent suicide by directing distressed individuals to appropriate resources such as helpline referral numbers, which may prompt help-seeking behavior before suicidal ideation turns into action. It has the added benefit of increasing the awareness of depression and suicidal ideation in bystanders.

Railroad safety initiatives and suicide-specific prevention efforts are implemented nationwide using a broad range of strategies to inform people on the dangers of trespassing and how to get help if considering ending one’s life. Signage may provide local helpline services for a person contemplating suicide, providing a timely intervention that may prompt help-seeking behavior before suicidal ideation turns into action. Signage—including posters, warning, and prohibitive signs—are often part of public awareness campaigns to educate people on the dangers of trespassing and/or for suicide prevention.

When implementing a signage campaign, carriers may choose to partner with local and/or national suicide prevention helplines, often providing both a phone number and a website.

Research into the efficacy of suicide-specific prevention signage found that when placed prominently near suicide “hot spots” or areas that are particularly attractive for suicide, providing a helpline number reduced suicides from 10 per year to less than 3.3 per year during the three-year study period (King & Frost, 2005). This research did not focus on rail suicide specifically; however, Gabree, Hiltunen, and Ranali (2019) reviewed publicly available information on the use of signage and found 14 U.S. rail carriers who have adopted signage at their stations. It is important to note, however, that the effectiveness of this strategy of providing hotline referral numbers is dependent on access to a phone, which may be limiting to some vulnerable populations.

The verbiage used on signs also matters, as a long history of research documents that the stigma associated with depression and help-seeking behavior can be a deterrent (Tracey et al, 1986; Covello, 2020). This finding is accentuated when viewed through a gender lens. In the United States, for example, men commit suicide at a higher frequency than women. In 2018 that rate was more than three to one (AFSP, 2018). Consequently, there is a need to ensure that the verbiage used in railroad safety signage is consistent with the latest findings for encouraging help-seeking behavior across reference group membership.

Addressing suicidal ideation through the printed word can suggest hope and a way forward. Signage may also help increase the awareness of depression and suicidal ideation in bystanders, rail staff, and others, which may lead to proactive efforts to assist those in need. In creating this signage, however, FTA should be cognizant of issues of equity. While it’s crucial to provide information on such hotlines and crisis resources, designers of such signage must keep in mind that vulnerable or at-risk populations might not have access to technology required to access hotline resources and may require telephones near signage.

### *Information Gaps*

Information gaps include:

- Lack of information on the efficacy of signage as a countermeasure
- Lack of consensus on standard messaging and language that will be an effective deterrent to trespassing behavior or will encourage individuals contemplating suicide to seek help
- Lack of outcome data on the frequency that a suicide prevention number is called because it was placed in or near a railroad setting

While there has been some research on the use of signage as a countermeasure, proposing that standard signage for rail stations be adopted could increase the number of agencies that implement signs and, in turn, provide more data on its effectiveness. Recommending that a standard message be adopted could also eliminate any confusion on what should be included on signs.

A potential approach to developing effective standardized messaging and signage for trespass prevention and suicide intervention is for FTA to first conduct appropriate baseline research on the effectiveness of different messaging currently used in the rail environment. Thereafter, FTA could establish a national committee or working group to develop effective messages and imagery for standardized signage. Key stakeholders may include representation from: FTA, FRA, transit agencies with rail transit and commuter rail systems, State Safety Oversight Agencies, railroads, national nonprofit safety educational organizations such as Operation Lifesaver or National Safety Council, and suicide prevention organizations including National Suicide Prevention Lifeline (*note: FCC approved 988 to be 3-digit number for national suicide hotline starting in 2022*).

Finally, there is an information gap regarding how to best address vulnerable populations who might not have access to a cell phone for resources such as suicide hotlines. Moreover, there is an absence of conclusive evidence on the efficacy of hotlines that utilize text messaging versus those that utilize voice calls.

### *Additional Justification*

In addition to the studies mentioned above, other studies have also found signage to be an effective solution. A study in Finland, for example, found that after installing signage with the text “No Trespassing” near a frequently crossed railroad track, trespassing reduced by 30.7 percent (Silla and Luoma 2011). In New Zealand, trespassing reduced from 59 percent to 36 percent after large warning signs were placed on or near platforms in conjunction with fencing and education measures (Lobb et al. 2001). A suicide prevention program “Crisis Link” in Toronto installed posters in every subway platform with some reports saying that the suicide rate dropped by almost 46 percent (Sherry 2016; TTC 2011). The posters read “Thinking of Suicide? There is help. Let’s talk.” and directed people to use the public phone available with a direct-dial button that connected to a helpline with trained counselors.

### *Conclusion*

Trespassing and suicides are the leading causes of rail-related deaths (FRA, 2018). As a cost-effective suicide and trespass countermeasure, the committee recommends that FTA develop standard language and placement guidelines for signage.

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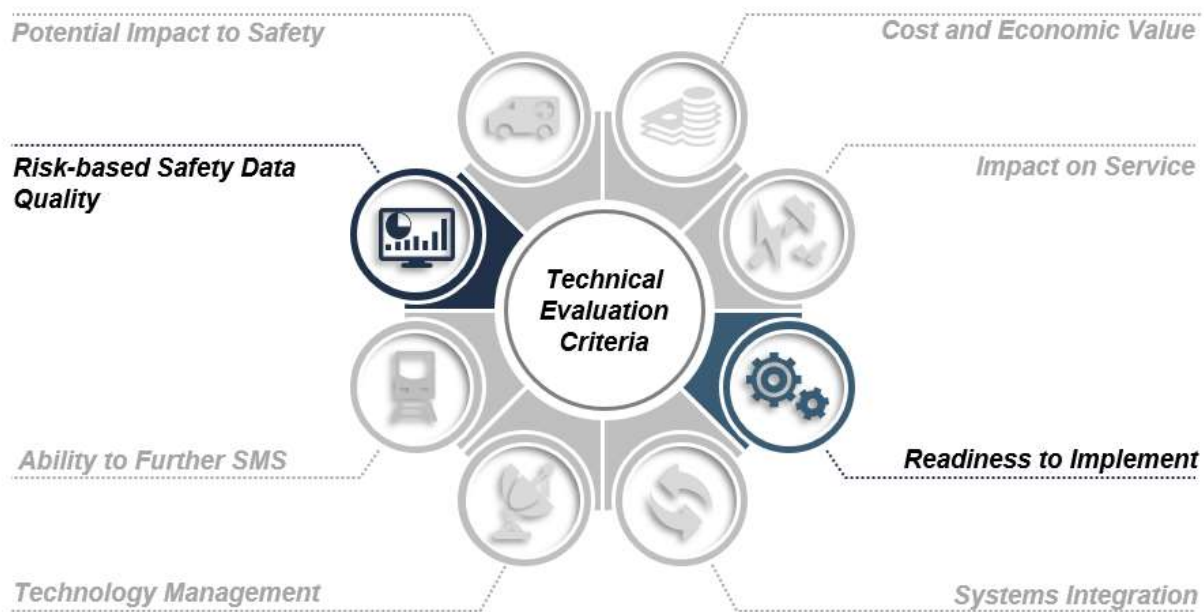
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## TSP Recommendation #4 – Support Research on Use of Detection Technologies to Identify Rail Trespassing Hotspots

### *Recommendation*

The Committee recommends that FTA support research and funding on the use of detection technologies, such as aerial photography, to identify trespassing hotspots and cross-reference that with suicide hotspots.

### *Technical Evaluation Criteria/Methodology*



Criteria used to evaluate this recommendation include **Risk-based Safety Data Quality** and **Implementation Readiness**.

Limited research has been conducted on detection technologies for the identification of trespassing hotspots and the development of appropriate exposure measures for tracking and monitoring the prevalence and incidence of trespassing. Previous studies analyzing trespassing or suicides patterns only relied on cases that had been documented and may not have taken into account unreported trespassing cases (Botha et al. 2010, 2014; Chase et al. 2018; daSilva and Ngamdung 2014; Sherry 2016; Topel 2019). More research on detection technologies, specifically aerial photography, would reveal whether these technologies are viable for increasing the capture of unreported trespassing incidents.

It is important to note that such technology would serve a greater benefit for detecting trespassing than for detecting suicidal behavior, however, such a system could help agencies cross reference trespassing data with suicide hotspots to better identify specific problem areas. Detection technologies could be used to capture and document details on trespassing incidents that at present may not be captured or documented: where trespassing is taking place, the exact time the trespassing is taking place, who is trespassing, or how they are trespassing. Aerial photography or drones may be able to obtain a closer look at areas that are not being patrolled by rail employees or are inaccessible by fixed security cameras. Satellite imaging or drones are already used by other industries, but do not require additional infrastructure to be built (Gabree, Scott H. et al. 2019; Knight 2016). Some of the applications for this technology include analysis of land-use changes, traffic patterns, and agriculture. Some industries may also be using drones to get a closer look at areas otherwise inaccessible, such as when working on an engineering project or assessing damage in a difficult-to-reach location.

Importantly, this technology would likely not require that any significant infrastructure or system changes be made to a railroad. Also, details gathered using detection technologies could be developed into a data reference and exposure measures system for cross-referencing trespassing data with suicide data, identifying hotspots, and tracking and monitoring relevant trespassing exposure data.

This recommendation is intended to be open-ended with regards to the type of detection technology researched and implemented, and does not seek to limit its scope only to aerial photography or drones, especially given the constant development of new technologies.

### *Key Takeaways*

Researching detection technologies such as aerial photography will help identify trespassing hotspots as well as deepen understanding of trespassing tendencies, going beyond what has been witnessed and reported. With additional research and testing of detection technologies, agencies could potentially implement a reference system of trespassing data that could be cross-referenced with suicide data. The resulting data could be utilized to enhance safety measure decision-making processes. Also, implementing detection technology would likely not require that any significant infrastructure or system changes.

Lastly, research of detection technologies may help further SMS. Enhanced data about trespassing will show that detection technologies are valuable tools for agencies and will also help identify the best countermeasures to implement to prevent trespassing.

### *Information Gaps*

The following gaps remain to be addressed:

- A limited number of studies have looked at detection technologies, such as sensors attached on railroad tracks, AI detection, or video surveillance technology, to detect

trespassers (Catalano et al. 2014; daSilva, Marco P et al. 2012; daSilva and Ngamdung 2014; Gabree, Scott H. et al. 2019; Zaman et al. 2018, 2019).

- Research looking at railroad trespassing and suicide focused on examining documented incidents (Botha et al. 2010, 2014; Chase et al. 2018; daSilva and Ngamdung 2014; Sherry 2016; Topel 2019), but not enough research has been conducted over a substantial time period to document whether recommended detection technologies effectively prevent trespassing or suicide.
- Previous research regarding railroad incidents or hotspots has mainly focused on where suicides or accidents have taken place, with little research documenting unreported trespassing incidents (Botha et al. 2010, 2014; Chase et al. 2018; daSilva and Ngamdung 2014; Sherry 2016; Topel 2019).

### *Additional Justification*

Although the research is limited, the following studies have shown some promise as to the effectiveness of technologies at detecting trespassing.

- A study in Pittsford, New York conducted research on video-based trespass monitoring along a railroad bridge over the course of three years (daSilva, Marco P et al. 2012). During the first year of the study, almost a third of the incidents detected were false alarms. However, the number of false alarms was reduced to about 10 percent by the third year of the study by adjusting the detection tools, such as adjusting the sensitivity of the motion detectors.
- Other studies in Palo Alto, California and Florida have used camera detection technology to detect trespassing (daSilva and Ngamdung 2014; Gabree, Scott H. et al. 2019). In Palo Alto, testing of camera detection showed positive results, leading the city to start shifting their monitoring systems from human monitoring to cameras (Gabree, Scott H. et al. 2019). The South Florida Regional Transportation Authority has installed cameras on the trains themselves, allowing the agency to get a different perspective on otherwise unseen trespassing (daSilva and Ngamdung 2014).
- Drones have also been considered for use by numerous rail agencies across the country (Gabree, Scott H. et al. 2019; Knight 2016). In Maine, for example, the Brunswick Police Department has proposed using drones to detect trespassers along an Amtrak rail line (Gabree, Scott H. et al. 2019). Freight rail carriers, such as BNSF and Union Pacific, have also started testing drones for inspecting rails and surrounding infrastructure that might be otherwise inaccessible (Knight 2016).

The FRA has also recently made efforts to increase their support and funding to address trespassing and suicide, having developed a National Strategy to Prevent Trespassing on Railroad Property specifically focused on data gathering and analysis, community site visits, funding, and partnerships with stakeholders (“National Strategy to Prevent Trespassing on

Railroad Property | FRA" n.d.). FRA has also recently announced a funding opportunity for agencies to develop their own strategies to combat trespassing on railroads in their local areas. Not only does this show growing support for additional research and funding to fix trespassing problems, but also shows that there is a willingness on a national level to take a more active approach to solving trespassing issues as a country rather than on a case-by-case basis, improving understanding and data of trespassing as a whole.

## Conclusion

Research on detection technologies will enhance understanding of trespassing, help agencies determine trespassing hotspots, and support cross-referencing with suicide hotspots. It can be implemented immediately. Detection data that tracks rail trespassing or suicide locations can be utilized by agencies to develop a reference system or database that allows cross-referencing and helps agencies focus safety measures and increase awareness of the issue among communities in their service areas.

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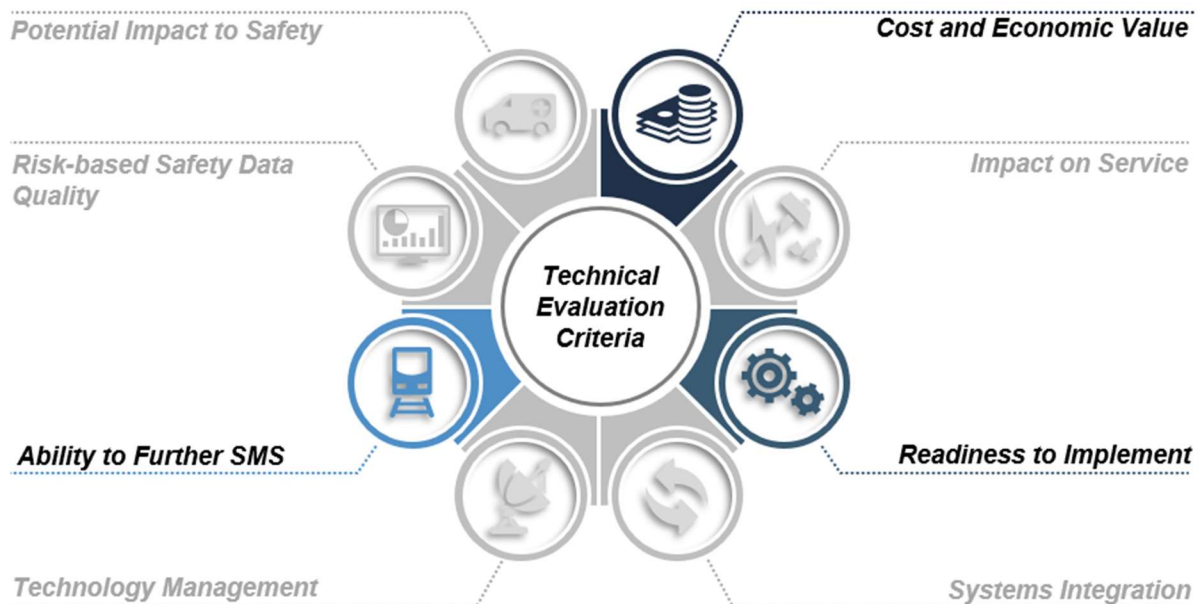
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## TSP Recommendation #5 – Support Building Low-Cost Barriers and Signage around Railroad Right-of-Way

### *Recommendation*

The Committee recommends that FTA support building low-cost barriers—such as landscaping, anti-trespass panels, fencing and other barriers—and signage, around the railroad right-of-way to reduce chronic trespassing and potential suicides.

### *Technical Evaluation Criteria/Methodology*



Criteria used to evaluate this recommendation include **Cost**, **Implementation Readiness**, and the **Ability to Further SMS**.

Landscaping, fencing, and signage can be economical barriers for reducing trespassing and suicide along a railroad right-of-way. Promising recent solutions such as anti-trespass panels (ATP), which are also relatively low cost, can be utilized in concert with vegetation and signage to discourage trespassing by creating a ground level barrier that is difficult to pass. Examples of ATP can be found at the RESTRAIL website: (<http://restrail.eu/toolbox/spip.php?article106>). Barriers such as fencing and vegetation are already common trespassing countermeasures for keeping people out of restricted areas, buildings, parking lots, etc., and have been implemented at the right-of-way of rail properties around the world. (While fencing has also proven to have a significant impact on reducing trespassing, some high-security fencing can come with high installation and maintenance costs.) The materials used for these countermeasures are typically readily available. Therefore, implementing barriers would be relatively easy and create

immediate impact. ATPs are similar to other low-cost measures in that they can be implemented quickly and show promising signs of efficacy.

Studies in Finland, Hong Kong, Japan, and New Zealand have shown that some type of fencing or barrier and signage has significantly decreased the number of trespassers and/or suicides near railways (Law et al. 2009; Lobb et al. 2001; Silla and Luoma 2011; Ueda et al. 2015). Similar results have been found in Maine and Washington D.C., as well as in Canada and the United Kingdom, where fencing was installed near bridges to reduce suicides (Bennewith et al. 2007; Lester 1993; Pelletier 2007; Sinyor and Levitt 2010). Capital Metro in Texas has even gone as far as creating a formal policy on the different fencing options available based on the situation in which they will be used (Stanchak et al. 2015). While fencing may not be the best low-cost solution, these studies show that any type of barrier, including landscaping and vegetation, can have a tremendous effect on reducing trespassing. Utilizing ATPs in conjunction with other barriers or on their own may also lead to reduced trespassing.

Making the implementation of low-cost barriers around potential trespassing hotspots a common practice would help further SMS. Encouraging agencies to have a policy on barriers may help put trespassing and suicide prevention at the forefront of their safety policies.

### *Key Takeaways*

All the studies reviewed by the committee regarding the use of barriers found them to be effective in reducing trespassing and suicide. A study in Finland evaluated three different types of barriers: vegetation, fencing, and signage (Silla and Luoma 2011). After comparing the number of trespassers from before and after the barriers were installed, the research team found that fencing reduced trespassing by 94.6 percent, landscaping reduced trespassing by 91.3 percent, and signage reduced trespassing by 30.7 percent. Other studies have found that barriers and fencing have reduced the number of suicides by half or almost entirely (Bennewith et al. 2007; Law et al. 2009; Lobb et al. 2001; Ueda et al. 2015). These results indicate that barriers are significantly effective at reducing trespassing and suicide, and that landscaping can be nearly as effective as fencing.

Barriers have been shown to be most effective at critical locations/hotspots. Targeting hotspots not only reduces costs by limiting the number of locations where barriers are installed, but has also been shown to help reduce the number of trespassers and suicides across railroad right-of-way.

Lastly, making some type of barrier a common requirement along the railroad right-of-way could help agencies establish clear and fixed policies regarding trespassing safety. Currently, there is no general policy regarding the use of barriers, but some agencies across the country have started to implement them (Stanchak et al, 2015). Establishing a clear set of guidelines to



follow regarding barriers could help agencies standardize trespassing mitigation practices across the industry.

Overall, this recommendation is intended to be flexible rather than constraining. The Committee recognizes that there are several types of barriers that could help prevent trespassing and suicide, whether they be part of an initial design or an addition to existing structures.

### *Information Gaps*

There are few, if any, information gaps pertaining to this recommendation. Additional research on the efficacy of ATPs would be helpful in potentially establishing this lower-cost measure as a bona fide solution.

### *Additional Justification*

In addition to the study conducted in Finland, other studies have found similar results as to the effectiveness of barriers at reducing trespassing and suicide. In Hong Kong, agencies installed platform screen doors/barriers at rail stations and found the suicide rate dropped by 59.9 percent and all injuries at platforms dropped by 68.8 percent (Law et al, 2009; Law and Yip 2011). In the United Kingdom, a study found that signs in a parking lot near a cliff that had been marked a suicide hotspot helped reduce suicides from ten per year to fewer than 3.3 per year (King and Frost 2005). Another poster campaign near subway platforms in Toronto was found to be very successful, with some reports saying that the suicide rate dropped by 46 percent (Sherry 2016). Although further research on the effectiveness of these countermeasures would be valuable, the research that has been done so far shows that the implementation of some type of barrier is one of the most effective approaches to reducing trespassing and suicide. FRA has implemented a National Strategy to Prevent Trespassing on Railroad Property to focus more of their efforts on data gathering and analysis, community site visits, funding, and partnerships with stakeholders (“National Strategy to Prevent Trespassing on Railroad Property | FRA” n.d.). Previous FRA efforts to combat trespassing were primarily focused on outreach, education, and addressing trespassing issues on a case-by-case basis, while this national strategy seeks to create a more unified effort across the country. The FRA has also recently announced a funding opportunity for agencies to implement their own strategies to reduce trespassing and suicide.

### *Conclusion*

Landscaping, some kinds of fencing, ATPs, and signage are low-cost options for reducing trespassing and suicide and can be implemented quickly. This recommendation should be implemented by FTA in order to reduce the number of trespassers and suicides near railroad rights-of-way.

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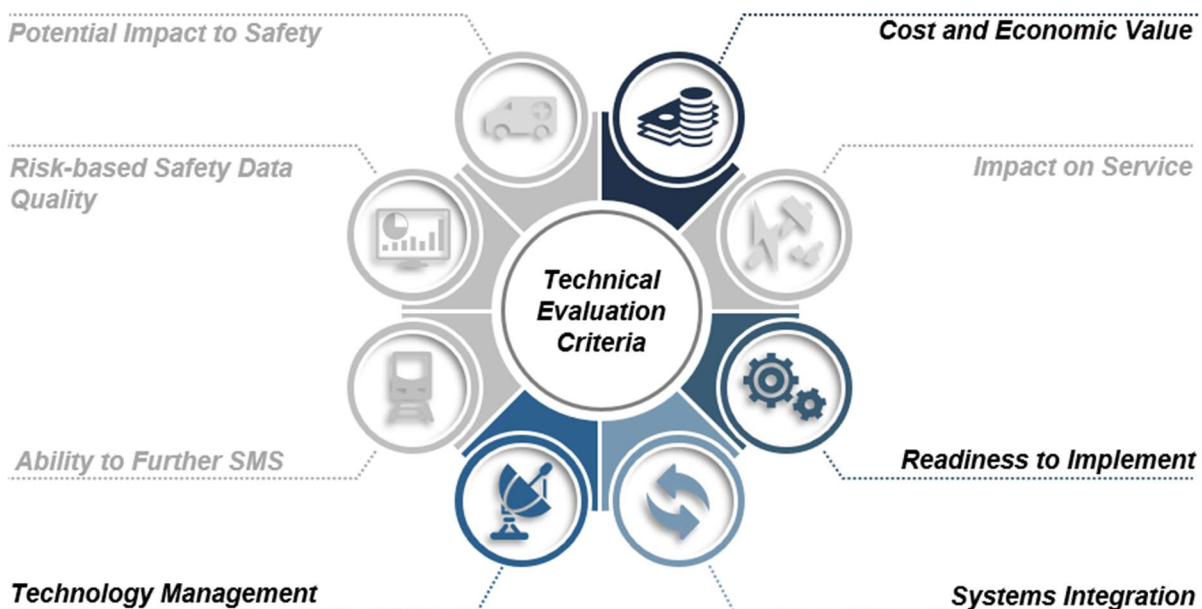
## TSP Recommendation #6 – Research Artificial Intelligence (AI) Technologies

### *Recommendation*

The Committee recommends that FTA research AI technologies used for trespass and suicide detection and prevention such as those outlined in best practices documents from FTA and/or APTA. Additional research should be supported by FTA on understanding and identifying potential suicidal behaviors, to help establish a set of inputs that support AI-based detection of potential suicides in rail transit environments.

This recommendation is closely related to Recommendation #4 and should focus especially on non-verbal behavior that can be observed from such technologies.

### *Criteria/Methodology*



Criteria used to evaluate this recommendation include **Systems Integration, Technology Management, Cost, and Implementation Readiness.**

With trespassing and suicide such a prominent issue along railroads, detecting trespassing incidents before they result in serious injury or fatality is a critical task. However, rail workers, commuters, and other individuals are often distracted or otherwise engaged and may not see risky behavior in time to respond. This limitation is removed with the use of AI, which can add significantly to the ability of railroad personnel to quickly and efficiently monitor tracks and right-of-way.

Zaman (2018) and Zaman, Baozhang and Liu (2019) studied an AI framework for the automatic detection of trespassing events in real time. The AI algorithm searched for six categories of trespassers—car, truck, bus, person, bicycle, and motorcycle—under varying environmental conditions, including fog, heavy rainfall, and daytime/nighttime cycles. Once intrusion is detected, “an alert text message” is transmitted with a video clip and relevant information that allows for real-time response. This intersection between human behavior and state-of-the-art AI tools utilizes existing closed-circuit cameras and infrastructure.

Cities across the nation have also begun using detection technologies to address the issue of trespassers. In fact, after a series of fatalities, the City of Palo Alto (2018) installed an integrated trespasser detection video system at four Caltrain at-grade crossings running through the central city. Cameras focus on the intersection and right-of-way and can identify objects up to 1,000 feet in variable conditions. The video feed, monitored by an AI algorithm designed to detect high-risk trespasser behavior, sends alerts to Palo Alto law enforcement for verification of the alert, and off-site operators have the ability to make live voice announcements or provide direction to people spotted on the tracks or in the immediate area. Combined, these and other studies reveal that AI algorithms, applied to data from existing closed-circuit camera feeds, show considerable promise for detecting trespasser behavior, and in doing so, allow for a real-time response.

With real-time detection and alerts, AI detection may make it easier to manage the data that comes in. Currently, most agencies that use video surveillance review it manually, which can reduce reaction time and cause missed trespassing events. AI technology video can be analyzed at a much faster and potentially more accurate rate. More data can be analyzed in real time, and that data can be stored for future reference. Additional research on suicidal behaviors can also help further refine the data that AI detection technologies use to recognize possible warning signs that someone might be attempting suicide. With this additional information, AI technology could possibly detect warning signs that a human might otherwise miss, creating opportunities for faster intervention in dangerous situations.

One of the potential drawbacks of this recommendation is cost. The AI technology is still fairly new and has not yet been widely researched. A variety of steps need to be taken to get a functioning system running, including obtaining data, analyzing data, and refining the technology. All these take time, resources, and money. With researching any new technology, in general, there is the potential for higher costs since there needs to be a significant amount of testing and research done before it can be used in real-world situations.

Another potential obstacle is implementation readiness. As mentioned above, AI technology is still new. With little prior research or testing behind it, there is still a great amount of work to be done before AI technology can be fully integrated into transit systems.

### *Key Takeaways*

AI algorithms can be used for detecting trespass and intrusions in rail settings and may identify trespassing “hotspots.” The identification of a standard AI algorithm, and metrics with which to evaluate its effectiveness, could advance the adoption of this technology. Some cities are implementing AI technology as a means of reducing trespasser incursions into railroad rights-of-way; federal funding could facilitate innovation and interest in developing new and more robust products. AI algorithms convert “big data” into actionable intelligence with real-time alerts for railroad staff and law enforcement; and the implementation of AI technology is well suited to transit (heavy rail or commuter rail, in particular) as the systems are self-contained, increasing the feasibility of real-time response.

As mentioned above, Zaman (2018) and Zaman, Baozhang and Liu (2019) studied an AI framework for the automatic detection of trespassing events in real time. The AI framework is used to detect objects in an image while simultaneously generating a high-quality segmentation mask for each instance. Investigators reviewed 120 hours of live footage of a specific grade crossing in Ashland, Virginia, and positively identified 145 trespassing events that were reported via the alert system between July 19<sup>th</sup> and July 25<sup>th</sup>, 2018. Results showed that the AI differentiated between the types of trespasser and correctly detected all trespassing events at the selected locations with 100 percent accuracy during the analyzed period. Building on these results, Zaman et al (2019) deployed the AI technology on three railroad video live streams, a grade crossing and two rights-of-way, in the United States. In each of these safety-critical scenarios, the AI system accurately detected trespasses, yielding no false reports. Though research has been limited, results demonstrate that AI technology shows promise at detecting trespassers.

### *Information Gaps*

Information gaps include the limited research to date on AI-driven video analytics and AI’s ability to distinguish between authorized track workers and trespassers, the lack of information on the reliability of trespasser detection at nighttime or in adverse weather conditions, and the lack of information concerning risks and benefits of handling privacy issues. Additionally, any usage of AI technology that actually controls or stops trains must take into consideration the potential for misuse, especially given the long distance required to stop a moving train.

The AI-driven detection technologies are in an early stage of safety research and further study is needed before industry implementation. This research includes refining the technology to accurately distinguish between track workers and trespassers, as well as making sure it is reliable at nighttime or during adverse weather conditions. Furthermore, it is crucial to note that AI technology generally requires vast data sets to be able to predict behavior indicative of trespassing and potential suicide. While simple usage of AI is entirely possible in this context,

the Committee lacks information necessary to determine the extent to which such technology can be implemented today.

### *Additional Justification*

Other studies have documented the use of technology solutions to help reduce trespassing and suicide. For example, in Pittsford, New York, a three-year study on video-based trespass monitoring was conducted (daSilva, Marco P. et al. 2012) using video cameras, motion detectors, infrared illuminators, magnetometers, speakers, and a central processing unit. When a trespasser was detected, the system alerted the security company/attendant, and the attendant would use the loudspeakers to give a warning to the trespasser. In the first year of the study, almost one-third of events recorded were false alarms. However, by the third year, false alarms were reduced to approximately ten percent of total events recorded. Other agencies have also started using drones to detect trespassers (Gabree, Scott H. et al. 2019) revealing that there is a growing desire for agencies to enhance their trespassing detection capabilities, and AI technology could be a part of that.

### *Conclusion*

Railroads are more commonly installing cameras along rights-of-way and around stations for trespass and suicide detection and prevention. These cameras provide valuable video-based sources of big data for railroads—but analyzing the data accurately in real time is a challenge. AI reduces the potential for human error and increases the ability to monitor trespassing events and alert railroad staff and law enforcement in real time.

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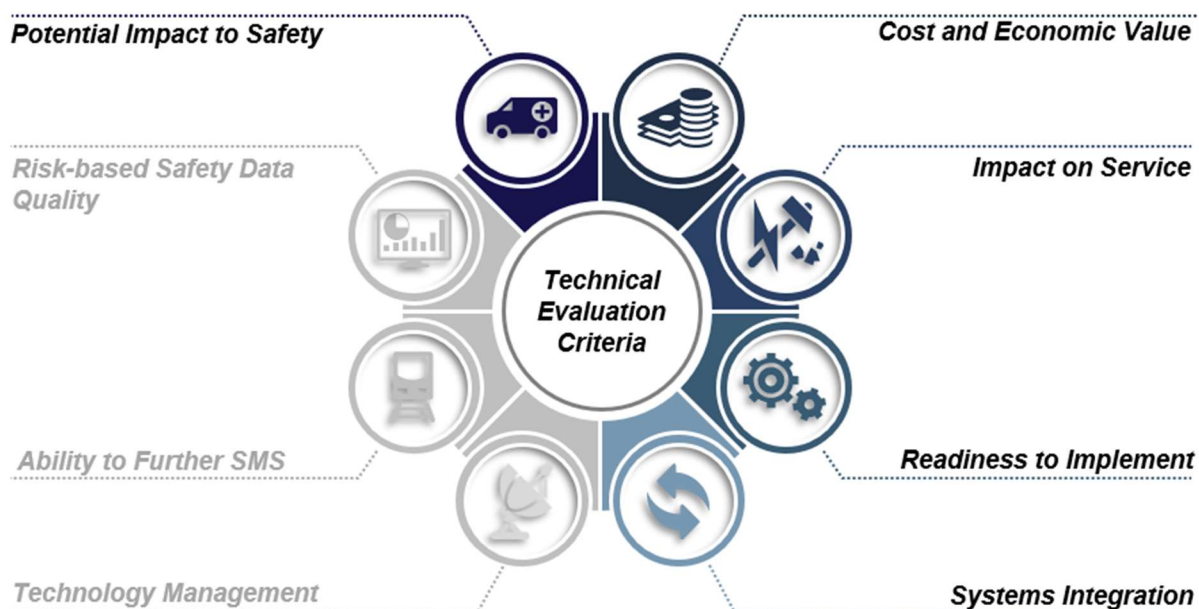


## TSP Recommendation #7 – Support Proof of Concept Research on Emerging Technologies that May Prevent Rail Trespassing and Suicide

### *Recommendation*

The Committee recommends that FTA support additional research to develop a proof of concept for the following emerging technologies that may prevent rail trespassing and suicide: (1) systems that detect intrusions on or at rail rights-of-way, station platforms, and grade crossings; (2) systems that communicate and integrate rail trespasser intrusion alerts with train controls; and (3) trespasser and suicide detection systems that can integrate with train control systems and existing protection systems.

### *Technical Evaluation Criteria/Methodology*



Criteria used to evaluate this recommendation include: **Potential Impact to Safety, Impact on Service, Systems Integration, Readiness to Implement, and Cost.**

#### **a. Safety:**

Supporting proof of concept research that demonstrates that emerging technologies to detect rail right-of-way intrusion, as well as communicate and integrate intrusion alerts with train controls and other existing systems, are feasible and will have a major impact on safety. There are a number of existing intrusion technologies deployed by transit agencies worldwide, some of which connect to train controls, either in the rail control center or in the rail vehicle. A technology that can dependably stop or slow a train before a collision with a person on the

right-of-way, with a very low occurrence of false positives, would substantially decrease the number of trespassing or suicide-related incidents.

#### **b. Impact on Service:**

A person hit by a train and killed or injured significantly impacts the rail system. Service on those tracks must be suspended while the body or injured person is removed and the onsite investigation has been completed, which can have a significant impact on operations. The train operator, engineer, conductor, and other rail system employees involved in the accident may be traumatized, and the family of the person who was hit by a train – either accidentally or because of suicidal intent – is intensely affected. Railroads, commuter rail systems, and transit agencies have actively sought out and deployed many kinds of countermeasures to prevent rail trespassing and suicide.

##### *b.1 Center for Urban Transportation Research (CUTR) Survey*

The Center for Urban Transportation Research (CUTR) at the University of South Florida conducted a survey of 11 U.S. rail transit agencies in December 2019-January 2020 regarding the incidence of rail trespassing and suicide on their systems and countermeasures that the agencies have deployed to prevent these events.

The survey reported on new technologies that are being deployed in passenger rail and transit environments to detect, report, and respond to rail trespassing and suicide:

- Digital billboards (MBTA)
- Laser Intrusion Detection System for tunnels (Port Authority of Allegheny County)
- Light Detection and Ranging (LIDAR) track intrusion detection system with communications link to train operator (Maryland Transit Administration)
- “See-Say” mobile phone app to report trespassing (MARTA)
- Video analytics to focus patrolling in critical areas (MARTA)

Other new technologies that are being considered by railroads and transit systems, but have not yet been deployed in revenue operation, include:

- Platform screen doors
- Unmanned Aerial Vehicles (UAVs) with cameras and infrared sensors
- Video Analytics with AI algorithms

Guideway Intrusion Detection systems are most frequently deployed on automated, unmanned train operations. They work on the principle of detecting motion or mass on the track bed and link to the communications-based train control (CBTC) system to stop the train before a collision occurs. Closed Circuit Television (CCTV) monitors on the platforms and roving

attendants provide back-up to the automated system. The detection technology varies, including radar frequency (RF), optical systems, laser systems, and LIDAR. Transit systems that currently employ Guideway Intrusion Detection systems include the Detroit People Mover, Kuala Lumpur Kelana Jaya Line, Miami Metromover, Nuremberg U-Bahn, and Vancouver Sky Train.

However, many agencies participating in the CUTR survey noted that most advanced technologies are not yet mature enough for deployment and there are cost concerns with deploying technologies that have not established proven track records.

### *c. Systems Integration:*

The three types of emerging technologies included in the Committee's recommendation are all currently available in some form to rail transit systems. However, many of these technologies have only recently been adapted for the purposes of detecting and preventing rail trespassing and suicide. The discussion below outlines existing technologies in use, in demonstration or proof of concept use, or could potentially be adapted for future use to detect and prevent rail trespassing and suicide.

#### *c.1 In Current Use*

**Guideway Intrusion Detection Systems:** According to a presentation made by Jon Hulse, P.E. at the APTA Rail Conference (June 2017), several automated or unmanned rail systems (monorails, automated people movers) throughout the world have guideway intrusion detection systems that use motion sensitive panels, optical sensors, radar, or laser imaging detection and ranging (LIDAR) to detect when an object of a certain size or mass has fallen or been placed onto the tracks. The drawbacks to these guideway intrusion detection systems is that there are a number of false negatives (not detecting objects that are within the defined tolerance or that are not in field of view for a sufficient time to be detected) and false positives (detecting objects that are not necessarily hazardous, like garbage, rodents, or birds). Researchers have recommended that a layered approach utilizing complementary technologies such as video analytics and interfacing with train signal systems can improve the reliability of intrusion detection systems.

#### *c.2 In Demonstration and Proof of Concept*

**Roadway Worker Protection (RWP) Systems:** There are several different types of RWP systems currently utilized on U.S. rail transit systems that are based on detecting train movements and communicating those movements to workers on the rail right-of-way. The communication systems used by these RWP systems can also be used to let train operators or operations control centers know when there has been an intrusion onto the tracks. This scenario would be an example of layering complementary technologies together, using the rail signal system, radio, communications-based train control, or other communications network to relay

messages to the operator or train itself when an intrusion detection system has detected a trespasser on the track bed.

### *c.3 Could Be Adapted for Future Use*

**Positive Train Control (PTC):** PTC is a processor-based/communication-based train control system designed to prevent train accidents. Freight railroads, intercity passenger railroads, and commuter railroads are required to develop and implement PTC on freight main lines over which hazardous materials are transported and on rail lines over which regularly scheduled passenger intercity or commuter operations are conducted. PTC technology is capable of automatically controlling train speeds and movements, and PTC systems must reliably and functionally prevent train-to-train collisions, overspeed derailments, incursion into an established work zone, and movement through a main line switch in the improper position. PTC systems are not required to prevent collisions with vehicles or people at highway-rail grade crossing or with people who are trespassing on the rail right-of-way. Since all commuter rail systems are required to have PTC, it is possible that trespassing detection systems could be integrated with the railroad's PTC system as a complementary technology that would automatically slow or stop a train if person is detected on the right-of-way or a vehicle is detected on a highway-rail crossing. There are many potential challenges to developing and implementing trespasser detection technologies that can be integrated with PTC, including the need to consider the potential service impacts of trains automatically being slowed or stopped by trespasser detections.

### *d. Readiness to Implement:*

The area of rail trespass and suicide detection and prevention is still an emerging technology area. By comparison, RWP technologies are more mature and widespread. As described above, the Committee believes that many RWP technologies can be layered together with complementary track incursion detection systems to create a trespass and suicide detection and prevention system that integrates with rail system communications and train control. A specific example of this approach is the Protran Technology LIDAR track intrusion system that was developed to integrate with the existing "Protracker" RWP system. It uses the same track wayside-based communications system to alert a train operator if there is a trespasser as is used to alert a train operator if there are maintenance of way employees on the tracks.

### *d.1 Presentation to TRACS of Technologies in Current Use*

During the February 2020 TRACS Conference, representatives of seven different transit safety equipment and systems vendors made presentations to the committee regarding technologies related to RWP and TSP that are currently in use under revenue service conditions at transit properties throughout the United States. The vendor companies and the technologies presented were:

1. Bombardier -- TrackSafe Roadway Worker Protection

2. EMTRAC – Rail System Communications System for Wayside Worker Safety
3. Metrom Rail – AURA Train Control System and Integrated Worker Protection Function
4. Miller Ingenuity – ZoneGuard Roadway Worker Protection System
5. Motorola Solutions – Avignilon Video Security and Analytics Artificial Intelligence
6. Protran Technology – Roadway Worker Protection “Protracker” Protran Technology - Pedestrian Warning/Trespasser Warning System
7. Trapeze – Roadway Worker Protection System for GPS-denied Areas

#### *d.2 Other Emerging Technologies*

Other emerging technologies that were not presented to the Committee but may support trespassing and suicide detection and prevention include:

- Aerial Drones (UAVs)
- Crossing Obstacle Detection System – Mermec
- Long-range Acoustic Device (LRAD)
- Long-Range Radar – Spotter RF
- On-Board Detection Systems – SeeFar, Shift2Rail, Rail Vision
- Rail Side Detection Systems – Forward Looking Infrared Cameras, IK4 TEKNIKER

#### *e. Cost:*

It is not possible to estimate costs for rail transit agencies or commuter railroads to install track intrusion detection, communication, and train control systems that will prevent trespass and suicide collisions. There are many different technologies and each rail transit property’s system will present unique challenges for implementation.

A possible basis for comparison are the costs that will be borne by commuter railroads to achieve full implementation of PTC. The current estimate for total PTC installation for 41 U.S. railroads (including freight, intercity passenger rail, and commuter rail) is \$14 billion. Of this, commuter railroads have estimated the cost of full PTC implementation on the 33 commuter rail systems to be \$4.1 billion. However, it is possible that, by utilizing existing RWP and track intrusion detection systems and integrating them with existing communications and train control systems, costs to develop and implement rail trespass and suicide detection and prevention technologies can be decreased. It is also likely that heavy rail systems (Metro and Subway) will need to focus their track intrusion efforts only in station areas where pedestrians have easy access to the right-of-way.

#### *Key Takeaways*

#### a. Track and Guideway Intrusion and Detection Technologies:

The FTA should consider compiling information and documenting the different intrusion detection systems that are in use, both in the U.S. and internationally, including the technological specifications of each system, a discussion of operational challenges such as false positive and false negative reports, how detection systems communicate intrusion detections to train control systems, and how data on intrusions are tracked and monitored.

#### b. Integration of Intrusion Detection and RWP Systems:

RWP technologies are mature and widely available to transit properties. However, the broad variety of technologies that are currently utilized may present a challenge to successful development of commercially viable, off-the-shelf products that integrate the communications and train control aspects of RWP with track/guideway intrusion detection. The FTA should support research that demonstrates this linkage and provide guidance to transit properties concerning which types of systems can be integrated to effectively work together.

#### c. Trespasser and Suicide Detection Systems that can Integrate with PTC:

Because rail trespassing and suicide are major safety risks for commuter rail systems, and because commuter railroads are required by law to implement PTC, it would be helpful for FTA to support proof-of-concept research on integrating right-of-way intrusion detection technologies, whether those intrusions are trespassers along the tracks, or vehicles or pedestrians at highway-rail grade crossings, with PTC systems in an interoperable environment.

### *Information Gaps*

Information gaps include:

#### a. Compilation Report on Track and Guideway Intrusion and Detection Technologies

Compiling information on and documenting the different track and guideway intrusion detection technologies that are currently in use around the world on rail systems will help FTA and rail transit operators understand the capabilities, challenges, and technological specifications of different detection systems.

#### b. Research that Demonstrates Integration of Intrusion Detection and RWP Systems

Supporting proof-of-concept research to integrate existing track/guideway intrusion detection technologies with RWP technologies will help address the concern that many transit agencies have with deploying new technologies that do not yet have a proven track record. The FTA-sponsored research that supports integrating the communications and train control aspects of RWP with track/guideway intrusion detection will encourage development of commercially viable, off-the-shelf products that will work with existing safety systems, making them more cost-effective for transit agencies.

### c. Research on Trespasser and Suicide Detection Systems that can Integrate with PTC

Commuter railroads are working to fully implement PTC before the statutory December 31, 2020 deadline. After this deadline has been met, it is possible that the existing PTC technology platform, which automatically controls train speed and movements, could be integrated with right-of-way intrusion detection technologies to prevent trespasser and suicide incidents or highway-rail crossing collisions. This would extend the capabilities of PTC beyond those required in the Federal mandate. If FTA supports proof-of-concept research in this area, the efforts should be closely coordinated with FRA to ensure that the required PTC capabilities do not experience any negative impact.

### *Conclusion*

This recommendation to FTA includes three research activities that represent different levels of effort and immediacy. Because trespassing and suicides are the highest-risk types of incidents on rail systems, representing 62 percent of rail transit fatalities and 72 percent of fatalities on the general railway system, it is imperative that FTA take a risk-based approach to allocating its limited research funding and resources.

A comprehensive and well-publicized compilation report on track and guideway intrusion and detection systems is a document that would require minimal effort and time but could help direct rail transit agencies to currently available off-the-shelf technologies that are appropriate for their rail operations. Research projects that demonstrate the integration of existing track and guideway intrusion detection systems with RWP communications and train control systems will help shape and encourage private sector market development and help keep costs lower for transit agencies since they will be able to utilize existing systems. A new and more future-facing area of research of assistance to the commuter rail sector is proof-of-concept research on integrating track intrusion detection – whether along the right-of-way or at a highway-rail crossing – with PTC systems. This research could help expand the capabilities of PTC to prevent trespassing and suicide incidents and highway-rail crossing collisions.

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## Appendices

### A – 1 TRACS Conferences

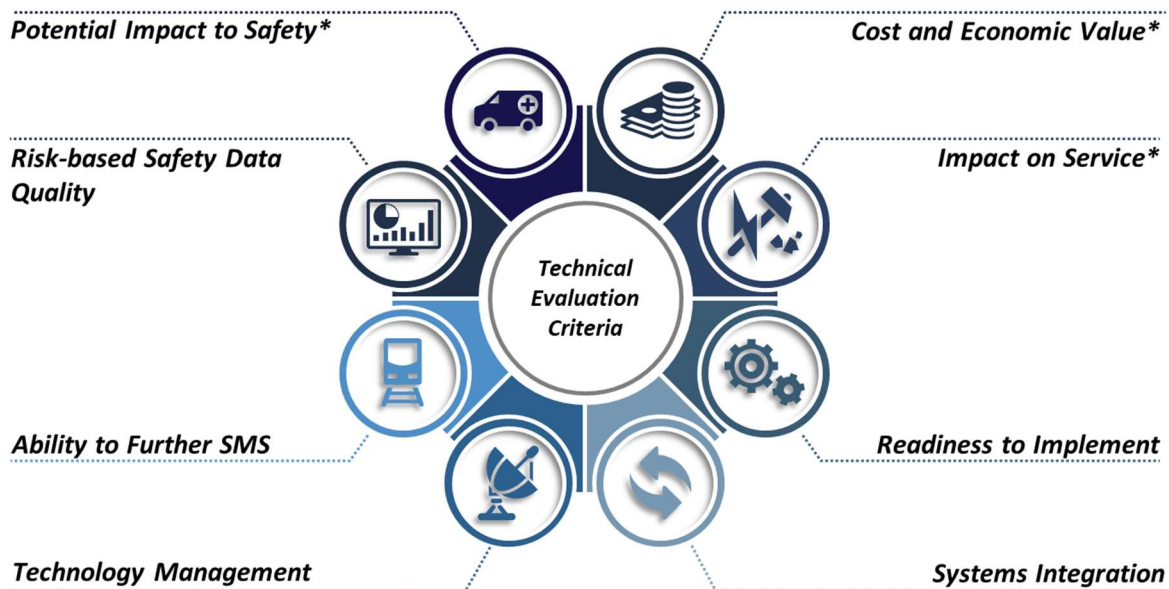
March 26-27, 2019 Conference

#### Goals and Objectives

In March of 2019, the 2018-2020 TRACS committee met for the first time and focused on defining its tasks. The FTA assigned TRACS the safety focus area Trespassing and Suicide Prevention (TSP) and requested that TRACS select two additional safety focus areas from a list of 25 potential topics. After a series of breakout groups and large group discussions, the Committee voted to select Roadway Worker Protections (RWP) and Employee Safety Reporting (ESR).

#### Outcomes

During the March 2019 TRACS Conference, the Committee identified and prioritized Technical Evaluation Criteria (TEC) that apply to all three safety focus areas identified by the TRACS 2018-2020 Charter. The TEC were established to support the assessment of technologies and innovations and were selected based on small- and large-group discussions. The TEC are as follows:



An asterisks (\*) represents the high priority technical evaluation criteria

The Committee identified three TEC as high priority, the first of which is *Potential Impact to Safety*. *Potential Impact to Safety* was used to evaluate the technologies and innovations on the basis of FTA's four safety performance measures identified in FTA's National Public Transportation Safety Plan (NSP): fatalities, injuries, safety events, and system reliability (Federal Transit, 2017). Fatalities and injuries represent "lagging indicators," which support the

assessment of long-term success *after* an intervention. This assessment is done by monitoring negative safety outcomes that agencies aim to prevent. Precursor safety events and system reliability declines are examples of “leading indicators,” which help predict the success of an intervention *before* it is implemented. As such, leading indicators are essential to evaluating emerging technologies. The Committee has consistently addressed both lagging and leading indicators in its safety reports (Transit Advisory, 2017). It is also important to note that leading indicators can address near-miss reports, known risks of automation use, opportunities for failure, and other risk-informing knowledge where no casualties have been documented on rail transit.

The other criteria deemed high priority were *Cost and Economic Value* and *Impact on Service*. *Cost and Economic Value* criteria include multiple factors, such as short- versus long-term costs, return on investment, affordability, integration costs, and maintenance costs. The Committee also considered the *Impact on Service* for new technologies and processes. For example, if a technology is extremely beneficial in preventing accidents but significantly decreases the number of trains running per hour, it may not be a viable solution.

While *Potential Impact to Safety*, *Cost and Economic Value*, and *Impact on Service* were deemed the highest priority criteria for evaluating technology, the Committee selected additional TEC to consider. *Readiness to Implement* is a technology’s maturity level and whether it is compatible with existing systems. Similarly, the Committee deemed it important to look at *Systems Integration*, which evaluates technology from the viewpoint of how it would complement information technology, training requirements, and human factors/engineering considerations. Additionally, the Committee considered *Technology Management*, which involves maintenance requirements and the introduction of unforeseen risks.

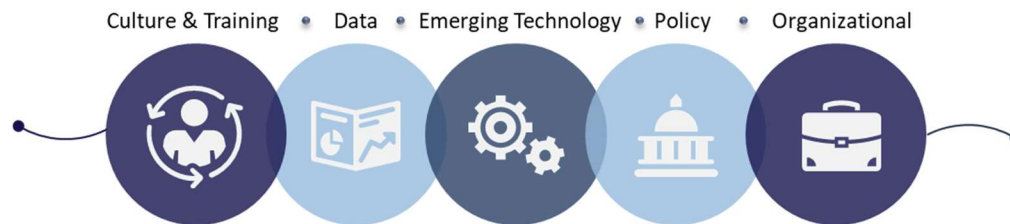
Moreover, the Committee acknowledged that the implementation of a SMS approach is paramount to FTA’s overall safety focus, as it is a collaborative approach to managing safety that brings management and labor together to control risk, detect and correct safety problems earlier, analyze safety data more effectively, and measure safety performance more precisely. Therefore, the Committee supported the recommendation of technologies and processes that promote the transit industry’s shift toward furthering SMS. The Committee also recognized the increased importance that data has in the transit industry’s environment and will consider how effective measuring and monitoring methods rely on obtaining and analyzing *Risk-based Safety Data Quality*.

Finally, the Committee recognized that transit agencies possess their own set of unique characteristics related to mission, size, operational practices, budget constraints, and so forth. The Committee considered these variables and agreed it would maintain the TEC as its primary driver for developing its recommendations.

## September 9-10, 2019 Conference

### Goals and Objectives

Through a literature review and multiple group discussions during the September Conference, TRACS identified an extensive list of key takeaways and information gaps that will contribute to the Committee's recommendations for FTA. These key takeaways and information gaps were grouped into the following five themes or categories, which were consistently found in the research:<sup>3</sup>



The *Culture and Training* category reflects how societal and organizational cultures influence decision-making and safety. Additionally, it looks at how education can be leveraged to benefit culture. By looking at *Data*, the Committee hopes to understand how information is compiled, analyzed, and used, and how systems could be improved to better understand the circumstances and environments in which trespass events and suicide incidents occur. Additionally, TRACS considered how *Data* can be used to apply value that comes from employee safety reporting programs. Through a review of *Emerging Technology*, the Committee sought to explore different technologies and how they can be/are being used to prevent trespassers and suicide attempts, increase safety for roadway workers, and improve employee safety reporting programs. The *Emerging Technology* theme assesses the various emerging technologies to see where and how each innovation will have the most impact. The *Policy* theme seeks to understand what is needed for developing successful rules and regulations. Policy can be looked at from an internal organizational perspective or an external governing body perspective. On a similar note, the *Organizational* theme seeks to understand the impact that specific organizations or differences between organizations can have on understanding different components of the safety focus area.

### Outcomes

#### Culture and Training

**Key Takeaways:** The role of culture and training focuses on how education and social resources can be used within communities, through the media, and across the transit industry to prevent trespassing and suicide. At a community level, the Committee identified a consistent theme that involved engagement with communities in the vicinity of railroads. Engagement may include discussing culturally specific causes of suicide and the development of local prevention

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<sup>3</sup> Note that none of the safety focus areas address key takeaways/information gaps in all five categories.

programs tailored for high-risk groups, as well as other grassroots efforts that are geared towards youth and families. When engaging the media, innovative processes focus on *responsible reporting* to prevent rail suicides. When the media negligently reports on sensational suicide events, it may cause individuals struggling with thoughts of suicide to consider the suicide-by-rail systems as a method to take their own lives. To add to this notion, widely published stories of suicide deaths on railways can lead people to believe it occurs more often than it does. This presents a conflict, as studies have also shown that open conversations about mental health can prevent suicide. To combat this, a best practice is not to avoid talking about suicide, but rather to learn how to discuss suicide responsibly (Gabree et al, 2019). At the transit authority level, the Committee focused on understanding training methods for employees focused on the behavioral indicators of suicide attempts and what actions to take when observing them. Additionally, the Committee's research showed that there is a need to improve comprehensive critical incident response training for train crews who have been exposed to traumatic incidents on the tracks to mitigate the potential negative effects. A focus on culture and training at the industry level is significant not only for transit authorities, but also for medical examiners (MEs) who have limited protections regarding their liability, insurance, and reputation. While transit agencies may rule a death to be a suicide based on their own internal investigations, an ME may come to a different conclusion. These differing conclusions may create inconsistent data and demonstrate conflicting cultural differences between the transit industry and those who serve as MEs (Texas Med., 2018). The question of whether rail-related deaths are recorded as trespassing or suicide has been an ongoing issue in FRA's safety data information, as statistics are updated on a monthly basis as deaths originally ruled trespassing are later determined to be suicides.

**Information Gaps:** Culture and Training information gaps relate to the "unknown unknowns" of how these elements can be used to minimize and prevent trespasser and suicide events and strengthen the Committee's key takeaways. While the impact of media reporting on copycat suicides has been established, there is limited knowledge on the relationship between suicide death and media reporting as it relates to the time and relative distance of the initial incident. The Committee sees value in improving understanding of clustering (i.e., trespass/suicide events happening in the same area in a condensed timeframe) that looks at copycat cases or longitudinal studies. It is worth noting that preliminary studies have been done, including a 2012 study that focused on investigating the association of suicide deaths with suicide news in longitudinal and special dimensions (Yang et al, 2013). Most significantly, additional research should be conducted at the industry level concerning the impact of suicides on operators, employees, and individuals who are involved in transit accidents. While anecdotal information about the impact of rail deaths on train crews exists, conclusive research documenting the negative effects of these incidents on train crews, including proper post-incident treatment/procedures, is lacking.

## Data

**Key Takeaways:** The Committee looked at various ways in which the industry can use information to understand how, when, and where trespass and suicide events occur so they may be prevented. The Committee's literature review found that the prioritization and analysis of technologies and processes that provide improved data collection and analysis can help transit agencies understand the circumstances and environments in which trespass and suicide incidents occur. Specifically, data analysis can support transit agencies in identifying vulnerable locations where they can install physical barriers or consider the use of other innovative processes and/or new technologies. A principal challenge in gaining a holistic understanding of rail trespassing and suicide data is that two different Federal agencies, FTA and FRA, collect safety data related to rail trespassing and suicide events using different definitions, data elements, and reporting protocols. These differences make it difficult, if not impossible, to consolidate and compare trespassing and suicide data between FTA- and FRA-regulated systems. This creates challenges for effectively implementing SMS, particularly at transit agencies that operate both rail transit and commuter rail systems. Data reporting processes for multimodal agencies would be streamlined and strengthened if the definitions and data elements for tracking and reporting rail trespassing and suicide were better aligned. The differing data definitions and reporting requirements also create a roadblock to effective interagency collaboration between FTA and FRA.

The Committee spoke considerably about identifying trespass and suicide hotspots and using them to develop databased risk analysis (Cox et al, 2013). Hotspots can be identified through multiple factors such as railway proximity to mental health facilities, proximity to schools, urban density, and proximity to transients. Transients may also have more alcohol and drug interactions, which can be related to the proximity to mental health facilities. It is also possible to physically identify and photograph areas with high occurrence of trespassing through aerial photography, which can reveal pedestrian trails to, along, and across rail rights-of-way. The TSP subcommittee received a briefing from representatives of the Washoe and Storey County Sheriff's Rail Auxiliary Team (Reno, Nevada), which is conducting an anti-trespassing enforcement program that utilizes unmanned aerial vehicles (UAVs) to help identify trespassing hotspots for targeted enforcement activities. Data on trespassing and suicide hotspots can help prioritize where countermeasures, enforcement, or community outreach efforts are conducted.

**Information Gaps:** While data has the capacity to play a powerful role in understanding trespass and suicide incidents, there are currently many unknowns and industry norms that are preventing transit agencies from using data to its full potential. A key deterrent is a lack of standardized terminology for recording data. This means that there is limited common language, phrases, or acronyms to consistently log data across agencies, which makes data mining and data analysis extremely difficult and could lead to incomplete or incorrect data. Additionally, individuals who commit suicide versus those who trespass exhibit different

behaviors and mindsets (Topel et al, 2018). Thus, combining suicide and trespass data could cause misleading results. The Committee also struggled to understand how the effectiveness of different solutions are measured. Due to this information gap, the Committee cannot evaluate which solutions have the greatest impact, and why, in preventing trespassing and suicide.

## Emerging Technology

**Key Takeaways:** The Committee explored a variety of technologies that are being used to prevent trespassing and suicide, how and where they are being used, and how they can be improved. The Committee highlighted the need for emerging technologies that are agency- and mode-specific and align with a specific issue. For example, an issue-specific solution includes AI and video analytics focused on behavioral monitoring, as individuals who attempt suicide exhibit different behaviors and are prone to different risk factors compared to trespassers. Further, one risk factor worth noting is the involvement of drugs and alcohol in suicide and trespass events. A 2014 study found that 37 percent of those who had committed suicide on railways had alcohol in their system (Berman, 2014). A 2012 study found that drugs and alcohol were involved in 55 percent of trespass related deaths (Lichenstein, 2012). AI video analytics that detect and flag behaviors of individuals at station platforms that are indicative of drug or alcohol impairment could help identify and prevent potential trespassing or suicide attempts and improve the general security of station environments.

It is important to develop technologies that are mode-specific because transit systems are inherently easier to access than other modes of public transportation, which make them higher-risk locations for trespass and suicide incidents. For example, emerging mode-specific intrusion detection and monitoring technologies can be used to detect trespassers and individuals who circumvent barriers and enter the rail right-of-way. Some technologies provide specific safety solutions, such as RWP systems that help prevent train collisions with employees working on the right-of-way, or PTC systems that automatically stop a train before a train-to-train collision or overspeed derailment occurs. Although neither RWP or PTC systems are designed to prevent train collisions with trespassers or individuals attempting suicide, it is possible that adapting these technologies to the rail transit environment and developing ways to make them interoperable with existing train control and communications systems will lead to mode-specific transit and passenger rail technologies that can detect and help prevent rail trespassing and suicide events.

Although it can be argued that barriers are not an emerging technology since they are already in use in many rail systems, an important key TSP takeaway is that fencing and other barriers are a proven technology that can have a substantial positive effect on reducing trespassing. Research reports reviewed by the TSP subcommittee found that, depending on the type of barrier, installing barriers can be one of the most economical countermeasures to reduce trespassing and suicide at stations and along railroad rights-of-way. Barriers are thought of

most frequently as fencing, but also can include landscaping or vegetation plantings that discourage trespassing by creating a ground-level barrier that is difficult to pass. Another ground-level physical barrier that deters and delays trespasser or animal access to prohibited areas are ATPs, with surface profiles that make walking difficult or almost impossible. The ATPs are most frequently installed at locations very close to the tracks where fencing is not possible. Finally, emerging technologies may also include help-seeking technology, such as platform help phones or other solutions that may increase awareness of how to support at-risk individuals. Although increased awareness of how to support at-risk individuals does not directly involve technology, the Committee recognizes it as a supporting factor in the success of help-seeking technologies.

**Information Gaps:** The Committee identified capabilities of AI as a major information gap, as there is room for greater understanding of what AI can achieve. While there is a growing interest in the capabilities of AI and the role it can play in behavior monitoring, significant work needs to be done to fully understand its capabilities and blind spots. The ability of AI-derived algorithms to accurately analyze video feeds and the readiness of these technologies remain unknown. While significant improvements have been made, these technologies are still in their infancies. While they may be valuable as they mature, it is questionable whether they are ready to be disseminated for mass implementation.

There is also a major information gap in identifying the specific opportunities for adaptation of existing rail safety technologies such as RWP and PTC systems and making those technologies successfully interface with existing rail transit train control and communications systems. There is a greater challenge associated with adapting these technologies to the transit environment because rail transit systems have a much broader spectrum of operational differences than more traditional commuter rail, intercity passenger rail, and freight rail systems do.

The Committee also noted a significant information gap in technologies that explore Behavior Based Safety (BBS), an approach that focuses on human factors and analyzes people's behaviors and actions. The BBS approach can help FTA and transit industry stakeholders better understand and improve the effectiveness of anti-trespassing educational and awareness signage and messaging; crisis intervention outreach and response; or infrastructure modifications that deter trespassing or suicide attempts.

Because none of the Committee's recommendations were Policy or Organizational related they are not included here.

## February 25-26, 2020 Conference

### Goals and Objectives

The conference objectives were as follows:



- Assess emerging technologies and processes against TEC
- Assess industry posture
- Begin development of recommendations
- Refine work plans for remainder of the 2018-2020 TRACS Charter

## Outcomes

During the February Conference, the Committee continued its work towards accomplishing its assigned task through research review and breakout group discussions covering the three safety focus areas approved by FTA. The agenda included a review of the TRACS tasking, work plan, and selected safety focus areas; an assessment of emerging technologies and processes against TEC identified during the March 2019 TRACS Conference; presentations on relevant research topics and technologies; public comments; and voting on decisions requiring consensus. An overview of the presentations is included in section A-3 of this Appendix.

## July 21-22, 2020 Conference

### Goals and Objectives

The July Conference objectives were for the TRACS subcommittees (RWP, ESR, and TSP) to present and discuss recommendations to be voted on for inclusion in the final TRACS reports submitted to FTA.

## Outcomes

The Committee discussed all recommendations, provided feedback on recommendations, and unanimously approved all eight RWP recommendations, all four ESR recommendations, and all seven TSP recommendations, with some recommendations requiring updates in advance of the final vote of approval on the final reports.

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## A – 2 Literature Review

The TSP subcommittee performed a literature review of 19 different journal articles and reports. The key takeaways and information gaps in the TSP recommendations came from a selection of the following recommended readings from the literature reviews:

Bardon, C. & Mishara, B.L. (2015) Research & Countermeasures to Reduce Suicide on Railway Right-Of-Way and Impacts on Railway Workers. *Center for Research and Intervention on Suicide and Euthanasia*.

Center for Urban Transportation Research (CUTR), University of South Florida, Lisa Staes, Director, Transit Safety and Workforce Development Programs. Presentation to TRACS subcommittee on Trespass and Suicide Prevention, June 13, 2019 “Trespassers and Suicides”.

Cox, G. R., Owens, C., Robinson, J., Nicholas, A., Lockley, A., Williamson, M., Cheung, Y. T. D., & Pirkis, J. (2013). “Interventions to reduce suicides at suicide hotspots: a systematic review.” *BMC Public Health*, 13(1), 214.

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Federal Transit Administration. (2020). *National Transit Database Safety and Security Policy Manual*. <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ntd/146986/2020-ntd-safety-and-security-policy-manual.pdf>.

Federal Transit Administration TRACS Technology Presentations, February 25, 2020.

Gabree, S., Hiltunen, D., & Ranalli, E. (2019). *Railroad Implemented Countermeasures to Prevent Suicide*. <https://railroads.dot.gov/elibrary/railroad-implemented-countermeasures-prevent-suicide-review-public-information>.

Law, C. K., Yip, P. S. F., Chan, W. S. C., Fu, K.-W., Wong, P. W. C., & Law, Y. W. (2009). “Evaluating the effectiveness of barrier installation for preventing railway suicides in Hong Kong.” *Journal of Affective Disorders*, 114(1-3), 254-262. doi:10.1016/j.jad.2008.07.021.

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Liu, X., Ren, B., & Zaman, A. (2019). AI-Aided Automated Detection of Railroad Trespassing. *Transportation Research Record*, 2673(7), 25-37.

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National Transportation Safety Board Public Forum, “Trains and Trespassing: Ending Tragic Encounters”, March 24-25, 2015.

Reduction of Suicides and Trespasses on Railway Property (RESTRAIL) project website [restrail.eu](http://restrail.eu), European Union organization devoted to collaborative research on improving rail safety.

Sherry, P. (2016). *Remedial Actions to Prevent Suicides on Commuter and Metro Rail Systems*. Mineta Transportation Institute. <https://transweb.sjsu.edu/sites/default/files/1129-suicide-prevention-on-commuter-metro-rail-remedial-actions.pdf>.

Silla, A., & Luoma, J. (2011). “Effect of three countermeasures against the illegal crossing of railway tracks.” *Accident Analysis & Prevention*, 43(3), 1089-1094. <https://doi.org/10.1016/j.aap.2010.12.017>.

Sinyor, M., & Levitt, A. J. (2010). “Effect of a barrier at Bloor Street Viaduct on suicide rates in Toronto: natural experiment.” *British Medical Journal*, 341  
doi: <https://doi.org/10.1136/bmj.c2884>.

Topel, K., Savage, I., Havârneanu, G., Gabree, S., Martino, M., Warner, J. (2019). A Literature Review of Rail Trespassing and Suicide Prevention Research. *Transportation Research Board Circular*, E-C242, 1-23.

U.S. Department of Transportation Volpe Center, Scott Gabree, PhD, Presentation to TRACS subcommittee on Trespass and Suicide Prevention, July 11, 2019 “Trespass and Suicide Prevention: Overview of Current Prevention Efforts”.

Ueda, M., Sawada, Y., & Matsubayashi, T. (2015). “The effectiveness of installing physical barriers for preventing railway suicides and accidents: Evidence from Japan.” *Journal of Affective Disorders*, 178, 1-4. <https://doi.org/10.1016/j.jad.2015.02.017>.

## A – 3 Research Presentations

March 2019 Conference	
Presenter(s)	Topic
Michael Coplen	TRACS Legislative/Rulemaking Update
Lisa Staes	Safety Data Analysis
Lisa Staes	Risk Based Analysis
Lisa Staes	Safety Risks and Potential Mitigations

September 2019 Conference	
Presenter(s)	Topic
Dr. Scott Gabree	Trespass and Suicide Prevention
Dr. Jordan Multer	Employee Safety Reporting

February 2020 Conference	
Presenter(s)	Topic
Dr. Pei-Sung Lei	FTA Standards Program Research: Mitigations for Trespasser and Suicide Fatalities and Injuries
Ben Bakkum and Dr. Dingqing Li	Roadway Worker Protection
Lisa Staes	Secondary Roadway Worker Protection Systems
Lisa Staes	Employee Safety Reporting Research Presentation
Michael Coplen	Behavior Based Safety (BBS) Presentation
Vendor Presentations: METROM-RAIL, Miller Ingenuity, Bombardier, EMTRAC, Trapeze Group, Protran, Hotrail Group, Motorola Solutions/Avigilon Video Security and Analytics	Vendor Presentations on RWP and TSP Technologies

Additional Presentations	
Presenter(s)	Topic
Hilary Konczal	Trespasser and Suicide Prevention Strategies
Dr. Richard Gist	Impact of Critical Incidents (CI) on Involved Train Crews
Dr. Paul King	BBS Studies/Articles written by Scott Geller