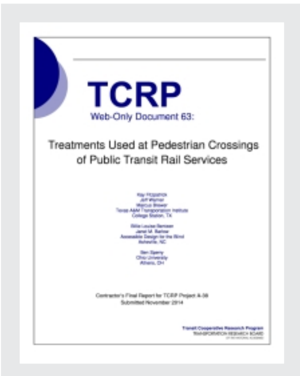

Treatments Used at Pedestrian Crossings of Public Transit Rail Services

DETAILS

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ABSTRACT

There is a natural interaction between pedestrians and public transit rail services. To compile the guidance from other existing resources into one document, and to supplement that guidance with observations of existing pedestrian-rail treatments, TCRP sponsored this project to develop a *Guidebook* for pedestrian crossings of public transit rail services. Several research activities were conducted to develop the *Guidebook* including conducting a literature review, investigating online transit crash databases, performing online survey of practitioners, and conducting telephone interviews to ask for further details. The key research activity was visiting several public transit rail services crossings to observe the challenges faced by pedestrians at public transit rail services crossings. Site visits were made to Boston, Portland, and Los Angeles. The purpose of pedestrian crossing devices is to make pedestrians aware of the presence of the train and/or to prevent pedestrians from crossing at inappropriate times. Some of the crossing treatments fit within a traffic control device category while others, such as fencing, are part of the infrastructure provided at the crossing. A single crossing treatment or device will not be sufficient; rather a combination of devices is needed to communicate appropriate crossing locations and crossing times.

EXECUTIVE SUMMARY

There is a natural interaction between pedestrians and public transit rail services. Transit rail services provide a high-capacity travel option for trips between major origin-destination pairs in an urban area, allowing pedestrians to travel to many more places than otherwise feasible on foot. Improving pedestrian access to transit rail stations obviously benefits the pedestrian by providing a safer and more usable route. Improving pedestrian access also benefits transit rail by resulting in a more attractive service and improved consistency at crossings.

To compile the guidance from other existing resources into one document, and to supplement that guidance with observations of existing pedestrian-rail treatments, TCRP sponsored this project to develop a *Guidebook* for pedestrian crossings of public transit rail services. The *Guidebook* discusses issues associated with pedestrian crossing of public transit rail services and provides examples of treatments in use. Included within the *Guidebook* are summaries of transit rail service options, safety and accessibility issues related to pedestrians and rail crossings, and methods of selecting appropriate treatments for a given crossing. A collection of existing treatments is described, and case studies provide additional insight on the process for identifying and implementing pedestrian crossing treatments.

Several research activities were conducted to develop the *Guidebook* including conducting a literature review, investigating online transit crash databases, performing an online survey of practitioners, and conducting telephone interviews to ask for further details. The key research activity was visiting several public transit rail services crossings within select regions. These visits provided the opportunity to observe the challenges faced by pedestrians at public transit rail services crossings and included observations made during three site visits to Boston, Portland, and Los Angeles.

A synopsis of findings from the research activities follow.

Rail Characteristics. The systems considered in this research—light rail, commuter rail, and streetcar transit systems—represent 58 unique transit rail systems that operated a total of 4,475 route-miles of service in 41 different urban areas of the United States. In 2011, more than 950.9 million unlinked passenger trips were made on these 58 systems, with trips covering more than 13.6 billion miles. The magnitude of these figures suggests that the transit rail systems within the scope of this research are important parts of the multimodal transportation system of the communities in which they operate.

Pedestrian Characteristics. Pedestrians possess certain unique characteristics and behaviors that must be considered in the planning, design, and operation of pedestrian crossings for public transit rail services. Some of these characteristics include that pedestrians are slow, flexible, fragile, sensitive to their surroundings, and may be inattentive.

Pedestrian Crossing Treatments. The purpose of pedestrian crossing devices is to make pedestrians aware of the presence of the train and/or to prevent pedestrians from crossing at inappropriate times. Several types of crossing treatments or devices are used at rail crossings.

Some of the crossing treatments fit within a traffic control device category while others, such as fencing, are part of the infrastructure provided at the crossing. A single crossing treatment or device will not be sufficient; rather a combination of devices is needed to communicate appropriate crossing locations and crossing times.

Crashes. Collisions between streetcar, light rail, or commuter rail trains and pedestrians are not common, but when they do occur the consequences are often very severe. This is demonstrated by the analysis of light rail vehicle collisions that found that while only 4 percent of all injuries as a result of light rail vehicle collisions were pedestrians, approximately 41 percent of fatalities were pedestrians. Crashes happened throughout the rail system, including where pedestrians should not be walking, such as along the rail track. However, crashes between pedestrians and transit trains also occur at designated crossing locations. The ability to determine where crashes may happen and under which circumstances is not fully identified by analyzing the available data sources alone, but these data sources do provide some general trends that can act as a component of a more in-depth safety evaluation.

Surveys. The results of the online survey and the phone survey indicated that a variety of treatments are currently in use. The results also indicated that there are some treatments used in more locations and other treatments that are rarely used, although each treatment was selected at least once by the respondents to the online survey. A common theme raised by survey respondents was that there was not a predominant set of standards or guidelines for applying specific treatments to specific situations. Consequently, one important aim of this research was to provide consistent guidelines based on good engineering judgment and consideration of site conditions as a useful tool for practitioners to use. In addition, even though transit agencies may use treatments and strategies based on prevailing conditions and existing guidance, their use does not negate the need for pedestrians to exercise personal responsibility or the need for some level of enforcement. Most of the phone interview participants acknowledged the difficulty in measuring the effectiveness of treatments. In large part, this difficulty is due to each crossing being unique and the fact that most do not identify with just a single treatment but with a system of treatments. In discussing particular issues, line of sight was the most significant issue identified, with several transit agencies actively working to identify and improve sight distance issues at grade crossings along their rail lines. In general, the transit agencies appear to be active in their interaction with people with disabilities and concerned with the mobility and safety of all potential system users or those that interact with it.

Site Visits. Members of the research team visited several public transit rail services crossings within select regions as part of this research. These visits provided the opportunity to observe the challenges faced by pedestrians at public transit rail services crossings. The observations were not intended to be a judgment on the condition of the rail systems. Rather, the observations helped with the development of the *Guidebook*. Therefore, post-site visit, the observations were grouped within broad categories that were used with the presentation of treatments within the *Guidebook*. The observations also influenced the discussions included within the *Guidebook*, so to emphasize how to analyze conditions at a crossing with respect to the needs of pedestrians. The site visits generated several key observations and findings for specific treatments that affected the presentation within the *Guidebook*. Rather than repeating those key treatment observations here, the reader should review the appropriate section of the *Guidebook.* Following is a brief, broad (i.e., non-treatment specific) overview of key findings from this research:

- A task force within the National Committee on Uniform Traffic Control Devices has developed figures for potential inclusion in the Manual of Uniform Traffic Control Devices. Several figures show potential sidewalk placements. Debates were held within the National Committee regarding whether these figures on the sidewalk geometrics should be included in a manual focused on traffic control devices. One of the comments made was the need for this type of information to be located in a national reference document, and currently there is no such national document. This story illustrates the need for the type of *Guidebook* being developed within this TCRP study. Relevant figures were incorporated into the *Guidebook*.
- The types of treatments used are related to the type of service (e.g., light rail or commuter) along with the roadside development (e.g., retail, residential) and the age of the rail lines. Train services integrated into an established, developed area or train lines that have been in service for many years typically have less space and more restrictions in the crossing and station designs. Retrofitting these lines to current accessibility requirements or to provide more pedestrian amenities is complicated and expensive.
- Transit agencies seem to understand that the old standards may not be adequate given current conditions and are periodically updating system design standards. In addition to constructing new transit rail lines that utilize current standards, transit agencies are actively working to bring older transit rail system lines up to current safety design standards.
- Other variables that can affect decisions regarding pedestrian-related treatments at a crossing include frequency of the trains, vehicles, or pedestrians along with the speed of the trains and the available sight distance. Because of the number of variables to consider at a crossing, the treatments or set of treatments to use cannot be standardized. Guiding principles can be used to aid in the selection process; however, the analysis is unique for each crossing and engineering judgment is needed to make the decisions on what should be installed.
- Pedestrians take the shortest path regardless of where the markings are or how the station is designed, unless there is a barrier directing them to a preferred crossing location. For example, although signs are present forbidding travelers to cross light rail tracks in a station, many alighting passengers took the shortest route to the exit, preferring to negotiate the elevation changes and roughness of crossing the track bed closer to the train instead of traveling down the platform to the marked (and smoother) crossing.
- General approaches to pedestrian safety at crossings include restricting the pedestrians to cross at designated locations and having the pedestrians look both ways before crossing rail tracks.
- Treatments need to be built with durability in mind, so people cannot bypass the treatment by altering or destroying it.
- Providing consistency within a region is challenging, especially when there are multiple systems or multiple line ownerships, including freight. Having a formal mechanism for communication between departments can address some of the challenges.
- Regular involvement of an advisory committee of transit users with disabilities in planning grade crossings and other pedestrian facilities can help to assure that facilities not only comply with the American with Disability Act but that they are user-friendly.

CHAPTER 1: INTRODUCTION

RESEARCH PROBLEM STATEMENT

The scope of this TCRP project was to develop a *Guidebook* for pedestrian crossings for public transit rail services. The *Guidebook on Pedestrian Crossings of Public Transit Rail Services* is available on the TCRP website (*1*). The *Guidebook* was to cover three public transit rail services:

- **Light rail** is a mode of rail service provided by single vehicles or short trains on either private (i.e., dedicated) right-of-way or in roads and streets (i.e., mixed with vehicle and pedestrian traffic). Passengers board in stations or from trackside stops in streets.
- **Streetcar** service is a type of light rail service with frequent stops with almost the entire route operated in roads or streets. Streetcars are typically used in denser, high-traffic areas with vehicles designed for lower speeds and to allow for quick boarding and alighting by passengers.
- **Commuter rail** service is defined as rail service that is provided on regular railroads or former railroad right-of-way, with trains made up of either self-propelled cars or locomotive-hauled cars. Commuter rail passengers board in stations, with greater spacing between stations than other public transit rail services. Commuter rail service is characterized by high-speed, infrequent-stop service over longer distances from outlying areas into the commercial centers of metropolitan areas.

RESEARCH OBJECTIVES

The objective of the research was to develop a *Guidebook* for safe and effective treatments for pedestrian crossings for public transit rail services, including light rail, commuter rail, and streetcar services. The *Guidebook* is to be practical, and aid practitioners in selecting design, operational, and traffic control device treatments to improve safety, mobility, and accessibility.

RESEARCH APPROACH

The research was conducted within five tasks. Each task listed is followed by the objectives of that task:

- **Task 1. Perform Review of Literature**. The objective of this task is to identify the existing literature regarding pedestrian crossings especially at public transit rail services crossings by gathering and synthesizing information on existing (customary and innovative) practices and research.
- **Task 2. Identify Treatments**. The objective of this task is to identify treatments that can be applied to public transit rail services crossings to address safety, mobility, and accessibility concerns. An inventory will be developed of best practices and recent innovations in North America to improve the safety and effectiveness of public transit rail services crossings for pedestrians.
- **Task 3. Develop *Guidebook* Structure, Identify Potential Case Study Locations, Submit Interim Report**. The objectives of this task are: 1) to develop the organization structure for the *Guidebook*; 2) to identify potential case study locations that will be

visited in Task 4; 3) to identify potential treatments and locations for the field studies to be conducted in Task 4; and 4) to develop and submit the interim report.

- **Task 4. Gather Information from Existing Crossings**. The objective of this task is to conduct case study reviews of existing locations and field studies of treatment effectiveness at selected installations.
- **Task 5. Prepare *Guidebook* and Final Report**. The objectives of this task are to prepare the final report and the *Guidebook*.

REPORT STRUCTURE

This report contains the research methodology used to develop the *Guidebook*. Information is provided within the following seven chapters:

- **Chapter 1: Introduction.** This chapter presents the research objective along with an overview of the tasks completed to develop the *Guidebook*.
- **Chapter 2: Literature Reviews.** Several literature reviews were conducted as part of this research with a focus on rail characteristics, pedestrian (including pedestrians with disabilities) characteristics, rail crossing treatments, crossing treatment selection techniques, and crash reduction factors. This chapter provides a summary of how the literature reviews were done along with a synopsis of some of the findings.
- **Chapter 3: Transit Crash Databases.** This chapter highlights the major online crash databases available regarding rail.
- **Chapter 4: Online Survey of Practitioners.** This chapter provides a summary of the findings from a web-based survey of practitioners at transit agencies in the United States. The survey, conducted through the internet, asks practitioners for information on current and previous treatments used to reduce conflicts between pedestrians and rail vehicles, as well as other approaches they have used with respect to pedestrian safety at transit rail crossings.
- **Chapter 5: Telephone Interviews.** This chapter summarized the findings from supplemental telephone interviews that were conducted to ask for further details on specific treatments, perceived effectiveness at reducing conflicts, experiences with education or enforcement programs, concerns with—in addition to treatments implemented because of—National Environmental Policy Act (NEPA) requirements, and results of any studies or surveys that the transit agency may have conducted.
- **Chapter 6: Site Visits.** Members of the research team visited several public transit rail services crossings within select regions as part of this research. These visits provided the opportunity to observe the challenges faced by pedestrians at public transit rail services crossings. This chapter summarizes the observations made during three site visits to Boston, Portland, and Los Angeles.
- **Chapter 7: Summary.** This chapter provides a summary of the work for the TCRP project.

CHAPTER 2: LITERATURE REVIEWS

INTRODUCTION

Several literature reviews were conducted as part of this research with a focus on rail characteristics, pedestrian (including pedestrians with disabilities) characteristics, rail crossing treatments, crossing treatment selection techniques, and crash reduction factors. This chapter provides a summary of how the literature reviews were done along with a synopsis of the findings. The key findings of merit for the developed *Guidebook* (*1*) are contained in that document.

RAIL CHARACTERISTICS

This research focused on three types of transit rail services: light rail, commuter rail, and streetcar. Information on each type of transit rail service and identification of the different types of grade crossings, right-of-way alignments, and station contexts for each type of transit rail service was identified. In addition, material was identified on how the unique characteristics of these three types of transit rail services impact the design and implementation of treatments at pedestrian crossings. This information was incorporated in the *Guidebook.*

PEDESTRIAN CHARACTERISTICS

In order to effectively plan and design pedestrian crossings for public transit rail services, an understanding of the characteristics of pedestrians can be beneficial. Information was identified on the general characteristics of pedestrians, considerations for special pedestrian groups, and impacts of mobile device use on pedestrian risk. The information was updated with the research team's knowledge and experience along with comments from those the research team met during the course of the project and incorporated into the *Guidebook.*

CROSSING TREATMENTS

The purpose of pedestrian crossing devices is to make pedestrians aware of the presence of the train and/or to prevent pedestrians from crossing at inappropriate times. Several types of crossing treatments or devices are used at rail crossings. Some of the crossing treatments fit within a traffic control device category while others, such as fencing, are part of the infrastructure provided at the crossing. A single crossing treatment or device will not be sufficient; rather a combination of devices is needed to communicate appropriate crossing locations and crossing times.

Minimizing the number of conflict points for pedestrian is another approach used to improve safety. Techniques suggested by Korve (*2*) to channelize pedestrian traffic are:

- Paving: A feature such as a sidewalk or path provides an area for pedestrians to use and can be expected to attract pedestrians and bikes.

- Delineation: Through the use of changes in pavement texture, materials, landscaping, or painted lines on a paved surface, the limits of the pedestrian pathway can be indicated so that pedestrians will stay within the allocated walking zone.
- Barriers: A wide variety of barriers, such as fencing, railing, chains with bollards, or wire strung between posts, can be used to provide positive control over most pedestrian movements.

Siques (*3*) notes that safe trackway crossing by pedestrian depends on four factors:

- Awareness of a crossing.
- Pedestrian path across a trackway.
- Awareness of and ability to see an approaching light-rail vehicle (LRV).
- Understanding of potential hazards at grade crossings.

At a given location, a pedestrian-rail crossing can incorporate several crossing treatment components or devices. For example, the crossing could include signs and pavement markings along with a barrier and an audible warning device. Following are discussions on the pedestrian crossing treatment components or devices identified during the literature review.

Traffic Control Devices

The *Manual on Uniform Traffic Control Devices* (MUTCD) (*4*) discusses traffic control devices used at highway-rail grade crossings within Part 8. The Federal Railroad Administration's (FRA's) *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*) notes that the MUTCD "has the status of law as it pertains to signs, signals, and pavement markings, and non-compliance with the Manual can ultimately result in the loss of federal-aid funding, as well as in a significant increase in tort liability incurred by the use of non-standard traffic control devices." The MUTCD presents information on the process for the incorporation of new devices in the Manual. The process enables transit agencies desiring the experimental use of traffic control devices that show promise in the enhancement of safety and mobility to evaluate these devices.

The Railroad/Light Transit Rail (RRLRT) Technical Committee of the National Committee on Uniform Traffic Control Devices (NCUTCD) is providing recommended changes (*6*) to the MUTCD to support pedestrians and pedestrian accessibilities needs. With the publication of and changes proposed in several American with Disability Act (ADA) related documents, the MUTCD is in need of modification to support accessibility at grade crossings. Further, with increasing ridership on light rail, commuter rail, and passenger rail facilities, pedestrian interaction with trains has led to an increasing trend in pedestrian/rail incidents. The purpose of the RRLRT efforts "is to provide information regarding the use of traffic control devices on pathway and sidewalk grade crossings to increase safety, provide for the uniform application of traffic control devices, and facilitate accessibility for all pedestrians which are inter-twined with various traffic control devices and design features." The proposed revisions include the addition of 20 new figures that provide examples of pedestrian gate placement or flashing light signal assemblies.

Passive Signs

The key resource for information about signs is the MUTCD (*4*). Passive signs used at a pedestrian pathway or sidewalk grade crossing can include the advance Railroad Crossing sign (known as W10-1 in the MUTCD), the Crossbuck assembly (R15-1) with a Yield sign (R1-2) or a Stop sign (R1-1), and the Look sign (R15-8). These signs are currently in the MUTCD, and the sign codes are provided in the previous sentence within the parentheses.

The Number of Tracks plaque is placed beneath the Crossbuck sign and helps to communicate the number of tracks. The Light Rail Do Not Pass sign (R15-5) is used to indicate that motor vehicles are not allowed to pass light rail vehicles that are loading or unloading passengers when there is no raised platform or physical separation from the lanes upon which other motor vehicles are operating. Instead of the R15-5 symbol sign, a regulatory sign with the word message DO NOT PASS STOPPED TRAIN (R15-5a) may be used.

Warning Messages

In addition to the MUTCD-compliant signs, several transit agencies are using signs with messages unique to the area to communicate the warning. FRA in *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*7*) included a warning sign that the Illinois Commerce Commission, in cooperation with the Northeast Illinois Regional Commuter Rail Corporation (Metra), is currently field testing at four locations on Metra’s Milwaukee West commuter line.

Per TCRP Report 137 (*8*), some transit agencies are also using signs to indicate the presence of a train or streetcar or that a second train may be possible. The second train warning signs are designed to remind pedestrians and motorists to look both ways and be aware of trains on all tracks. Varieties of Look Both Ways signs are in use; however, a second train warning sign is not in the MUTCD. These signs are being installed where pedestrians and motorists may not look for a second train approaching beyond the view of the train that is readily visible. The main purpose of train warning signs is to increase motorist, pedestrian, and cyclist awareness of the possibility of a train approaching from either direction, even when a visible train is already present on the track. Salt Lake City, Utah, used a sign that is shown in the TCRP 137 report where they note that the trolley symbol used is not in the MUTCD, but is used in a number of cities.

In 2001, Bentzen and Barlow observed an audible information device resembling an accessible pedestrian signal that used a speech message to announce the approach of a light-rail vehicle at a pedestrian crossing in Gothenberg, Sweden.

Warning Signs for Enforcement

FRA in *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*) included a warning sign related to enforcement. Glenview, Illinois, on Metra’s Milwaukee District North Line, has established a $250 fine for any pedestrian who violates railroad warning devices. Warning devices include both a bell and flashing light signals.

Blank-Out Signs

Addressing the condition of warning pedestrians of the presence of a second train has resulted in several different active signs being used (*9*) (such as the Light Transit rail Approaching-Activated Blank-Out Warning Sign [W10-7]), which are also known as train activated signs or blank-out signs. They supplement the traffic control devices to warn road users crossing the tracks of approaching light rail transit (LRT) and may be used at signalized intersections near highway-LRT grade crossings or at crossing controlled by STOP signs or automatic gates.

They are illuminated to display a message to motorists, pedestrians, and cyclists when an event has occurred such as the approach of a train. The signs may also be used to notify motorists, pedestrians, and cyclists of a left or right turn prohibition due to a train coming. According to TCRP Report 137 (*8*), transit agencies reported that blank-out provides more specific useful and timely information to motorists, pedestrians, and cyclists. In addition, the TCRP Report 137 project team reported more positive feedback about turn restriction blank-out signs than about blank-out signs with the train symbol. Blank-out signs should be illuminated long enough to allow motorists and pedestrians to respond and to clear the tracks, but not so long that the sign becomes ineffective (perceived as incorrect) or easy to ignore.

Experiences with Signs for Second Train Condition

An important contributing factor for many train/vehicle and train/pedestrian collisions is the presence of a second train, either a slower-moving freight train or a second LRV. Second train signals are active signs illuminated to indicate that a second train is approaching. The sign may be a blank-out sign or it may use flashing lights or another type of indication (such as backlit illumination) to an otherwise passive sign. The signals are more effective when the warning is within a short time of the second train approaching. Signs that are on for too long may be ignored. The effectiveness of the signs is assumed to be greater if they deliver specific and valuable information to motorists, pedestrians, and cyclists, e.g., the direction from which the second train is approaching. No quantified information on the safety impacts of these engineering crossing treatments has been found.

A demonstration project in Los Angeles (*10, 11*) investigated whether risky pedestrian crossing behavior would change due to train activated warning signs. The demonstration project was conducted on the south sidewalk at the Vernon Avenue intersection with the Metro Blue Line and Union Pacific Railroad (UPRR) tracks. The sidewalk crosses two LRT tracks and two UPRR freight tracks. The data were collected and analyzed by viewing video tapes recorded at the crossing. The video camera was activated only when there were two trains at or near the crossing. The before video data (before warning sign installation and operation) were recorded from March 24 to June 9, 2000. The after video data (recorded when warning sign was in operation) were recorded at various times from June 10, 2000, to June 18, 2001. Difficulties arose with interruptions caused by a strike and equipment failure. The after periods analyzed were July 30 to September 5, 2000, and May 20 to June 18, 2001. On an average weekday, approximately 1,600 pedestrians traversed that crossing site, approximately 1,200 passengers boarded and alighted from the LRVs, and approximately 220 LRT trains and 16 freight trains used the rail right-of-way. From the analysis of before and after video data, the demonstration project found that the warning sign was effective in reducing risky behavior by pedestrians. Overall, the number of pedestrians crossing the LRT tracks at fewer than 15 seconds in front of an approaching LRT train was reduced by 14 percent after the warning sign was installed. The number of pedestrians crossing the tracks at six seconds or fewer before an LRT train entered the crossing was reduced by about 32 percent. The number of pedestrians crossing the tracks at four seconds or fewer in front of an approaching LRT train was reduced by 73 percent.

Pavement Markings

The key resource for information about pavement markings is the MUTCD (*4*). Section 8B.27 of the 2009 MUTCD provides information regarding pavement markings for railroad and light transit rail grade crossings. The section notes that all grade crossing pavement markings shall be retroreflectorized white.

TCRP Web-Only Document 42 (*12*) reported on a study by Cairney and Diamantopoulou (*13*) on the use of pavement marking crossing treatment of "a painted strip that consisted of continuous lines defining the outside of the area, and broad diagonal stripes running across the area at regular intervals." The painted strip was tested at two separate locations and was "intended to induce more orderly traffic flow and thus simplify the crossing task for the pedestrian, while also providing a refuge in the middle of the road." Video recordings were used to collect the data. The before measures were obtained some months before the devices were installed. The during observations at the painted strip were obtained approximately one week after and then three weeks after the installation. The after measurements were collected for a period of 6 months after the crossing treatments had been installed. The authors' analysis of the before, during, and after periods led them to report that after the pavement markings were introduced at the two tram sites:

- There were significantly fewer pedestrians running across the road at both tram sites.
- Slightly more time was spent in the area between the tram tracks in the middle of the road.
- There were significantly fewer close conflicts in 1998 (after) than in 1997 (before).
- Although no formal measurements were taken, the lateral position of the traffic was more uniform than it had been before the installation of the painted strip (e.g., straying outside of the designated lane was reduced).

Cairney and Diamantopoulou (*13*) observed that traffic behavior had been more influenced by the painted strip than has pedestrian behavior.

Farran (*14*) examined a system of pedestrian crossing warning devices in Barcelona. The system included a combination of delineation, LRT warning signs, pedestrian signals, and audio devices to alert pedestrian about LRVs approaching the crossings from both sides. The delineation used arrow striping, which incorporates the LRV symbol. The arrow striping and the signs are used to help pedestrians to look in the most appropriate direction before they walk onto the track area. The arrow is striped between the two rails for a given LRV direction and is located immediately upstream of the pedestrian pathway. A single arrow is used where LRVs typically operate in a single direction. Two arrows are used where LRVs typically operate two-way on a single track.

Per TCRP Report 137 (*8*), these pavement markings are similar to ones used in Dusseldorf, Germany.

Dynamic Envelope Markings

The dynamic envelope markings indicate the clearance required for the train or LRT equipment overhang resulting from any combination of loading, lateral motion, or suspension failure. If used, pavement markings for indicating the dynamic envelope shall comply with the provisions of MUTCD Part 3 and shall be a 4-inch normal solid white line or contrasting pavement color and/or contrasting pavement texture.

Pavement marking, texturing, and striping are changes to the pavement appearance or texture to denote the LRT right-of-way or dynamic envelope. These crossing treatments indicate the right-of-way of the LRV and alert motorists, pedestrians, and cyclists to the possible presence of an LRV so that they can be prepared for its arrival or passing. Pavement marking, texturing, and striping are assumed to be effective in conveying information, but the effect of pavement marking, texturing, and striping on LRT crashes has not been quantified. Pavement markings and texturing require ongoing maintenance. They are effective in areas where snow and/or ice do not cover the markings. Rain can make markings difficult to see. Examples of pavement markings and texturing are seen in the TCRP 137 report.

Detectable Warnings

Truncated dome detectable warning surfaces that contrast visually with adjacent walking surfaces, either light-on-dark or dark-on-light, can be used to warn pedestrians about the locations of the tracks at a grade crossing. The MUTCD references the *Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)* for "specifications for design and placement of detectable warning surfaces" (*15*). More recent publications, *ADA Standards for Transportation Facilities* (*16*) and *Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (Proposed PROWAG*) (*17*), provide additional information regarding the use of detectable warnings at rail crossings.

Proposed PROWAG provides the following general information regarding detectable warning placement with respect to pedestrian at-grade rail crossings:

- **Pedestrian At-Grade Rail Crossings.** At pedestrian at-grade rail crossings not located within a street or highway, detectable warning surfaces shall be placed on each side of the rail crossing. The edge of the detectable warning surface nearest the rail crossing shall be 1.8 m (6.0 ft) minimum and 4.6 m (15.0 ft) maximum from the centerline of the nearest rail. Where pedestrian gates are provided, detectable warning surfaces shall be placed on the side of the gates opposite the rail.
- **Boarding Platforms.** At boarding platforms for buses and rail vehicles, detectable warning surfaces shall be placed at the boarding edge of the platform.
- **Boarding and Alighting Areas.** At boarding and alighting areas at sidewalk or street level transit stops for rail vehicles, detectable warning surfaces shall be placed at the side of the boarding and alighting area facing the rail vehicles.

Pathway Stop Lines

The MUTCD (*4*) provides the following guidance regarding pathway stop lines: "if used at pathway grade crossings, the pathway stop line should be a transverse line at the point where a pathway user is to stop. The pathway stop line should be placed at least 2 feet farther from the nearest rail than the gate, counterweight, or flashing light signals (if any of these are present) is placed, and at least 12 feet from the nearest rail."

Flashing Light Signals

The typical railroad flashing light assembly can warn motorists and pedestrians that a train is present or about to enter the crossing area. An example is the assembly developed by members of NCUTCD, Railroad/Light Transit Rail Technical Committee (RRLRT TC) (*6*) for consideration for inclusion in the next edition of the MUTCD.

In-Pavement Flashing Lights

Per the FRA *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*) report, Oregon has expressed interest in the use of train-activated, in-pavement flashing lights at high-profile, high-traffic pedestrian locations.

Pedestrian Signals

Pedestrian signals are active signal devices that tell pedestrians when it is permissible to begin or to continue a crossing. The MUTCD pedestrian crossing signal heads are composed of a walk symbol (walking person) that indicates the interval during which crossings should be initiated, a flashing hand that indicates that a crossing should not be started but may be completed, and a solid hand that indicates when pedestrians should not enter the roadway.

MUTCD 4E.07 requires the use of countdown signal heads at crossings where the pedestrian change interval is longer than seven seconds. The countdown signal informs pedestrians of the number of seconds remaining in the pedestrian change interval. While some transit agencies are using pedestrian signals (as discussed in TCRP Report 137), the proposed revisions to the MUTCD developed by the RRLRT TC (*6*) include the following:

> Standard: Pedestrian signals as described in Chapter 4E utilizing Upraised Hand and Walking Person symbols shall not be used at a pathway or sidewalk grade crossing except as provided in the following option.
>
> Option: A pedestrian signal may be used at a pathway or sidewalk grade crossing where the movements of LRT vehicles are controlled by a traffic control signal.

Preemption of Traffic Signals near Railroad Crossings

Signal preemption may be used at railroad grade crossings to allow rail vehicles to have unimpeded access through intersections to ensure they remain on schedule and improve commute times. MUTCD (4D.27 paragraph 08 B) permits the shortening or omission of a pedestrian change interval during the transition into preemption control. Omission or shortening of the pedestrian change interval places all pedestrians at risk, but especially pedestrians with disabilities who may not be able to increase their rate of travel across the tracks or to quickly reverse direction. When preemption is being considered for a rail crossing, the approaching trains should be both visible and audible.

A sign assembly from the LaGrange Road Metra Station in Illinois notifies pedestrians who are able to see and read it that the walk time is shortened when a train is approaching (*5*). Whether the passive sign is accompanied by a device that would communicate similar information to a blind pedestrian was not mentioned in the report.

Audible Crossing Warning Devices

Audible warning devices are another active measure for pedestrian safety. Audible devices can be attached to other warning devices at the crossing or on-vehicle audible warnings can be used. TCRP Research Results Digest 84 (*18*) describes the development and testing of two alternative audible warnings. The first was a conventional bell sound while the second was a blended staircase signal that combined the sounds of an approaching train and a conventional crossing bell. The sounds were processed so that the pedestrian approaching the intersection hears a bell sound that rises in pitch and an approaching train that increases in loudness. The study did not produce conclusive evidence on the effectiveness of the signals. Extensive recommendations about the design and installation of audible signals can be found in TCRP Research Results Digest 84 (*18*).

TCRP Report 137 provides the following summary about audible crossing warning devices: "Audible crossing warning devices provide supplemental warning for pedestrians and cyclists. Audible warning devices such as bells, horns, and synthesized tones installed either onboard the LRV or wayside along the tracks are used in conjunction with flashing light signals at grade crossings. The key design issues to consider are appropriate placement of the device and tuning the sound produced so that the warning sound can easily be distinguished from the environmental noise in the area. Improving placement and the type of tone are believed to be more effective than simply increasing the device volume."

Rules regarding the sounding of on-vehicle warning devices are usually outlined at the transit agency level and vary greatly depending on the agency. Many LRVs are equipped with multiple sound types, and operators may use different levels of sound in different situations. Because audible warnings may disturb residents, the warning may be limited where there is residential development near the LRT line. *TCRP Research Results Digest 84* acknowledges that different transit agencies have different philosophies about sounding audible warnings and outlines a general overall practice for evaluating rules for sounding onboard audible warning devices at crossings. The evaluation system is based on three characteristics: emergencies, sight distance, and surrounding conditions. More details can be found in the report (*18*).

Pedestrian Automatic Gates

Pedestrian automatic gates are arms that block the pedestrian/cyclist path across the tracks. The principle is similar to the use of gates on roadways to stop motorists and cyclists when a train is approaching. Pedestrian automatic gates may be provided in addition to roadway gate(s). On narrow streets, the pedestrian gate may be a part of the vehicle gate, with both pedestrians and vehicles blocked by a single gate that is placed behind the sidewalk. A second gate is required on the downstream side of the rail crossing for pedestrians approaching the crossing from the opposite direction.

Korve et al. (*2*) recommend that pedestrian automatic gates be installed at all pedestrian crossings (sidewalks or other designated pathways) where sight distance is limited and leads to situations where pedestrians are unable to see an approaching LRV until it is very close to the crossing, and/or LRV operators are unable to see pedestrians in the vicinity of the crossing until the LRV is very close. At crossings where such conditions exist, pedestrian automatic gates function to take away a pedestrian's decision about whether to cross the tracks or wait until the LRV passes.

Per TCRP Web-Only Report 42 (*12*), to avoid compromising the safety of a pedestrian trapped between the tracks and the automatic gate as it lowers, some transit agencies (such as the LACMTA in Los Angeles) have installed pedestrian automatic gates set back from the track so that pedestrians have a refuge area between the track and gate where they can wait safely. The setback distance is wide enough to accommodate a wheelchair. An alternative solution, used by CalTrain, a commuter railroad in northern California, is a swing gate installed next to the pedestrian automatic gate.

Pedestrian swing gates can be provided together with pedestrian automatic gates to allow pedestrians and cyclists to exit the right-of-way if they began crossing before the gates went down and also in the case of an emergency (see following discussion).

Pedestrian Automatic Gate with Horizontal Hanging Bar (Also Known as Gate Skirts)

Horizontal hanging bars (commonly called gate "skirts") are being added to automatic gates to decrease the number of pedestrians crossing under a deployed automatic gate. Per a presentation by FRA (*9*), the Dallas Area Rapid Transit installed horizontal hanging bars (gate skirts) on the Blue Line in 1996 because of concerns with the presence of children walking to and from a nearby elementary school (*9*). The FRA presentation reported on a study that found risky pedestrian behavior reduced by about 70 percent with the use of the horizontal hanging bar. The presentation also quoted the Rail Safety and Standards Board of the UK (Requirements for Level Crossings, Railway Group Standards G1/RT7012), "at any level crossing equipped with full barriers, skirts shall be fitted where either there is a significant risk of pedestrians deliberately passing under the lowered barriers or where herded animals are regularly taken over the crossing on the hoof. Where provided, skirts shall be of light colour, light construction and shall fence in the space between the lowered barriers and the road surface" (*9*). Horizontal hanging bars have the additional benefit of enabling pedestrians who are visually impaired to detect a lowered gate with a long cane, if used, and come to a stop prior to bodily encountering the gate.

Pedestrian Swing Gates

Pedestrian swing gates, sometimes called pedestrian fence gates, are gates that pedestrians and cyclists must open manually to cross the tracks). Pedestrian swing gates, like other pedestrian barriers and gates, are installed to discourage pedestrians and cyclists from making inappropriate crossing movements. The gates force crossing users to have additional time to check for an approaching LRV.

Irwin (*19*) suggested using pedestrian swing gates where: a) pedestrian to train sight lines are restricted, b) a high likelihood exists that persons will hurriedly cross the trackway, c) channeling or other barriers reasonably prevent persons from bypassing the gates, and d) acceptable provisions for opening the gates by disabled persons can be provided.

Per TCRP Report 137 (*8*), Calgary Transit installed various combinations of gates and barriers at a number of stations. The installations included active overhead railroad flashers. The swing gates are intended to prevent pedestrians from crossing into the track area without pausing and checking. As pedestrians are required to actively open the gates, they are forced to be more alert to the risks associated with crossing the LRT tracks. The gates also provide a positive barrier between where it is safe and not safe to stand when an LRV is approaching (*2*). Transit officials in Calgary have reported; however, that pedestrian violations of the swing gates (opening the gates while the warning devices are flashing) have increased following the initial reductions in risky behavior that occurred immediately after the gates were installed (*2*).

Automatic swing gates do not require action on the part of the pedestrian to enter the crossing. The gate is normally held open (under power) exposing a walkway across the tracks. When activated by a LRV approaching the grade crossing, the gate closes. As the gate closes, it exposes an emergency exit. After the LRV passes, the gate opens and access to the walkway across the tracks is permitted. As the gate opens, the emergency exit is closed. If there is a power failure, the swing gate will automatically close under spring tension. Used widely in Australia, automatic swing gates have been successful in fatality prevention and operational reliability (*3*).

Channelization

Channelization is a technique to control pedestrian (or vehicle) movements. It may involve parallel longitudinal barriers of various types used to separate the pedestrians and/or motorists from the tracks. Channelization devices are to restrict the path of pedestrians or motor vehicles and prevent them from crossing the tracks or direct them to an appropriate crossing location. Examples of channelization devices can include barriers, medians, fences, landscaping, and curbs.

Barriers

Minimizing the number of conflict points for a pedestrian is an approach used to improve safety. One of the techniques used to channelize pedestrian traffic is barriers. A wide variety of barriers, such as fencing, railing, chains with bollards, or wire strung between posts, can be used to provide positive control over most pedestrian movements, but not all will be sufficiently detectable to pedestrians who are visually impaired.

TCRP Report 137 (*8*) noted that the most restrictive form of channelization is the barrier. Barrier channelization can control pedestrian access to the tracks, thereby focusing pedestrian movements at a designated crossing location. Fixed barriers restrict the movements of pedestrians approaching a rail crossing and lead pedestrians toward a designated crossing location. The barriers include various forms of fencing and railing.

As reported in TCRP Web-Only Report 42 (*12*), Huddart and Thompson investigated design and safety issues on the Tuen Mun –Yuen Long LRT line in Hong Kong (*20*). In the central area of Yuen Long, a barrier was implemented alongside tracks running down the center of the right-of-way to channel and feed pedestrians toward a platform in the center alignment. Due to high pedestrian volumes to and from the platform, the barrier caused considerable pedestrian congestion. Huddart and Thompson acknowledged that this type of barrier alignment will likely limit platform widths and that a careful review of pedestrian movement and space available should be conducted. Where LRT operates in areas with high pedestrian usage, Huddart and Thompson suggest that special treatments should be planned and operated. The standard practice is to fence the tracks so that pedestrians can cross only at defined crossing points, but this approach can conflict with unobstructed pedestrian movement. The authors suggest that a solution can be to limit LRT speeds to 15 km/h. In high pedestrian environments, the authors also recommend that the track layout should be more generous so that pedestrians can avoid LRVs, particularly when two vehicles traveling in opposite directions are present simultaneously.

As reported in TCRP Web-Only Report 42 (*12*), the most common types of fixed barrier are Z-crossings and bedstead barrier crossings. Z-crossings and bedstead barrier crossings are typically used in combination with other devices such as pedestrian signals or pedestrian automatic gates. Calgary Transit has used both Z-crossings and bedstead barrier crossings. These pedestrian barriers are installed in a zigzag style pattern on sidewalks and at LRT stations. The configuration of the paths forces pedestrians to face the direction of a potentially approaching LRV. Z-crossings should be used only at pedestrian crossings with adequate sight distance (if pedestrians are turned to face approaching LRVs but cannot see them because of obstructions, the Z-crossing is useless). Z-crossings and bedstead crossings should not be used where LRVs operate in both directions on a single track, because pedestrians may be looking the wrong way in some instances. Although pedestrians may also look in the wrong direction during LRV reverse-running situations, reverse running should not negate the value of Z-crossings and bedstead barrier crossings as this type of operation is performed at lower speeds and is typically used only during maintenance or emergencies (*2, 21*).

Pedestrian Fencing

Pedestrian fencing is designed to channel pedestrian movements to designated crossing areas and limit the number of potential pedestrian-rail conflict points. Landscaping can be used in some situations to obtain a similar restriction.

TCRP Report 17 (*22*) recommends "channel[ing] pedestrian flows on sidewalks, at intersections and at stations to minimize errant or random pedestrian crossings of the LRT track environment." One channelization option is fencing or landscaping. Also reported in TCRP Report 137 (*8*) is that "pedestrian-rail at grade crossing design is only effective if pedestrians actually cross at the designated point and take a path that allows them clear observation of the warning devices." Fencing and landscaping, along with signage and markings, encourage pedestrians to cross at designated crossings. Physical channelization is also necessary for the effective installation of all types of automatic or manual pedestrian gates. Pedestrians will violate pedestrian gates at sites with inadequate channelization.

Pedestrians must not be trapped within the dynamic envelope of the LRV; it is important to leave room for a pedestrian between the fencing and the dynamic envelope (see discussion on pedestrian refuge). The height of fences and barriers near crossings needs to be limited to ensure the visibility of approaching trains. In *Pedestrian-Rail Crossing in California* (*23*) a maximum height of 3 feet 7 inches is recommended.

Clearly Define Pedestrian Crossing

The preferred location for a pedestrian crossing of a track should be clear and easy for the pedestrian to detect. When the path is along an existing sidewalk, the continuation of the sidewalk can provide that message. When the path is within a station, the preferred crossing location may not be as easy to define. If a crossable surface was applied to the length of the station and beyond, this could encourage pedestrians to cross at several different locations. If the crossing location is restricted by fencing, pedestrians can only exit to the roadway in select locations. A reasonable length of crossable surface depends on the number of pedestrians expected at the station.

Channelization devices can assist with delineating the location along with the use of pavement markings or paving materials.

Pedestrian crossings should consider pedestrian flow patterns. Attempting to prohibit pedestrians from crossing at a location where they typically cross LRT tracks may encourage risky pedestrian behavior, such as crossing tracks at an unprotected location. Pre-existing pedestrian travel patterns should be maintained if possible, considering any sight distance limitations.

Flangeway Filler

The maximum flangeway gap is 2.5 inches. The FHWA publication *Designing Sidewalks and Trails for Access* (*23*) notes that the flangeway gaps can cause the loss of control and entrapment for people who use wheelchairs or for bicycles. The problem is exacerbated if the crossing is not at 90 degrees. When the crossing is not at 90 degrees, a wider crossing can enable wheelchair users to orient their chairs to approach the rails at 90 degrees. The use of rubber flangeway fillers at light rail tracks mitigates the gap problem. Freight railroad require a 3-inch flangeway gap at installation, which would also occur where commuter transit rail systems operate on freight rail lines (*24*).

Smooth and Level Surface

In addition to minimizing the flangeway gap, a need exists to control the vertical difference between the rail and the adjacent surfaces. This can be as critical as the horizontal gap because the vertical differences can cause the swivel casters of a wheelchair to turn sideways and drop into the flangeway gap.

Pedestrian Crossing Designs that Consider Accessibility

Research has been done in the United Kingdom and Australia to identify problems of pedestrians with disabilities at rail crossings and to develop and evaluate treatments. In the UK, research (*25*) was undertaken on behalf of the Road-Rail Interface Safety Group with the involvement of the Disabled Persons Transport Advisory Committee (Rail), the Joint Committee on Mobility of Blind and Partially Sighted People, and representatives from the rail industry. Advocacy groups submitted an initial list of rail crossing problems experienced by disabled pedestrians, and this was refined by a task force of people with disabilities and representatives from the rail industry through discussions and site visits. Existing level crossings were found to be moderately accessible, and implementation of guidance provided in the *Railway Safety Principles and Guidance (RSPG2E)* (*26*) was recommended to substantially improve accessibility.

Nonetheless, three categories of access problems were identified:

- Identification of the crossing.
- Deciding when to cross.
- Navigation and physical access.

The research also identified 30 viable engineering solutions to the problems and refined the list into 12 recommendations. The recommendations are generic and intended to help stakeholders understand the issues and approaches to solutions to enhance accessibility.

In Australia, research carried out by Sinclair Knight Merz and the Victoria Department of Infrastructure identified seven key issues for people with disabilities at rail crossings. Based on these seven areas, a toolkit of crossing treatments was developed to address the needs of pedestrians with hearing, visual, or mobility impairments (*27*,*28*,*29*).

In the Australian research, the highest priority for improving pedestrian-rail crossings was given to crossing treatments intended to decrease the likelihood of pedestrians being trapped on crossings. These were identified as a) improved surface quality through better maintenance, b) grade separation, and c) realigning crossings so that the openings are aligned with one another.

The Australian standard for railway crossings was updated in 2007 and now includes a number of recommendations from the research (Australian Standard. Manual of Uniform Traffic Control Devices, 2007, Part 7: Railway Crossings, Section 6: Pedestrian and Bicycle treatments) (*30*). Particular attention is given to: the geometry of mazes (pedestrian fencing) to accommodate larger wheelchairs and gophers (scooters); providing more visual and audible cues to provide greater accessibility for people with visual and hearing disabilities; provision of a red man (pedestrian signal) at active rail crossings; consideration of displays to alert pedestrians of an approaching second train; provision of more visual cues on the crossing; minimizing the flange gap; standardizing warning signs; and consideration of latches on escape gates to prevent wrong way movement through pedestrian bypasses.

Recently published in the UK, *Level Crossings: A Guide for Managers, Designers, and Operators* (*31*) recommends treatment decisions based on the volume of pedestrian traffic and the anticipated frequency of crossings by people with disabilities. Level and well-maintained paths of travel, audible warnings, and high contrast markings are recommended at all pedestrian crossings. Tactile thresholds (tactile paving surfaces) are recommended at pedestrian-rail crossings where there is high pedestrian volume, and pedestrian signals are recommended only on rail crossings having exceptionally high pedestrian volume.

Offset Pedestrian Crossing

An offset pedestrian crossing, commonly referred to as a Z pedestrian crossing, channelizes pedestrian movements. Offset pedestrian crossings include fencing or barriers designed to direct pedestrians to walk facing oncoming LRVs before crossing the tracks to increase pedestrian awareness of oncoming LRVs. Offset pedestrian crossings increase pedestrian safety and alertness by slowing and channeling pedestrian movements. The crossing treatment is not effective when trains are running reverse track or along a single track as the pedestrian would be oriented to face the wrong direction in those cases. In some configurations, however, pedestrians can be forced to turn 180 degrees thereby having a view of both directions as they approach the tracks.

Pedestrian Refuge

Siques (*3*) describes a pedestrian refuge area and encourages its use at locations where pedestrians must cross multiple modes of traffic. For example, along median-running alignments, where pedestrians are required to cross motorist traffic, LRT tracks, and another set of motorist traffic to go from one curb to the other. As such, each crossing is separated into a distinct movement, and pedestrians are not left standing on the tracks, or in the roadway, when a train approaches. The pedestrian refuge area should be clearly defined with contrasting materials.

One of the changes the RRLRT (*6*) is proposing for the MUTCD is to include a figure that shows an example of a refuge area.

Sidewalk Relocation

Per the FRA *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*) report, Oregon routes any pedestrian facility 5 ft behind any crossing gate arm assembly to account for the position of the gate arm counterweight when the gate is horizontal.

Stop/Terminal Design

In TCRP Web-Only Report 42 (*12*), Currie and Smith (*32*) noted that curbside stops are a well-known problem for LRT systems that operate in mixed traffic in Toronto, Canada, and Melbourne, Australia. At curbside stops, passengers wait at the curb, but need to cross traffic lanes without signal protection to reach the LRVs running on tracks in the center lanes. They sometimes wait on-street without protection from moving traffic. Similarly, when passengers alight, they often do so without protection from moving traffic. In addition to safety concerns, LRT systems of this type are not accessible to persons with disabilities because no platforms are provided.

Curbside stops are thought to lead to 25 pedestrian road traffic accidents and a far higher number of near-misses each year in Melbourne, Australia (*32*). Examples of alternative designs being used in Melbourne for curbside stops include the following:

- **Safety Zone Stops** - Safety Zone Stops are the most common adopted solution for tram stops in mixed traffic in Melbourne. A safety zone is a boarding area located in the center lanes of roads. The zone has railings to protect waiting passengers from the traffic flow. Traffic is not permitted on tracks at these stops. No platforms are provided. Signalized pedestrian access is usually provided (*12*).
- **Super Stops** - Super Stops are high quality station style designs located in the center lanes of roads. The design includes platforms, shelters, and real-time passenger information. The road is narrowed to a single lane in each direction. Traffic is not permitted in the track area of the road and is required to pass the stop in the curbside lane. Pedestrian access is limited to few protected crossing points (*12*).
- **Curb Access Stops** - Curb Access Stops are sidewalk “flareouts” or curb extensions where the road is narrowed to a single lane in each direction. A platform is constructed on the edge of the extended curb to aid tram access. Traffic can use the track area next to the stop, but must wait behind the tram as passengers board/alight. Curb Access Stops are cheaper than Super Stops, but limited in number because they have a significant impact on road space and capacity (*12*).

Removable Barriers

Removable barriers restrict the crossing movements of pedestrians and cyclists and prevent them from randomly entering LRV trackways. The barriers can be installed temporarily to restrict pedestrian and cyclist movements for limited periods and/or for infrequent events, such as sporting events. As reported in TCRP Report 137 (*8*), SF Muni uses portable steel barriers supplemented by yellow fabric caution tape and numerous transit staff and police to manage large crowds crossing the LRT alignment adjacent to the baseball stadium. Light rail agencies such as Utah Transit Agency and Minneapolis have found removable barriers to be effective at locations with high volumes of pedestrian traffic.

Sight Distance

Adequate sight distance is critical regardless of the presence of active or passive warning devices. In some cases, the railroad wayside signal cabinets adjacent to the sidewalk approaching the light rail station, the controllers for the grade crossing system, and the nearby development limit the sight distance available to a pedestrian to see along the tracks.

At crossings controlled by active devices, pedestrians may still enter the crossing if they do not see a train approaching. In addition, if one train has already passed, pedestrians may enter the crossing unaware of a second train approaching from the opposite direction. Adequate pedestrian sight distance is based on the time for a pedestrian to see an approaching train, make a decision to cross the tracks, and completely cross the trackway. Note that additional sight distance might be necessary in locations where pedestrians walk more slowly, such as near a retirement community or hospital.

At crossings controlled by only passive devices, the need for adequate sight distance becomes even more important. A pedestrian needs to be aware of an approaching train to determine the potential hazard at the crossing. For crossings controlled by either passive or active devices, if the sight distance is inadequate, active, positive control is essential.

Illumination

Illumination of crossings refers to lighting systems installed to increase the visibility of the rail crossing at night. MUTCD Chapter 8 (*4*) suggests “illumination is sometimes installed at or adjacent to a grade crossing in order to provide better nighttime visibility of trains or LRT equipment and the grade crossing (for example, where a substantial amount of railroad or LRT operations are conducted at night, where grade crossings are blocked for extended periods of time, or where crash history indicates that road users experience difficulty in seeing trains or LRT equipment or traffic control devices during hours of darkness).” The MUTCD provides the following recommendation: “types and locations of luminaires for illuminating grade crossings are contained in the American National Standards Institute’s (ANSI) “Practice for Roadway Lighting RP-8,” which is available from the Illuminating Engineering Society.”

Mirrors

Convex mirrors have been used to provide pedestrians greater visibility of a second train or a train approaching from behind them.

Required Stop

FRA in *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*) states that “in rare circumstances within a station, a transit system may elect to have a safety stop for all outbound vehicles." The required stop is used to allow passengers to cross over to the inbound platform, which only has access from one side.

Overview of Crossing Conditions

FRA in *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*) provided a review of pedestrian devices. They stated that based upon the information received, "it can be seen that effective devices are a necessary complement to law enforcement initiatives and public outreach and education efforts in the enhancement of pedestrian safety at grade crossings."

Their observations of pedestrian behavior led them to the conclusions that pedestrians "do not think of themselves as part of the overall traffic stream, and therefore not really subject to traffic control devices" and that "their crossing behaviors often indicate an 'I'll go when I want to; after all, I'm just walking' attitude that can prove very difficult to overcome." The authors recommended effective use of channelizing devices that force pedestrians to look and move in certain directions and to cross tracks at certain places so to enhance safety at grade crossings by accumulating pedestrian traffic to flow through a single, well-designed crossing point.

The authors' also noted that transit and local agencies have been developing their own signs, signals, and pavement markings, which are frequently not in compliance with the MUTCD (*4*), the established national standard. Such non-standard devices are often not without merit and may incorporate innovative features. Non-standard devices that have been shown to be effective in more than one geographic area through scientific evaluation studies should be proposed for inclusion in the MUTCD, as outlined in Section 1A.10 of the Manual. Inclusion in the Manual makes effective and innovative devices available for use by the wider community of transportation and engineering professionals, and can enhance safety for more of the population.

CROSSING TREATMENT SELECTION

FRA in *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*) included the following general points to consider during device selection. The selection of a traffic control device for use where pedestrians are intended to cross railroad tracks at grade should be the result of an engineering study whose simplicity or complexity will be determined by conditions at the crossing in question. In general, the factors to be examined during device selection should include the following:

- Collision experience, if any, at the crossing, as it involves pedestrians.
- Pedestrian volumes and peak flows, if any.
- Train speeds, numbers of trains, and railroad traffic patterns, if any.
- Sight distance that is available to pedestrians approaching the crossing.
- Skew angle, if any, of the crossing relative to the railroad tracks (*5*).

TCRP Report 69 (*2*) provided a pedestrian controls decision tree for LRT alignments with LRV traveling at speeds greater than 35 mph with at-grade crossings. The decision tree defines the type of pedestrian devices and controls using six criteria (decision points) relative to the pedestrian crossing environment. The authors of TCRP Report 69 emphasized there are numerous possible outcomes based on the answers to the six criteria. In the least restrictive condition with at least some minimal level of pedestrian activity—a crossing with relatively low activity levels, where LRT speed does not exceed 55 km/h (35 mph), where sight distance is good, that is not located in a school zone, and where no other factors warrant special consideration—the recommended practice is to provide access and passive warning devices at the crossing. For the most restrictive conditions—a crossing where LRT speeds exceed 55 km/h (35 mph), where sight distance is inadequate, the crossing is located in a school zone, or pedestrian surges or high pedestrian inattention occurs—active warning devices, barrier channelization, and pedestrian automatic gates (positive control) are recommended.

The Southern California Regional Rail Authority (SCRRA) has a publication, the *SCRRA Highway-Rail Grade Crossing Recommended Design Practices and Standards Manual* (*24*), which provides information on highway-rail crossings. The publication states that "in order to determine if a crossing has, or has the potential for, pedestrian activity, pedestrian-rail crossings shall be evaluated using the 10-minute walk rule. This rule is based upon research conclusions that pedestrians will walk 10 minutes to reach their destination. This equates to a one-third to one-half mile walk. Therefore, if the crossing is located within this radius of schools, hospitals, substantial pedestrian generators or other facilities, then the lead Engineer should consider pedestrian traffic features over the crossing."

The *SCRRA Highway-Rail Grade Crossing Recommended Design Practices and Standards Manual* (*25*) also has a similar design process and consideration table as TCRP Report 69, but with changes to several of the decision points.

The *Pedestrian-Rail Crossing in California* (*33*) includes in an appendix a copy of a UK assessment sheet for evaluating crossings located at stations. When the crossing score is more than 55, "then the risk must be reduced." A crossing score between 35 and 55 is when "measures to reduce the risk must be considered." Factors being considered include crossing abuse; number of people using the crossing; number of trains passing over the crossing; percent of non-stop trains over the crossing; maximum speed of non-stop trains; tracks crossed without a pedestrian refuge; warning time at the crossing; chance of stepping out behind another train or obstruction and being hit by a train; loud external noise source; use of significant numbers of vulnerable, distracted, or encumbered users; potential for slippery conditions; potential for fog/smoke; is the crossing on canted tracks; and other local factors. Suggested countermeasures to use when a crossing score is high was not provided with the assessment sheet.

CRASH REDUCTION FOR PEDESTRIAN-ROADWAY CROSSING TREATMENTS

A 2013 Issue Brief (*34*) provided estimates of the crash reduction that might be expected if specific countermeasures or a group of countermeasures are implemented with respect to pedestrian crashes. Note that the Issue Brief is for pedestrian crashes on roadways rather than pedestrian crashes at rail crossings. Similar type of information is not available for rail crossings.

CHAPTER 3: TRANSIT CRASH DATABASES

OVERVIEW OF AVAILABLE CRASH DATABASES

There are two primary sources of data related to collisions between transit rail vehicles and pedestrians. Light rail and streetcar safety data are through the Federal Transit Administration (FTA) and commuter rail safety data are through FRA. The following section highlights the major online crash databases available from both entities and presents analyses of these databases.

Federal Transit Administration – National Transit Database

The FTA National Transit Database (NTD) indicates that the United States Congress established the NTD to be the primary source for information and statistics on the transit systems of the United States (*35*). The FTA *Safety & Security Manual* lists the legislative requirement for the NTD as follows:

> TITLE 49 SECTION 5335 National Transit Database
> (a) NATIONAL TRANSIT DATABASE — To help meet the needs of individual public transportation systems, the United States Government, State and local governments, and the public for information on which to base public transportation service planning, the Secretary of Transportation shall maintain a reporting system, using uniform categories to accumulate public transportation financial and operating information and using a uniform system of accounts. The reporting and uniform systems shall contain appropriate information to help any level of government make a public sector investment decision. The Secretary may request and receive appropriate information from any source.
> (b) REPORTING AND UNIFORM SYSTEMS — the Secretary may award a grant under Section 5307 or 5311 only if the applicant and any person that will receive benefits directly from the grant, are subject to the reporting and uniform systems (*36*).

The NTD Program involves four reporting modules, each consisting of a series of data modules. The four reporting modules include:

- NTD Annual Reporting.
- NTD Monthly Reporting.
- NTD Safety and Security Reporting.
- NTD Rural Reporting (exclusively rural reporters).

Transit rail collisions are reporting as part of the Safety and Security module.

The FTA *Safety & Security Manual* provides guidance for reporting safety and security incidents to the NTD Program. Within the NTD Safety and Security Reporting module, the Major Incident Report (S&S-40) form is used to report detailed information on the most severe incidents, and the Safety Monthly Summary Report (S&S-50) form is used to summarize the number of non-major fires and other non-major safety incidents. For both of these forms, all reporting transit agencies without waivers are required to report, except commuter rail and the Alaska Railroad.

Both commuter rail and the Alaska Railroad report security incidents to the NTD but safety reporting falls under the guidance of FRA.

Reportable incidents within the Safety and Security module are defined as an event that is related to or affects revenue service and meets one or more reporting thresholds:

- A fatality due to an incident including suicides, but excluding deaths by natural causes, or deaths not associated with an incident.
- One or more persons immediately transport away from the scene for medical attention.
- Property damage equal to or exceeding $25,000.
- An evacuation due to life safety reasons (*36*).

The Safety and Security data are available at the FTA NTD Program website (http://www.ntdprogram.gov/ntdprogram/data.htm). Two Microsoft Excel® spreadsheets are available for download: Safety & Security Time Series Data, which includes data from forms S&S-40 and S&S-50, and Safety & Security Major-Only time Series Data, which only includes form S&S-40.

Both databases include annual incident data for each transit agency, by specific mode. Rail collisions are reported for cable cars, heavy rail, inclined plane, light rail, monorail/guideway, streetcar, or hybrid rail modes. Pedestrian-specific data were not collected prior to 2008, but beginning in 2008, fatality and injury numbers are presented for the following pedestrian categories, according to the *Safety & Security Manual*:

- **Pedestrian in Crossing –** Number of pedestrians in crosswalks killed/injured.
- **Pedestrian Not in Crossing –** Number of pedestrians not in crosswalks killed/injured.
- **Pedestrian Crossing Tracks –** Number of pedestrians crossing tracks killed/injured.
- **Pedestrian Walking Along Tracks –** Number of pedestrians walking along tracks killed/injured.

The crosswalk in the definitions above also relates to grade crossings, which are defined as "intersections of a road/highway/street/pedestrian path and rail lines or railroad tracks, or the intersection of two rail lines" (*36*). The manual makes a special note that grade crossings can be a pedestrian-only crossing. Other person categories included in the NTD Safety and Security data are passenger, revenue fare occupant, employee, other worker, bicyclist, other vehicle occupant, trespasser, and suicide.

The NTD Safety and Security databases lag behind about 90 days and are released about the fourth day of each month. Therefore, the databases include all months of 2012 data reported as of April 1, 2013 (*37*).

FTA also receives State Safety Oversight (SSO) agency annual reports for each state that contain similar data but differ due to slightly different thresholds or from the availability of information on an event prior to submission. The Safety & Security Time Series Read-Me material states that the "SSO Annual Reports are used to provide probable cause data for each reported incident; and to provide additional insight into the nature and consequences of the reported incidents" (*37*).

Federal Railroad Administration – Office of Safety Analysis

FRA's accident/incident reporting requirements, found in 49 CFR Part 225, are currently issued under the dual statutory authority of the Accident Reports Act of 1910 and the Federal Safety Act of 1970 (*38*). The three primary groups of reportable accidents/incidents include highway-rail grade crossing (Form FRA F 6180.57); rail equipment (Form FRA F 6180.54); and death, injury, or occupational illness (Form FRA F 6180.55a). Some situations require multiple forms to be utilized, such as a highway-rail grade crossing collision resulting in reportable injuries (6180.57 and 6180.55a).

According to the *FRA Guide for Preparing Accident/Incident Reports* in reference to Form F 6180.55a – Railroad Injury and Illness Summary (Continuation Sheet), "a report must be made for each fatality and each injury that requires medical treatment beyond first aid, results in loss of consciousness, or meets the definition of significant injury, that is discernibly caused by an event or exposure arising from the operation of the railroad. There is a general presumption that any death or injury that occurs on a railroad's premises, more likely than not, is related to the operation of the railroad." FRA uses a classification system for affected persons, with two of the classifications related to pedestrian activity on railroad property. These two categories are defined below, along with a listing of the remaining categories grouped as Other Categories for this analysis. The classifications of non-worker persons include the following definitions:

- **Non-trespassers—on railroad property –** persons lawfully on that part of railroad property that is used in railroad operation (other than those herein defined as employees, passenger, trespassers, volunteers, or contractor employees), and persons adjacent to railroad premises when they are injured as the result of the operation of a railroad. This class also includes other persons on vessels or buses, whose use arises from the operation of a railroad.
- **Trespassers –** persons who are on the part of railroad property used in railroad operation and whose presence in prohibited, forbidden, or unlawful. A person on a highway-rail grade crossing should not be classified as a trespasser unless: a) the crossing is protected by gates or other similar barriers, which were closed when the person went on the crossing, or b) the person attempted to pass over, under, or between cars or locomotives of a consist occupying the crossing. A person or vehicle that enters the crossing without a physical barrier (e.g., gates in a lowered position) is not classified as a trespasser, even when the highway-rail grade crossing lights are activated or other warning systems are functioning. The person would be classified as a non-trespasser.
- **Other Categories –** The classifications combined in this category include Worker on Duty – Employee; Employee Not on Duty; Worker on Duty – Contractor; Contractor – Other; Passengers on Trains; and Non-Trespasser – Off Railroad Property.

For Form FRA F 6180.57 – Highway-Rail Grade Crossing Accident/Incident Report, the guide indicates "any impact, regardless of severity, between railroad on-track equipment and a highway user at a highway-rail grade crossing site, is to be reported." Highway users include automobiles, buses, trucks, motorcycles, bicycles, farm vehicles, pedestrians, or other mode of surface transportation motorized and un-motorized. The term highway-rail grade crossing is defined as:

1. A location where a public highway, road, or street, or a private roadway, including associated sidewalks, crosses one or more railroad tracks at grade.
2. A location where a pathway explicitly authorized by a public authority or a railroad carrier that is dedicated for the use of non-vehicular traffic, including pedestrians, bicyclists, and others, that is not associated with a public highway, road, or street, or a private roadway, crosses one or more railroad tracks at grade.

The FRA Office of Safety Analysis maintains a publicly available website (safetydata.fra.dot.gov) that contains pre-developed queries and full databases for download. The downloadable online databases available were current through December 31, 2012, as of March 24, 2013, and include:

- Highway Rail Accidents (Form F 6180.57).
- Railroad Casualties (Form F 6180.55a).
- Operational Data (Form F 6180.55).

The Highway Rail Accident database maintains over 100 fields of data, while the Railroad Casualties database maintains 50 fields that can be utilized for evaluation. Each event has a unique identifier, which allows for cross-referencing between the two databases. The Highway Rail Accident database has one record per event, while the Railroad Casualties database has a record for each person injured or killed during the event. For the purpose of understanding the event in more detail, one of the most valuable fields is the narrative provided in the accident/incident report.

DATABASE ANALYSIS

This section provides analysis of the most current FTA, NTD, and FRA databases, along with data analysis results documented in recent studies.

Light Rail and Streetcar

As indicated above, the NTD Safety and Security data lag approximately 90 days behind. Therefore, the available data are through December 2012 for reported data through April 1, 2013. Table 1 and Figure 1 present the pedestrian-specific safety data included in the NTD for 2008 to 2012. Beginning in 2012, the data provide segregation of the light-rail designations into light rail and streetcar. Table 1 contains the total combined light rail-streetcar fatalities and injuries for 2008 to 2011, and the separate light rail and streetcar fatalities and injuries for 2012. The table only contains the pedestrian categories and excludes other categories, such as Bicyclists, Trespassers, or Suicides.

Approximately 41 percent (64 out of 156) of the total fatalities involving pedestrian-light rail or streetcar transit rail vehicles between 2008 and 2012 were pedestrians, according to Table 1. However, pedestrian injuries for that time period only accounted for approximately 4 percent (179 out of 4,880) of all injuries. The percentage of each pedestrian category for fatalities and injuries is presented in Figure 1. The top pedestrian categories for both fatalities and injuries compared to other pedestrian categories were Pedestrians Crossing Tracks and Pedestrian in Crossing.

Table 1. Pedestrian fatalities and injuries reported by transit agencies operating light rail and streetcar transit systems, 2008–2012.

Year	2008	2009	2010	2011	2012		Total
Mode	LR & SR Combined				LR	SR	
Fatalities							
Total Pedestrian Fatalities	7	18	9	13	17	0	64
• Pedestrian in Crossing	3	5	2	6	3	0	19
• Pedestrian Not in Crossing	2	4	1	1	1	0	9
• Pedestrian Crossing Tracks	1	4	4	4	7	0	20
• Pedestrian Walking Along Tracks	1	5	2	2	6	0	16
Total Non-Pedestrian Fatalities	10	16	15	23	28	0	92
Total All Fatalities	**17**	**34**	**24**	**36**	**45**	**0**	**156**
Injuries							
Total Pedestrian Injuries	36	31	35	39	36	2	179
• Pedestrian in Crossing	15	9	12	12	10	0	58
• Pedestrian Not in Crossing	3	6	6	8	5	0	28
• Pedestrian Crossing Tracks	12	9	10	15	15	2	63
• Pedestrian Walking Along Tracks	6	8	7	4	6	0	31
Total Non-Pedestrian Injuries	980	1,046	890	929	808	48	4,701
Total All Injuries	**1,016**	**1,077**	**925**	**968**	**844**	**50**	**4,880**

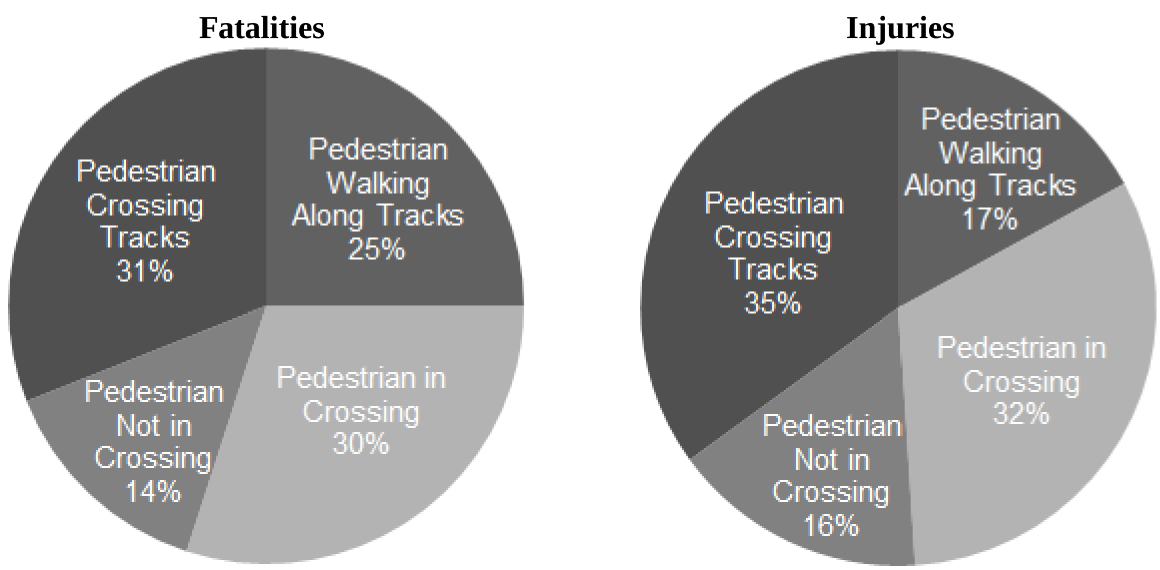


Figure 1. Percentage of total 5-year pedestrian fatalities and injuries.

Several mode definition adjustments were made as part of the analysis in order to match the system designations listed by APTA and presented earlier in this document. These adjustments include:

- Little Rock, AR (River Rail Streetcar): from Light Rail (LR) to Streetcar (SR).
- Newark, NJ (Newark Light Rail): from Hybrid Rail (YR) to LR.
- Oceanside, CA (NCTD Sprinter): from YR to LR.
- Philadelphia, PA (SEPTA Light Rail): from SR to LR.
- San Francisco, MUNI: from Cable Car (CC) to SR.

Hybrid rail is defined as a rail system primarily operating routes on the national system of railroads, but not operating with the characteristics of commuter rail. The service typically operates light rail-type vehicles. Other hybrid rail designated systems, such as in Austin, TX (Capital MetroRail), are not included in the safety incident data because safety oversight for these transit agencies falls under FRA (*37*).

Several recent studies examined pedestrian safety at light transit rail systems. In TCRP Web-Only Document 42, the authors characterized the findings of previous TCRP reports. In the review of TCRP Report 17, it is stated that "accidents between pedestrians and LRVs are the least common type of LRT-related accident" (*12*). Both TCRP 17 and TCRP 69 indicate that although crashes between pedestrians and LRVs are not common, the consequences are often severe, according to TCRP Web-Only Document 42.

TCRP Web-Only Document 42 contains selected appendices of TCRP Report 137 *Improving Pedestrian and Motorist Safety Along Light Rail Alignments*. The project team for TCRP Report 137 performed an extensive evaluation of the available LRT safety data from local transit agencies, SSOs, and the NTD. The analysis of the NTD for the years 2002 to 2007 discovered that "the risk of fatality compared to injury is much higher for collisions between LRT vehicles and pedestrians (79.4 percent of the 63 fatal collisions involved a pedestrian and 24.8 percent of all LRT collisions involving a pedestrian were fatal)" (*5*). This characteristic is demonstrated in the analysis of provided local agency data, with collisions with pedestrians accounting for 75 percent of the fatalities and 33 percent of the injuries.

The FTA *2009 Rail Safety Statistics Report* provides analysis of safety data reported by SSO agencies and transit rail agencies for the years 2003 to 2008. The pedestrian-related findings in this analysis showed that 39 of the 382 public fatalities were pedestrians involved in collisions and that pedestrian actions caused 61 percent of light rail collision public fatalities (*39*).

Commuter Railroads

FTA, in collaboration with FRA, performed a safety analysis of the US commuter railroads. The November 2006 *Commuter Rail Safety Study* set out to identify the most frequent, highest risk causes of commuter rail accidents. It utilized the data from FRA's Office of Safety Analysis forms discussed earlier, using in-depth reports from commuter railroads for the 79-month study period between January 1, 2000, and July 31, 2006, and summary data for the 10-year period between January 1, 1996, and December 31, 2005 (*40*). The study included the 18 commuter railroads receiving FTA funding, plus the Alaska Railroad.

The *Commuter Rail Safety Study* provides an important note related to pedestrian collisions with commuter trains within FRA databases. It states within the definition of a trespasser that "a person on a highway-rail crossing is not classified as a trespasser unless the crossing is protected by gates, or other similar barriers that were closed when the person went on the crossing" (*40*). If the crossing has no physical barrier, such as only flashing lights, then the person would be classified as a non-trespasser.

Some of the pertinent findings for the 10-year period between 1996 and 2005 include a decline of 22 percent in the total number of annual accidents and incidents, despite a stated increase of the number of annual passenger transport by 50 percent and increase of the number of annual passenger miles of service by 40 percent.

The more in-depth 79-month period between January 1, 2000, and July 31, 2006, found that fatalities totaled 526 with Type of Person listed as 26 (5 percent) non-trespassers on railroad property and 463 (88 percent) trespassers. As an Event, highway-rail collision/impact fatalities were categorized as 132 trespassers and 12 non-trespassers on railroad property, out of 145 total highway-rail collision/impact fatalities. The only other fatality was a passenger on the train.

Over the 79-month period, injuries totaled 11,900 with the Type of Person listed as 1,038 (11 percent) non-trespassers on railroad property and 294 (2 percent) trespassers. As an Event, highway-rail collision/impact injuries were categorized as 127 trespassers and 33 non-trespassers on railroad property, out of 259 total highway-rail collision/impact injuries.

The FRA 2012 Operational Data database contains 810 different railroad reporting marks, with 185 railroad reporting marks containing passenger movements. These include the 24 US commuter rail systems, Amtrak, Alaska Railroad, and some light rail systems. The remaining entities, not included in this analysis, are tourism trains or railroads that moved some sort of passenger excursion train during the year. Utilizing the analysis format undertaken by the *Commuter Rail Safety Study*, Table 2 contains commuter rail fatality and injury-related data analyses for the latest 5-year period.

Table 2 shows a total of 414 fatalities and 10,233 injuries occurred between 2008 and 2012. Trespassers made up 86 percent of the fatalities but only 3 percent of the total injuries, when compared to the other types of people involved.

A review of the Events listed as highway-rail collisions/impacts finds that for the 5-year period, a total of 85 fatalities and 199 injuries were captured in the data. The Type of Person listed as trespasser resulted in 74 fatalities and 93 injuries; while the Type of Person listed as non-trespasser on railroad property resulted in 11 fatalities and 15 injuries.

Table 2. Commuter rail fatalities and injuries by type of person.

Year / Type of Person	2008	2009	2010	2011	2012	Total	% of Total
Fatalities							
Non-Trespasser on Railroad Property	4	0	3	5	7	19	5%
Trespasser	75	63	10	64	84	356	86%
Other Categories	29	3	2	3	2	39	9%
Total All Fatalities	**108**	**66**	**75**	**72**	**93**	**414**	**100%**
Injuries							
Non-Trespasser on Railroad Property	466	476	515	506	404	2,367	23%
Trespasser	48	51	67	50	67	283	3%
Other Categories	1,583	1,514	1,531	1,546	1,409	7,583	74%
Total All Injuries	**2,097**	**2,041**	**2,113**	**2,102**	**1,880**	**10,233**	**100%**

One issue with FRA data is that no one or two variables can be used to capture the entire population of pedestrian-train collisions at dedicated crossing locations. Several combinations of variables within FRA databases broadly describe the scenarios experienced during those collision types. One option to ascertain more detailed information from FRA data is to examine the narratives included for each record, where populated. In general, the descriptions provide an explanation from the railroad's perspective of the details related to the incident. Below are several paraphrased sample narratives related to pedestrian collisions with commuter trains found in FRA databases:

- Location – grade crossing; Circumstance – pedestrian walks around gate arms; Type of Person – trespasser.
  The victim attempted to cross over the tracks at crossing after the gates lowered to catch up with his wife who was on the westbound platform. He was struck by eastbound train. Collision was fatal.
- Location – sidewalk at other rail crossing in passenger terminal; Circumstance – distracted pedestrian; Type of Person – non-trespasser on railroad property.
  A pedestrian using their cell phone failed to yield at crosswalk to train entering the station and was struck by train. Collision was non-fatal.
- Location – grade crossing; Circumstance – distracted pedestrian; Type of Person – trespasser.
  A 14-year-old male wearing headphones walked around activated gates and was struck by the train. Collision was fatal.
- Location – grade crossing; Circumstance – person in wheelchair disregarded gates; Type of Person – trespasser.
  Subject in motorized wheelchair attempted to cross the tracks while the gates were down and was struck by the train. Collision was non-fatal.

CHAPTER 4: ONLINE SURVEY OF PRACTITIONERS

INTRODUCTION

This chapter provides a summary of the findings from a web-based survey of practitioners at transit agencies in the United States. The survey, conducted through the internet, asks practitioners for information on current and previous treatments used to reduce conflicts between pedestrians and rail vehicles, as well as other approaches they have used with respect to pedestrian safety at transit rail crossings. The survey also asks respondents what types of transit services their transit agency provides, and it asks respondents to provide contact information for possible follow-up questions by telephone and/or email.

SURVEY ADMINISTRATION

Based on information obtained through Task 1 activities, researchers developed a list of questions to ask transit agency practitioners about their experiences with various treatments related to pedestrian safety at transit rail crossings. Details from references used in Task 1, along with the research team's professional contacts and information from the project's panel members, led researchers to compile a list of practitioners who would be potential respondents to an invitation to complete the survey. Researchers invited those practitioners to participate in the survey via an email, which is reproduced in Figure 2. The email was sent to over 80 individuals representing 46 transit agencies and the project panel members and liaisons. More than one practitioner within an agency may have received the request.

Practitioners who agreed to participate in the survey clicked on the link provided in the email and were taken to a website containing the survey form that they could complete and submit to the research team. The survey was formatted such that survey respondents were presented with 26 questions, though most of the responses requested were merely multiple choices within seven primary questions:

1. What type(s) of transit rail service(s) does your transit agency operate?
2. Which of the following treatments does your transit agency currently use to reduce conflicts between pedestrians and rail vehicles?
3. Has your transit agency tried any treatments listed in the previous questions that you later removed? If yes, which treatments?
4. Which of the following approaches has your transit agency used to identify, evaluate, and/or improve pedestrian safety at transit rail crossings?
5. Please provide any comments/observations regarding treatments, devices, or strategies for improving conditions for pedestrians crossing transit rail tracks.
6. Would you be willing to be contacted by a member of the research team to discuss pedestrian crossing treatments or issues?
7. Please provide your name, agency, email address, and phone number.

The entirety of the survey in the format that respondents viewed, including introductory and concluding remarks, is reproduced in Figure 3 through Figure 10.

The Texas A&M Transportation Institute (TTI) is conducting a research project sponsored by the Transit Cooperative Research Program (TCRP) to develop a ***Guidebook for Pedestrian Crossings for Public Transit Rail Services.*** As part of this project, we are investigating the types of treatments that transit agencies use to improve pedestrian crossing safety at public transit rail services crossings (i.e., light rail, commuter rail, and streetcar).

Your transit agency was identified as one that may offer insights on current pedestrian safety treatments for public transit rail services. **We are conducting an online survey to obtain this information.** If you are willing to participate, please complete the 6-question, mostly multiple-choice, survey available at the following link: (link provided)

If another person in your transit agency is more suitable for this effort, we would ask your help in contacting that individual.

We designed the survey so your response time is minimal and would like your response by May 22, 2013.

If you have any questions about the survey, please contact me through one of the points of contact noted below. If you have general questions about the research project, you can contact me as TTI's Principal Investigator, or you can contact Dianne Schwager, TCRP Senior Program Officer.

Additional information about TCRP A-38 project is available at: (link provided)

Figure 2. Survey invitation email sent to practitioners.

Dear Practitioner,

Thank you for agreeing to participate in this survey. The primary goal of this project is to develop a guidebook for safe and effective treatments for pedestrian crossings for public transit rail services, including light rail, commuter rail, and streetcar services. The guidebook will, at a minimum:

- Present effective options considering rail vehicle speed and frequency, geometry of the crossing, sight lines for pedestrians and rail vehicle operators, and operating environment.
- Include drawings, illustrations, or photos of treatments and ranges of costs.
- Provide guidance for planning and implementation.

As part of that project, we are seeking to understand the current state of the practice in transit agencies across the country. We ask for your assistance in completing the survey on the following pages and we thank you for contributing your time and expertise to this research.

If you have questions about the project in general, you can contact Kay Fitzpatrick, TTI Principal Investigator or Dianne Schwager, TCRP Senior Program Officer.

Additional information about the TCRP A-38 project is available at: (link provided)

Please click the "Next" button below to start the survey.

There are 26 questions in this survey.

Figure 3. Introduction to online survey.

Type of Transit rail Service Operated

1. What type(s) of transit rail service(s) does your transit agency operate?
Please choose **all** that apply:
- ❑ Light Transit rail
- ❑ Commuter Transit rail
- ❑ Streetcar Transit

Figure 4. First question of online survey.

Pedestrian Crossing Treatments Currently in Use
Which of the following treatments does your transit agency currently use to reduce conflicts between pedestrians and rail vehicles? (Please check all that apply)

2. Barriers
Please choose **all** that apply:
- ❑ Channelization/fencing at approach to grade crossing
- ❑ Channelization/fencing at other locations
- ❑ Pedestrian automatic gate
- ❑ Pedestrian automatic gate with horizontal hanging bar (also known as gate skirts)
- ❑ Pedestrian swing gates

3. Design
Please choose **all** that apply:
- ❑ Changes to stop/terminal design
- ❑ Flangeway gap treatment
- ❑ Illumination/lighting
- ❑ Mirrors
- ❑ Offset pedestrian crossing (also known as Z-pedestrian crossing)
- ❑ Pedestrian refuge areas
- ❑ Removable barriers
- ❑ Sidewalk or pathway changes to improve accessibility
- ❑ Sidewalk relocation (move sidewalk away from gate arm counterweight)
- ❑ Sight distance improvements – relocate or eliminate restrictions

4. Education & Enforcement
Please choose **all** that apply:
- ❑ Education campaigns
- ❑ Enforcement officers

5. Markings
Please choose **all** that apply:
- ❑ Detectable warnings (truncated domes) on sidewalk or pathway surface
- ❑ Dynamic envelope markings (longitudinal lines)
- ❑ Pavement markings (words on pavement)
- ❑ Stop lines on sidewalk or pathway surface

6. Operations
Please choose **all** that apply:
- ❑ Required stop for all outbound trains
- ❑ Reduced speed limit for entering crossing

7. Signals
Please choose **all** that apply:
- ❑ Audible crossing warning devices
- ❑ Flashing light signals
- ❑ In-pavement flashing lights
- ❑ Low-rise flashing lights
- ❑ Pedestrian signals
- ❑ Accessible pedestrian signals

8. Signing
Please choose **all** that apply:
- ❑ Second train warning signs (static or active)
- ❑ Signs with beacons that are continuously active
- ❑ Signs with beacons that become active when train is approaching
- ❑ Static signs at crossing
- ❑ Static signs on roadway/pathway approaches
- ❑ Warning signs for enforcement at crossing

9. What other types of treatments does your agency currently use?
Please write your answer here:

Figure 5. Questions 2–9 of online survey.

Pedestrian Crossing Treatment Removal
10. Has your transit agency installed any pedestrian crossing treatments listed in the previous question (also listed below) that were later removed? Please choose **only one** of the following: Yes No
(*NOTE: Questions 11–19 [that repeated questions 2 to 9] appeared on the respondent's screen only if the answer to Question 10 was "Yes." Otherwise, the respondent was directed to Question 20.)*

Figure 6. Questions 10–19 of online survey.

Pedestrian Safety Approaches
20. Which of the following approaches has your transit agency used to identify, evaluate, and/or improve pedestrian safety at transit rail crossings? Please choose **all** that apply: a. Consultation with organizations of or for people with disabilities. b. Enforcement efforts at specific location(s). c. General survey of transit passengers on pedestrian safety issues. d. General survey of non-passengers on pedestrian safety issues. e. "Close Call" reporting/documentation system. f. Pedestrian safety study at specific location(s). g. Safety audit/diagnostic team review of pedestrian crossings. h. Safety educational/outreach to passengers. i. Safety educational/outreach to non-passengers. j. System-wide enforcement efforts. k. System-wide pedestrian safety study. l. Systematic review of pedestrian-rail crossing devices/treatments. m. Other:

Figure 7. Question 20 of online survey.

Additional Comments/Observations
21. Please provide any comments/observations regarding devices, treatments, or strategies to improve pedestrian safety at transit rail crossings. Please write your answer here:

Figure 8. Question 21 of online survey.

Contact Information
22. Would you be willing to be contacted by a member of the research team to discuss pedestrian crossing treatments or issues? Please choose **only one** of the following: Yes No
23. Your Name: Please write your answer here:
24. Transit Agency: Please write your answer here:
25. EMail Address: Please write your answer here:
26. **Phone:** Please write your answer here:

Figure 9. Questions 22–26 of online survey.

Thank you for participating in this survey. Your responses will be helpful in generating the guidebook for safe and effective treatments for pedestrian crossings for public transit rail services. For more information about the TCRP A-38 project, please click on the link below or close this window to end your session. (link provided) Thank you for completing this survey.

Figure 10. Conclusion to online survey.

SURVEY RESPONSES

The website for the online survey was active from May 1 to May 24, 2013. During that time, the survey was accessed 30 times from 26 unique IP addresses, suggesting that four respondents began the survey and then returned to it again at a later time. Of the 30 times the survey was accessed, it was completed 13 times. The remainder of this section will summarize the results from the 13 completed surveys.

Question 1: Type of Transit Rail Service

Respondents were presented with three types of transit rail service and asked which of those three types were provided by their transit agency. Results from the 13 respondents are summarized in Table 3. Both of the agencies in this survey that do not offer light transit rail offer commuter transit rail, and the two agencies offering streetcar transit indicated that they provide all three types of service described in the survey.

Table 3. Type of transit rail service offered by respondents' transit agencies.

Type	Light Transit rail	Commuter Transit rail	Streetcar Transit
Affirmative Responses	11	8	2

Question 2: Treatments Currently in Use

The survey asked respondents to indicate which of 35 different pedestrian safety treatments their transit agencies currently used; it also asked them to describe any other treatments they use that were not specifically listed. Responses to this question are summarized in Table 4, with treatments listed in the order they were presented in the survey. Every treatment had at least one response, and each of the treatment categories except for Operations had at least one treatment with eight or more responses, suggesting that transit agencies are utilizing a variety of approaches in addressing pedestrian safety. The most commonly cited treatments were detectable warnings on sidewalks and static signs at crossings, both of which were used by 11 agencies. Sight distance improvements and education campaigns were acknowledged by 10 respondents. The four other treatments mentioned by respondents are listed below:

- "LOOK signs on pavement in addition to STOP - if STOP is farther than 16 ft from centerline, or if LOOK provides improved site distance. STOP HERE WHEN RED LIGHTS ARE FLASHING sign on fence identifying where to stop, and reinforcing rules. Have Distracted Pedestrian UTA Ordinance as additional reinforcement effort.

Table 4. Pedestrian treatments currently in use.

Treatment	Responses
Barriers [Channelization/fencing at approach to grade crossing]	8
Barriers [Channelization/fencing at other locations]	9
Barriers [Pedestrian automatic gate]	5
Barriers [Pedestrian automatic gate with horizontal hanging bar (also known as gate skirts)]	1
Barriers [Pedestrian swing gates]	6
Design [Changes to stop/terminal design]	4
Design [Flangeway gap treatment]	5
Design [Illumination/lighting]	9
Design [Mirrors]	6
Design [Offset pedestrian crossing (also known as Z-pedestrian crossing)]	9
Design [Pedestrian refuge areas]	8
Design [Removable barriers]	3
Design [Sidewalk or pathway changes to improve accessibility]	7
Design [Sidewalk relocation (move sidewalk away from gate arm counterweight)]	4
Design [Sight distance improvements – relocate or eliminate restrictions]	10
Education & Enforcement [Education campaigns]	10
Education & Enforcement [Enforcement officers]	8
Markings [Detectable warnings (truncated domes) on sidewalk or pathway surface]	11
Markings [Dynamic envelope markings (longitudinal lines)]	3
Markings [Pavement markings (words on pavement)]	9
Markings [Stop lines on sidewalk or pathway surface]	9
Operations [Required stop for all outbound trains]	4
Operations [Reduced speed limit for entering crossing]	5
Signals [Audible crossing warning devices]	8
Signals [Flashing light signals]	8
Signals [In-pavement flashing lights]	1
Signals [Low-rise flashing lights]	2
Signals [Pedestrian signals]	9
Signals [Accessible pedestrian signals]	2
Signing [Second train warning signs (static or active)]	8
Signing [Signs with beacons that are continuously active]	2
Signing [Signs with beacons that become active when train is approaching]	3
Signing [Static signs at crossing]	11
Signing [Static signs on roadway/pathway approaches]	8
Signing [Warning signs for enforcement at crossing]	6
What other types of treatments does your agency currently use?	4

Table 5. Pedestrian safety treatments in use by type of rail service offered.

Treatment	Number of Agencies Indicating Treatment Use*			
	L (n=5)	C (n=2)	L/C (n=4)	L/C/S (n=2)
Barriers [Channelization/fencing at approach]	3	0	3	2
Barriers [Channelization/fencing at other]	4	0	3	2
Barriers [Pedestrian automatic gate]	2	1	1	1
Barriers [Gate Skirts]	0	0	1	0
Barriers [Pedestrian swing gates]	3	0	2	1
Design [Changes to stop/terminal design]	2	1	1	0
Design [Flangeway gap treatment]	1	0	2	2
Design [Illumination/lighting]	4	0	3	2
Design [Mirrors]	2	1	2	1
Design [Offset pedestrian crossing]	3	1	3	2
Design [Pedestrian refuge areas]	4	0	3	1
Design [Removable barriers]	1	0	1	1
Design [Sidewalk or pathway changes]	2	0	4	1
Design [Sidewalk relocation]	0	0	2	2
Design [Sight distance improvements]	3	1	4	2
Education & Enforcement [Education campaigns]	3	1	4	2
Education & Enforcement [Enforcement officers]	2	1	3	2
Markings [Detectable warnings]	4	2	3	2
Markings [Dynamic envelope markings]	1	0	1	1
Markings [Pavement markings]	5	0	2	2
Markings [Stop lines on sidewalk or pathway]	4	0	3	2
Operations [Required stop for outbound trains]	1	0	2	1
Operations [Reduced speed limit]	2	0	2	1
Signals [Audible crossing warning devices]	3	0	4	1
Signals [Flashing light signals]	2	1	3	2
Signals [In-pavement flashing lights]	1	0	0	0
Signals [Low-rise flashing lights]	0	0	1	1
Signals [Pedestrian signals]	4	0	4	1
Signals [Accessible pedestrian signals]	0	0	1	1
Signing [Second train warning signs]	3	0	4	1
Signing [Signs with continuous beacons]	0	0	1	1
Signing [Signs with train-activated beacons]	1	0	2	0
Signing [Static signs at crossing]	4	1	4	2
Signing [Static signs on approaches]	4	1	2	1
Signing [Warning signs for enforcement]	1	0	3	2
Other Types of Treatments	2	0	1	1
*Type of Rail Service Offered by Agency: (L = Light Rail, C = Commuter Rail, S = Streetcar Rail)				

- We use pedestrian poles (with wires in between) at most of our stations to separate the trackway from the street. This prevents pedestrians from jaywalking between the

platform and sidewalk across the tracks and street and channels them to the crosswalk at either end of the platform.
- Audible Pedestrian Units in certain low noise areas.
- Active warning devices such as W10 with Flashers and EMS [Extinguishable Message Sign] signs. And active train approach signs at some crossings."

The two transit agencies that provided only commuter rail each used only six of the 35 suggested treatments, the five agencies offering only light rail service varied between 12 and 24 treatments, and the two agencies offering all three services listed 24 and 22 of the treatments. The distribution of treatments by the type of rail services offered is shown in Table 5.

Transit agencies offering light rail services used a wide variety of treatments listed in the survey. Those five agencies used 31 of the 35 treatment options suggested, along with two other treatments not specifically mentioned. The only treatments they did not use were gate skirts, sidewalk relocation, low-rise flashing lights, and second train warning signs. All five light-rail agencies used word markings on the pavement, and eight other treatments were used by four of the five agencies.

Transit agencies offering only commuter rail had the least variety of treatments, using only 11 of the 35 suggested options. The only treatment used by both commuter rail agencies was detectable warnings on sidewalk or pathway surfaces.

The four transit agencies that offered both light rail and commuter rail had the widest variety of treatments, using all but one of the 35 suggested options and one other treatment. The only treatment not used by these agencies was in-pavement flashing lights. The following treatments were used by all four agencies:
- Sidewalk or pathway changes to improve accessibility.
- Sight distance improvements – relocate or eliminate restrictions.
- Education campaigns.
- Audible crossing warning devices.
- Pedestrian signals.
- Second train warning signs (static or active).
- Static signs at crossing.

Though there were only two agencies that offered all three types of transit rail being considered in the survey, they used all but four of the 35 treatment options and one other treatment. This is not surprising considering the variety of terminals and transit stops, as well as the potential number of other pedestrian crossings that can be associated with three transit rail systems. The only treatments they did not use were:
- Pedestrian automatic gate with horizontal hanging bar (gate skirts).
- Changes to stop/terminal design.
- In-pavement flashing lights.
- Sign with beacons that become active when train is approaching.

Even with the fewer responses by commuter rail agencies, there did not appear to be any category of treatment that was especially emphasized or avoided by any agency. Barriers, design treatments, education/enforcement, markings, operational treatments, signals, and signing all had representation on a relatively widespread basis.

Question 3: Treatments Removed from Use

The survey asked respondents to indicate if they had removed any pedestrian crossing treatments that were previously installed. Only one respondent indicated that the agency had done so. The response revealed that three treatments (pedestrian swing gates, sidewalk relocation, and low-rise flashing lights) had all been previously installed and then later removed. The transit agency represented by this response offers both light rail and commuter rail services.

Question 4: Approaches to Identify, Evaluate, and Improve Pedestrian Safety

The survey asked respondents to indicate if they had used any of the 12 particular methods or approaches to identify potential pedestrian safety issues or otherwise evaluate and/or improve pedestrian safety at transit rail crossings. Responses to this question are summarized in Table 6, listed in descending order of number of responses. Every suggested approach had at least four responses, and six had at least eight responses, again suggesting that transit agencies are considering a variety of methods to improve pedestrian safety. The most commonly cited approaches were safety/education outreach programs to passengers and to non-passengers, both of which were used by 11 agencies. A close call reporting system was used by 10 respondents. The three other approaches with at least eight responses included enforcement efforts at specific location(s), safety audit/diagnostic team review of pedestrian crossings, and systematic review of pedestrian-rail crossing devices/treatments.

Table 6. Approaches to identify, evaluate, and improve pedestrian safety.

Treatment	Responses
Safety educational/outreach to passengers.	11
Safety educational/outreach to non-passengers.	11
Close Call reporting/documentation system.	10
Enforcement efforts at specific location(s).	9
Safety audit/diagnostic team review of pedestrian crossings.	9
Systematic review of pedestrian-rail crossing devices/treatments.	8
Pedestrian safety study at specific location(s).	7
Consultation with organizations of or for people with disabilities.	5
System-wide enforcement efforts.	5
System-wide pedestrian safety study.	4
General survey of transit passengers on pedestrian safety issues.	3
General survey of non-passengers on pedestrian safety issues.	3
Other	0

The distribution of treatments by the type of rail services offered is shown in Table 7. Among the five transit agencies offering only light rail service, all of them used a Close Call system, while four other treatments (safety audit/diagnostic team review of pedestrian crossings, safety educational/outreach to passengers, safety educational/outreach to non-passengers, and systematic review of pedestrian-rail crossing devices/treatments) were each listed by four agencies. The same four agencies did not use all four of those methods, but three agencies had all of those approaches in common. Overall, each of the five light transit rail agencies reported using five to seven of the approaches listed.

Table 7. Pedestrian safety approaches in use by type of rail service offered.

Approach	Number of Agencies Indicating Treatment Use*			
	L (n=5)	C (n=2)	L/C (n=4)	L/C/S (n=2)
Consultation with orgs of/for people with disabilities.	1	1	1	2
Enforcement efforts at specific location(s).	2	1	4	2
Survey of passengers on pedestrian safety issues.	0	0	2	1
Survey of non-passengers on safety issues.	0	0	2	1
Close Call reporting/documentation system.	5	1	3	1
Pedestrian safety study at specific location(s).	2	0	3	2
Safety audit/diagnostic team review of crossings.	4	1	2	2
Safety educational/outreach to passengers.	4	1	4	2
Safety educational/outreach to non-passengers.	4	1	4	2
System-wide enforcement efforts.	1	0	2	2
System-wide pedestrian safety study.	1	0	1	2
Systematic review of crossing devices/treatments.	4	0	2	2
Other	0	0	0	0
*Type of Rail Service Offered by Agency: (L = Light Rail, C = Commuter Rail, S = Streetcar Rail)				

The two transit agencies that provided only commuter rail used six of the 12 suggested approaches, though five of them were used by one agency and the other agency used only the Close Call system. Among the four agencies offering both light rail and commuter rail, every approach was used at least once; these four agencies were fairly active, each responding affirmatively to between five and 10 approaches. All of them used enforcement efforts at specific locations, safety educational/outreach to passengers, and safety educational/outreach to non-passengers. As in Question 2, the two agencies offering all three types of rail services were the most active, listing 9 and 12 of the approaches as being currently used.

Question 5: Other Comments and Observations

The survey asked respondents to provide any comments/observations regarding devices, treatments, or strategies to improve pedestrian safety at transit rail crossings. The intent of this question was to determine if there was a topic not previously addressed in the survey that a respondent deemed important and relevant to the study. Five respondents provided comments to this question; two of them were from transit agencies that offered only light rail services, two agencies offered both light rail and commuter rail, and one offered all three types considered in the survey. The five responses, verbatim from survey responses, were as follows:

- "Each crossing is unique - so rigid standards are difficult. General guidelines, distances, devices to be implemented should be provided with 'adjust as needed at each crossing' Provide general guidelines to initiate the design efforts. Design systems to fail safe. Maximize visibility at crossings and along the corridors. Minimize trespassing and hiding opportunities. Provide appropriate lighting, and required emergency backup power. Minimize pedestrian crossings at approach ends of platforms. No straight approaches to or across stations. Implement appropriate safety treatments, such as: (*remainder of answer truncated by survey software for exceeding maximum allowed length*).

- Enforcement, while not always easy or politically attractive, is by far the best means of demonstrating that an agency is serious about compliance.
- Keeping things consistent throughout a system is important so people in the region know what to expect when encountering a crossings. Also, going back and retrofitting older crossings with newer technologies to enhance crossings is important.
- Regardless of the amount or type of devices used, responsibility for pedestrian safety also needs to be shared by the pedestrian. In many cases, we have found that despite the several devices installed, pedestrians continue to ignore or disregard them and take unnecessary risks.
- Devices and treatments meet MUTCD but no formal program or strategies for pedestrian safety improvements."

Questions 6 and 7: Potential Follow-Up and Respondent Contact Information

The survey asked respondents if they would be willing to be contacted by a member of the research team to further discuss pedestrian crossing safety. Eleven of the 13 respondents gave a positive response in Question 6, and in Question 7 all of those 11 provided their name, transit agency, email address, and/or telephone number.

FINDINGS

Several findings can be made from the results to the online survey of transit agency practitioners. Those findings, based on the 13 completed responses to the survey, are as follows:

- Among the 35 treatments suggested, static signs at crossings, detectable warnings on sidewalk and pathway surfaces, sight distance improvements, and education campaigns were nearly universal in their current use by respondents, used by either 10 or 11 of the 13 practitioners who completed the survey.
- In addition to the four treatments listed above, 13 of the 35 treatments were used by at least eight respondents:
    - Channelization/fencing at approach to grade crossing.
    - Channelization/fencing at other locations.
    - Illumination/lighting.
    - Offset pedestrian crossing (also known as Z-pedestrian crossing).
    - Pedestrian refuge areas.
    - Enforcement officers.
    - Pavement markings (words on pavement).
    - Stop lines on sidewalk or pathway surface.
    - Audible crossing warning devices.
    - Flashing light signals.
    - Pedestrian signals.
    - Second train warning signs (static or active).
    - Static signs on roadway/ pathway approaches.

- Every treatment had at least one response, and each of the treatment categories except for Operations had at least one treatment with eight or more responses, suggesting that transit agencies are utilizing a variety of approaches in addressing pedestrian safety. Gate skirts, in-pavement flashing lights, and low-rise flashing lights were rarely used by respondents.
- Transit agencies providing only light rail services tended to implement more treatments (12 to 24 per agency) than those offering only commuter rail services (six per agency).
- For agencies offering more than one type of rail service, the variety and frequency of the treatments they used was typically greater than agencies with only one type of service. This is not surprising considering the variety of terminals and transit stops, as well as the potential number of other pedestrian crossings, which can be associated with three transit rail systems.
- Only one respondent indicated that the agency had removed any pedestrian crossing treatments that were previously installed. The response revealed that three treatments (pedestrian swing gates, sidewalk relocation, and low-rise flashing lights) had all been previously installed and then later removed. The transit agency represented by this response offers both light rail and commuter rail services.
- Of the 12 approaches to identify, evaluate, and improve pedestrian safety concerns, all of them had at least four agencies that indicated they currently used them, and half of the 12 approaches had at least eight responses, again suggesting that transit agencies are considering a variety of methods to improve pedestrian safety. Surveys, of either passengers or non-passengers, were rarely used.
- The most commonly cited approaches were safety/education outreach programs to passengers and to non-passengers, both of which were used by 11 agencies. A Close Call reporting system was used by 10 respondents.
- As with crossing treatments, light transit rail agencies used more evaluation approaches than commuter transit rail agencies. The more types of rail service offered by an agency, the more approaches that agency used, in general.

A common theme raised by survey respondents was that there was not a predominant set of standards or guidelines for applying specific treatments to specific situations. Consequently, one important aim of this research was to provide consistent guidelines based on good engineering judgment and consideration of site conditions as a useful tool for practitioners to use. In addition, even though transit agencies may use treatments and strategies based on prevailing conditions and existing guidance, their use does not negate the need for pedestrians to exercise personal responsibility or the need for some level of enforcement.

CHAPTER 5: TELEPHONE INTERVIEWS

INTRODUCTION

The online survey of practitioners asked responding participants if they would be willing to be contacted by a member of the research team to discuss pedestrian crossing treatments or issues. The purpose of these supplemental telephone interviews was to ask for further details on specific treatments, perceived effectiveness at reducing conflicts, experiences with education or enforcement programs, concerns with—in addition to treatments implemented because of—NEPA requirements, and results of any studies or surveys that the transit agency may have conducted.

TELEPHONE INTERVIEW ADMINISTRATION

The goal of the telephone survey was to speak with up to 10 survey respondents from those that indicated they were willing to be contacted. Of the completed online surveys, 11 respondents answered they were willing to be contacted and provided contact information. The research team selected 10 of these participants for the phone survey.

The online survey closed on Thursday, May 24, 2013. The schedule for the phone interviews was to be completed, if possible, by the early part of the following week. The researcher performing the telephone interviews began sending emails Tuesday, May 22, 2013, to those transit agencies that completed the online survey. The email language sent to the target transit agency persons was: "Thank you for participating in our online survey for our project to develop a *Guidebook* for Pedestrian Crossings for Public Transit Rail Services. You indicated that you are willing to be contacted for additional discussion on the pedestrian crossing treatments and issues associated with your agency. Please let me know a time this week or early next week that best accommodates your schedule for such a discussion."

The researcher received prompt replies from seven of the target persons. The remaining three were sent a follow-up email on Tuesday, May 28, 2013, with the following language: "I wanted to follow-up in hopes that you are able to accommodate this week a discussion on the pedestrian grade crossing treatments. Please let me know if there is a time that best suits your schedule." Two of the remaining three agencies were scheduled following a reply from participants. A third brief follow-up email was sent to the remaining target person. This person had responded to the original email request indicating that they were very busy during the requested time period, so the two additional email requests were personalized to include possible time windows in an effort to identify workable interview time slots.

The phone survey consisted of 15 questions (shown in Figure 11) that are generally divided into six areas of interest:

- Treatment effectiveness (Questions 1 through 4).
- Removal of treatments (Question 5).
- Audit/diagnostic review (Questions 6 and 7).
- Education and enforcement (Questions 7 through 11).

- NEPA accommodation (Questions 12 and 13).
- Guidance documents (Questions 14 and 15).

Questions 1 through 3 target each treatment identified by the responder within the online survey, so the phone interview could cover as many as 35 treatments, plus any others posted in the comment box. Question 4 prompts the interviewer to repeat the first three questions for each treatment. Question 5 asks about identified treatments that the transit agency used and later removed. This question also would be asked for each treatment identified in the online survey.

Follow-up Telephone Interview Questions for up to 10 Survey Respondents

1. In your Web Survey you indicated that your transit agency uses ___________________ (treatment/device/strategy) to improve pedestrian safety at public transit rail services crossings, including light rail, commuter rail, and streetcar services. What effect did (this treatment/device/strategy) have on reducing incidents for pedestrians?
2. How did you determine/document the effectiveness of this treatment/device/strategy? (*Suggest the choices below if needed to assist the respondent in providing an answer.*)
   - □ Crash (accident) data analysis/safety study.
   - □ Incident data analysis.
   - □ Survey of pedestrians and transit riders.
   - □ Observations or reports of risky behavior or near-misses.
   - □ Anecdotal evidence.
   - □ Other (please explain)
3. (*If a formal study or other written report is available, ask if we can obtain a copy.*)
4. (*Repeat Questions 1–3 for each treatment of interest that was reported by the respondent in the web survey.*)
5. (*If the transit agency tried and removed a treatment, ask…*) In your Web Survey you indicated that your transit agency used and later removed ___________________ (treatment/device/strategy). Why?
6. *(If the transit agency uses an audit/diagnostic team review of pedestrian crossings, ask…)* In utilizing a safety audit/diagnostic team review of pedestrian crossings do you use any guidance document or checklist? If so, can we obtain a copy?
7. What personnel is typically part of the audit/diagnostic team?
8. To what extent have you used education/outreach strategies to improve pedestrian safety at public transit rail services crossings?
9. What was the result or effect of the educational strategies you used (and how did you determine that)?
10. To what extent have you used enforcement strategies to improve pedestrian safety at public transit rail services crossings?
11. What was the result or effect of the enforcement strategies you used (and how did you determine that)?
12. Has accommodation of NEPA requirements led your transit agency to consider or implement particular treatments to maintain or to improve pedestrian safety at public transit rail services crossings? If so, what treatments, and why were they considered or implemented? Were there treatments you considered, but rejected because of NEPA?
13. What was the result or effect of the NEPA-related strategies you used (and how did you determine that)?
14. What manuals or guidance documents does your transit agency typically use (or are required to use) when planning for, designing, and installing pedestrian treatments at rail crossings? (*Suggest the choices below if needed to assist the respondent in providing an answer.*)
   - □ Federal MUTCD.
   - □ State MUTCD.
   - □ ADA regulations.
   - □ Transit agency manual(s) (please specify).
   - □ State agency manual(s) (please specify).
   - □ Other manual(s) from a state regulating agency (please specify).
   - □ Other (please explain).
15. Thinking of the documents you just mentioned, what guidance on pedestrian treatments at rail crossings would you like to see added or improved in those documents?

Figure 11. Telephone interview questions.

TELEPHONE INTERVIEW RESPONSES

This section summarizes the findings from telephone interviews undertaken by nine transit agency persons who identified their interest in being contacted for further discussion within the online survey. It begins with a section of general findings gleaned from the conversations, with following sections related to the six areas of interest defined above.

Treatment Effectiveness

The initial interview questions were intended to discuss the treatments selected by the transit agencies in the online survey. Most responses did not include a measure of effectiveness. On some occasions, the participant would say that a particular device seemed to be effective in maintaining pedestrian safety at a crossing. Most of the discussion involved how the particular devices were used on their system. Responses related to the particular treatments are discussed in the following subsections.

Barriers

Treatments categorized as barriers either provide channelization to direct pedestrian movements or a physical barrier to stop pedestrian movements:

- **Channelization.** Channelization proactively creates a situation where the pedestrians cross the tracks in the designed location.
    - Channelization can be designed at crossings in a way that forces the users to point in the direction of a potential oncoming train. The Z-pedestrian or maze crossing design forces the user to face one direction and then the other before approaching the crossing.
    - Respondents largely identified channelization use around station locations, with other uses at locations with limited sight distances. Channelization not at crossings was designed to force pedestrians toward designated crossings, including between tracks at stations.
    - In designing channelization, one transit agency highlighted the need to place channelization back away from the crossing enough to capture users. If too short or placed too close to the crossings, users could choose to bypass the channelization and use the street. If they find themselves already in the channelization they will continue through as designed.
    - In general, channelization is less likely to be utilized in a downtown setting.
    - As far as effectiveness, one transit agency classified channelization at the approach to a crossing as very effective. Another transit agency indicated that they have a new standard to not allow straight approaches to platforms or straight paths across platforms, which entails utilizing channelization.
- **Pedestrian automatic gate or pedestrian swing gates.** Gates block passage of pedestrians by either actively shielding the path for a train movement, such as with automatic gates, or by causing a user to stop and open a gate before proceeding.
    - The use of pedestrian swing gates is usually coupled with channelization. However, one transit agency mentioned using a pedestrian swing gate at one location where space did not allow for a maze.

   - Active warning systems (lights/gates/bells) were stated to be placed on the outside of the sidewalk on some occasions, which allows the gates to cover both the sidewalk and roadway when activated. However, this approach was not necessarily a standard approach but one that was necessitated by the individual crossing design requirements.

Design

Design treatments selected during the online survey covered a wide-array of treatments:

- **Changes to stop/terminal design.** One transit agency performed a couple of terminal design changes by moving two inbound crossings to outbound. Their evaluation found several incidents that occurred while trains were traveling into the station.
- **Flangeway gap treatment**. Three transit agencies described flangeway gap treatments. One survey respondent indicated making a commitment to the ADA community that involves regularly measuring and monitoring the flangeway gaps. They use both wood and plastic, with plastic stated as performing the best. Another respondent uses an extremely firm rubbery material that last a long time. The third transit agency has installed metal bars to close the gap that was originally designed to freight rail standards.
- **Illumination/lighting.** Whether it is from existing street lighting or lighting as part of their system, all the respondents that selected lighting indicated the desire to provide well-lit pedestrian crossings. One transit agency highlighted that good lighting is important for both the pedestrians and the train operators.
- **Mirrors.** Two transit agencies mentioned utilizing mirrors for pedestrian crossing safety. Both agencies did not think they are effective for grade crossing line of sight issues.
- **Offset pedestrian crossing.** The offset pedestrian crossing (Z-pedestrian crossing) was discussed by respondents in conjunction with channelization.
- **Pedestrian refuge area.** The creation of refuge areas is dependent on the spacing between the two track centers and the overall crossing width. Where the light rail runs in the middle of a street and there are multiple roadway lanes in each direction, a refuge area is created in the middle to accommodate crossing the street over two cycles.
- **Removable barriers.** One transit agency installed removable bollards and chains in the downtown near a Saturday market area to provide a barrier between the market area and train tracks.
- **Sidewalk.** Sidewalk changes described by respondents involved redesigning crossings so people are crossing the tracks at a 90-degree angle.
- **Sidewalk relocation.** The active crossing system gate counterweights protruding into the sidewalk path is typically the reason for sidewalk relocation. One option identified is cutting back the counterweights in addition to adjusting the sidewalks.
- **Sight distance improvements.** Sight distance improvements included the removal of some sound walls away from crossings, trimming trees, and other vegetation removal. More sight distance improvement discussion is included within the NEPA discussion later in this section.

Markings

Several respondents feel that markings provide clear delineation for pedestrians, with one observation being that users do not like standing on markings and will stop behind a marking to wait for a train to pass. Another observation is that markings benefit train operators in seeing people intruding into the right-of-way by providing a delineation line. One respondent indicated that their train operators will sound the horn if someone is standing on or beyond the yellow stop line. Treatments discussed during the interviews include:

- **Detectable warnings on sidewalk.** Detectable warning surfaces provide a physical warning on sidewalks and pathways, which are especially effective for people with disabilities. Five of the agencies described using detectable warnings at the approach of grade crossings.
- **Pavement markings.** Pavement markings are often used in conjunction with other treatments, including the detectable warning strips. Three respondents indicated pavement markings with words or STOP sign symbols. One respondent indicated this clearly tells people what to do. Three specific activities identified include:
    - Placing either a red 4-inch band with the message WATCH FOR TRAINS or a 3-foot wide tactile strip.
    - Utilizing pavement markings as stop lines that say STOP HERE that contain a STOP sign between the words. The STOP HERE pavement marking is coupled with the tactile warning strip, placed just prior to the strip. They also have DO NOT STAND HERE pavement markings between tracks, depending on the distance between tracks.
    - Using a thermoplastic STOP sign on the pavement at every crossing and a LOOK marking after the tactile strip, if the distance between the tactile and track is beyond a certain distance.
- **Stop lines on sidewalk.** Two transit agencies indicated using stop lines that do not contain wording. One transit agency has stop lines on all light rail pedestrian crossings and the two commuter rail pedestrian crossings.

Operations

Two of the transit agencies indicate the light rail vehicles are required to stop at every station. However, one transit agency indicated that trains that are out-of-service pass through the stations at 5 mph. One respondent highlighted that although light rail vehicles stop at every station that is not the case for commuter and Amtrak trains that can pass through shared stations at elevated speeds.

Signals

Signals can provide visual and audible warning to pedestrians, such as:

- **Audible crossing warning devices.** Audible warning devices are largely represented as bells on active warning systems. Those bells are either mechanical bells or electronic devices that mimic the sound of a mechanical bell. To focus the noise, the bell housing can be shrouded to direct the sound toward approaching pedestrian and roadway users. In an effort to reduce the impact of the audible warning to surrounding areas, one transit agency is using a device that adjusts the volume output to be 10 decibels over the ambient decibel level. Another option to reduce the noise impact on the surrounding area is to only have the bell sounding while the gate arms are lowering and rising, instead of constantly chiming. Another transit agency specified using crosswalk bells at station crossings. An additional transit agency indicated there was a project in the past that included a special audible warning that stated a message of DO NOT STOP. A final transit agency mentioned installing audible train warnings with flashing lights on a new system alignment and having the bell sound on blank out signs.

- **Flashing light signals.** One respondent indicated that on a new line they have pedestrian flashing light signals with white LOOK signs and blank out active second train coming signs. Another respondent indicated flashing light signals are effective, with theirs being used in conjunction with signage on ground and target signs.
- **In-pavement flashing lights.** One transit agency indicated they are experimenting with utilizing embedded lights that are triggered by approaching trains. They currently have a vehicle application.
- **Low-rise flashing lights.** One respondent discussed the use of low-rise flashing lights. They are currently changing these applications to a 5-foot high lighting system, along with some new pedestrian flashing light assemblies as found in the MUTCD.
- **Pedestrian signals.** Pedestrian signals were discussed as being used in downtown areas, with in-street running, and at platforms. One transit agency has been adding countdown timers on the pedestrian signals, which appear to be more effective.

Signing

Sign usage involved both static and active signs, such as:

- **Second train warning signs**. Second train warning signs, both active and static, were discussed by seven agencies. Not all were described as specifically second train warnings but as just a warning of any train approaching. Below is a listing of how transit agencies are using these signs:
    - Placing a big yellow static LOOK FOR TRAINS sign at crossings.
    - Using two blank out signs for pedestrians. For this transit agency on the new line, they are adapting the blank out sign for pedestrians prior to the active warning device at crossings adjacent to the stations only. The second active blank out sign by stations is on the active warning device and consists of a yellow diamond sign with red SECOND TRAIN that lights up.
    - Utilizing active blank out signs on new corridors. This transit agency is looking to retrofit on older corridors and make standard at crossings on future corridors.
    - Classified as an EMS that lights up when a train is coming, it is active when the standard flashers are activated and is used at locations if a pedestrian cannot typically cross the tracks into a zone of safety within 20 seconds. This transit agency only has a few applications on their system where the crossing characteristics required additional safety treatments.
    - Utilizing black signs with white cutouts that say SECOND TRAIN COMING. This transit agency characterized these as expensive and complicated since the system monitors both tracks and both directions.

    - Utilizing an active sign that consists of an arrow at the top that points one way and a second arrow on the bottom that points the other way. The goal is to get users to look both ways before crossing the tracks.
    - Using a LOOK sign at each crossing with the goal to get people to look both ways at every crossing, every time. In addition, this transit agency utilizes an active blank out sign at high pedestrian count crossings or at school zone areas with LOOK BOTH WAYS with red arrows above a train. The system also emits an audible bell sound.
- **Static Signs.** Other static signs utilized include standard highway-rail grade crossing signs, LOOK signs, LOOK BOTH WAYS signs, LOOK BOTH WAYS BEFORE CROSSING TRACKS signs, DANGER MOVING TRAIN signs, NO TRESPASSING signs, DANGER HIGH VOLTAGE signs, and STOP HERE WHEN FLASHING.
    - One transit agency indicated that the big yellow static LOOK FOR TRAINS sign has regularly increased in size to its current large size.
    - Another transit agency uses the STOP HERE WHEN FLASHING signs to point to the tactile strip and stop line on the ground. The sign provides the proper message when there is snow on the ground covering the pavement markings.
    - Two transit agencies mentioned placing static signs on the vehicular active grade crossing system gate arm counterweights. When the gates are activated and the counterweight raises, one transit agency has decals on the counterweight with STOP on them along with the statue and fine. Another transit agency has LOOK FOR TRAINS on their counterweights.
- **Warning signs for enforcement**. The use of warning messages for enforcement on signs involves including the local civil code and code number. They may also list the specific fine amount. One respondent feels that these signs provide a short term effect when used on new projects, with the impact lessening over time.

Removal of Treatments

Only one respondent indicated that they used and later removed particular treatments. The three treatments indicated were removed as part of retrofitting older crossings with newer technologies or design standards. One crossing that formerly used an old-style pedestrian gate, which was difficult to use and was often not properly functioning, was redesigned to their new channelization design and treatments.

Audit/Diagnostic Review

Seven of the nine agencies indicated performing audit/diagnostic team reviews of pedestrian crossings. The California agencies that participated in the telephone interview indicated state mandates through the California Public Utility Commission (CPUC) require a diagnostic review when changes are made to crossings. These agencies also indicate they may prompt a diagnostic review based on internal guidelines. One of the California transit agencies submits a hazard analysis report for each new crossing to the CPUC. This process includes a diagnostic team review that brings out all interested parties (local city engineer, CPUC, transit agency staff, freight railroad if parallel) to examine design plans and validate or identify missing items. The other way to get approval for a new crossing through the CPUC is with an application process.

In terms of using a checklist, one transit agency indicated they use a formal checklist, while another transit agency indicated they use an informal checklist for internal use only. Others indicated that the MUTCD or other guidance documents were the references used.

Education and Enforcement

All the agencies interviewed indicated that some level of education and enforcement activities were taking place on their systems. Those activities varied greatly among the participants. One respondent was not entirely aware of what their agencies were doing for education and enforcement because those activities are outside their department but stated that some activities were happening.

In addition to regularly distributing material, all the responders that mentioned recently opened or soon-to-open lines indicated significant educational activities related to the opening. Most mentioned providing targeted mailings to people near the new corridor, pamphlets and other handouts; radio and television spots; presentations at school, churches, and other civic locations; and discussions and presentation to city councils and other local agencies where the line traverses. One transit agency, through their Community Relocations Department, educates children on how to safely ride trains and interact with trains at crossings and stations by first showing the unsafe behaviors and then showing the proper behavior. One highlighted that the targeted campaigns for new lines also translates into education for the entire system. One respondent mentioned that it used to be difficult to get into schools to share safety messages, but now they are invited into the schools. Two innovative education activities are discussed below:

- **Los Angeles County MTA.** They have a Rail Safety Ambassador Program where retired train operators are positioned at new rail crossing locations for 12 months (6 months before and 6 months after opening) to observe behaviors and educate the public out in the field. These Rail Safety Ambassadors also provide input into any perceived safety concerns at the crossing. This program received an APTA Innovator Award in June 2013.
- **Denver RTD.** They developed a mock-up of a crossing on a flatbed trailer and went to different schools to demonstrate how to safely cross at crossings. It has an active warning system (lights/bells/gate arms) that activates to demonstrate the safety devices at grade crossings.

Enforcement activities also varied widely between the transit agencies. Some of the activities are performed by in-house police or security departments, while others are done along with local agencies. Three transit agencies indicated the use of targeted enforcement. One of these transit agencies targets a different grade crossing each week. They also have a distracted pedestrian ordinance that allows for citations for those persons who cross the tracks without looking because their attention is focused on their phones, music device, or other distracting item. In addition to Engineering, Education, and Enforcement, this transit agency also adds Encouragement. So in addition to handing out citations and warnings for improper behaviors they hand out rewards for good behavior.

In discussing enforcement, two transit agencies pointed out that enforcement activities are enhanced by the publicity and attention drawn to them. Basically, people talk about it, so the message spreads. In determining effectiveness, one respondent felt that enforcement helps greatly in the short term but was not certain that behaviors are permanently adjusted as a result of enforcement activities.

NEPA Accommodations

Discussions on the impact of NEPA on crossing treatments largely revolved around sound issues. A couple of the respondents did not know what the acronym NEPA stood for, which prompted a question as to whether they had to make adjustments or implement treatments based on noise or other environmental concerns. Common treatments to reduce the noise impacts include placing shrouds on the bells on active warning devices to focus the sound, activating the bells only while the gate arms are descending, and adjusting the volume levels. As stated previously, one transit agency is using a device, which adjusts the volume output to be 10 decibels over the ambient decibel level.

Several transit agencies mentioned having sound walls along portions of their system. One respondent specifically discussed recently improving sight distance for pedestrians at crossings by redesigning sound walls placed along the corridor. This included purchasing homes at the corners in order to open up visibility, largely to pull sound walls back and angle the wall. In one location where sight distance is an issue, not as a result of a NEPA action, they added a second train coming blank out sign as an extra treatment.

Guidance Documents

The major guidance documents included the MUTCD (federal and/or state), ADA regulations, state regulations, and transit agency specific design documents. One respondent also mentioned reviewing crash write-ups from National Transportation Safety Board and FRA, while one mentioned reviewing standards from around the world.

There were not many guidance items mentioned for the final question. One transit agency mentioned wanting a summary of what treatments each agency uses, so they would know who to call. Another one mentioned a scenario often asked by community members along new routes, which involves how to determine effective treatments if only five pedestrians an hour cross compared to 40 pedestrians an hour. Basically, they want to know why lower counts would get less safety treatments than crossings with higher counts.

FINDINGS

Most of the respondents acknowledged the difficulty in measuring the effectiveness of treatments. One was adamant that it was impossible to tell effectiveness, stating that the same treatments at two different crossings will result in different behavior and ultimately different safety results. They also stated that effectiveness of any device is only as good as people choose to obey it. The major theme in discussions seemed to be that the difficulty is largely due to each crossing being unique and the fact that most do not identify with just a single treatment but with a system of treatments.

Another general finding is that they all seem to know what each other is doing and will copy each other if they think it is a good idea. One person indicated that they now flash the lights on their device because someone else started flashing the lights. One respondent provided good insight into this idea by stating it assists them in justifying their proposed actions (installing new device, etc.) by noting how another agency addressed a similar issue with an installation. Two respondents indicated that this is a good reason for this project and the potential for a standardized approach around the country.

Line of sight was the most significant issue discussed by participants. Two respondents highlighted the importance of maintaining good line of sight for the transit vehicle operator, in addition to vehicle and pedestrian line of sight. One transit agency has actively addressed sight distance issues at crossings and began installing treatments, such as the Z-design, that force pedestrians to look in the direction of a potential oncoming train. The design, along with pavement markings and signs, also encourages every pedestrian to look both ways every time they approach a grade crossing.

Budget constraints were discussed by several respondents. One respondent highlighted that it is cheaper to properly install treatments from the beginning than to add or alter the treatments later. Another suggested that they attempt to maintain their standard design at all crossings, with a few exceptions that necessitate increased protection devices, in order to not create a precedent that will cost more money than they can support. One transit agency, however, is actively going back and retrofitting older crossings with newer technologies to enhance crossing safety, which indicates that as systems mature changes will likely be required to maintain safety to new standards.

Two transit agencies mentioned they are very active in their interaction with people with disabilities. One participant mentioned a Mobility Advisory Committee that reviews and provides comments on any additions or modifications at crossings and also provides input based on daily interaction with the system. The other agency has a School for the Blind near a station and welcomes the school to use the station platform for training and experience gaining. This same agency includes persons with disabilities as participants in all exercises to provide real-world responses.

In relation to approaching pedestrian safety, general approaches include:

- Directing the pedestrians to cross where you want them to cross the tracks.
- Encouraging the pedestrians to look both ways before crossing.
- Providing consistency in safety treatments throughout the system by providing the basics and enhancing when required.

CHAPTER 6: SITE VISITS

Members of the research team visited several public transit rail services crossings within select regions as part of this research. These visits provided the opportunity to observe the challenges faced by pedestrians at public transit rail services crossings. The observations were not intended to be a judgment on the condition of the rail systems. Rather, the observations helped with the development of the *Guidebook*. Therefore, post-site visit, the observations were grouped within broad categories that were used with the presentation of treatments within the *Guidebook*. The observations were also envisioned to affect the discussions included within the *Guidebook*, so to emphasize how to analyze conditions at a crossing with respect to the needs of pedestrians.

OVERVIEW OF SITE VISIT METHODOLOGY

Region Selection

Regions considered for the site visits were shortlisted based on the nature of their pedestrian treatment crossing design (either geometric or traffic control device), crossing policies, and the extent to which a site represents a distinct category of treatment practice, service area type, or regional category. Another consideration was to have the sites represent different areas of the United States. The sites selected, and the reason for the selection, are listed in Table 8. The initial site visit was to Boston. It occurred between August 4 and 9, 2013, within Phase I of the project. After meeting with the panel, the remaining two site visit locations were identified. The second site visit was to Portland (January 23 and 25, 2014) and the third visit was to the Los Angeles area (January 26 and 29, 2014), and these visits occurred within Phase II of the project.

Table 8. Reasons for selecting locations for site visits.

Region	Reasons for Selection
Boston	• Operates light rail and commuter rail and has Amtrak operating in some stations. • Most used light rail system in the United States. • Wide variety of pedestrian treatments and approaches to improve safety. • Location also provides the opportunity to attend one day of a national meeting where pedestrian/rail issues were discussed.
Portland	• Operates streetcar, light rail, and commuter rail. • Uniform application. • Updating devices throughout to current standards. • Mature network with new/recent/upcoming lines. • Removed devices. • Variety of treatments used.
Los Angeles	• Operates light rail but has connections with commuter rail. • Extensive network with high ridership. • Wide variety of pedestrian treatments, both MUTCD and non-MUTCD-compliant, and approaches to improve safety. • Willing to test new treatments.

Research Staff for Visits

Three key personnel, representing rail (Jeff Warner), pedestrians with disabilities (Billie Louise Bentzen), and roadway design/traffic control devices (Kay Fitzpatrick), participated on each trip with a focus on his or her particular areas of expertise. The team approach was critical for the site visits. Pedestrian-rail crossings involve many disciplines; however, unification of these perspectives into a single coherent vision of pedestrian crossings of public transit rail services was critical for the practical application of this research. Consequently, the site visit team integrated their respective observations and insights on a real-time basis during the site visit and immediately following the conclusion of each regional trip.

Pre-Visit Plans

The mechanics of the site inspection process included extensive pre-visit planning to identify crossing locations with certain specified features and to schedule interviews with key transit and roadway agency staff and local disability specialists, as appropriate. Desired was agency staff with planning, operations, design, and/or traffic control device responsibility, including selecting treatments for pedestrian-rail crossings, to participate in the meetings with the site visit team.

Prior to the visit, the research team requested that agency staff suggest between 12 and 20 pedestrian-rail crossings that the research team should visit. A mix of locations with good pedestrian accommodations and locations where the pedestrian accommodations could be improved was sought. A reasonable route to visit as many of these pedestrian-rail crossings as feasible was developed prior to travel. Examples of site characteristics of interest included the following:

- High pedestrian activity.
- Recently installed pedestrian treatments (and the reason the treatments were installed).
- Pedestrian-rail crossing with typical pedestrian treatments for the system.
- Pedestrian-rail crossings with unique pedestrian treatments due to characteristics of the crossing.
- Pedestrian-rail crossings at stations with connections with other rail systems and/or part of an intermodal transfer center.
- Pedestrian-rail crossing modified with input from disability specialist or advocacy group.

Site Visit – Review of Pedestrian-Rail Crossings

The research team visited several pedestrian-rail crossing sites prior to interviews with agency representatives. Completion of the inspection before the interviews enabled the researchers to prepare for discussion of details during the scheduled meetings. The inspection of the pedestrian-rail crossings used passive observation of the actual use of physical facilities, including the individuals using those facilities and the artifacts of their use. This tactic is appropriate for pedestrian-rail crossings because the level and nature of the use of a facility is a critical indicator of the success of the design and placement of that feature. During each visit to a crossing, the research team:

- Documented site characteristics.
- Photographed the crossing, nearby area, and installed treatments.

- Used the crossing(s) in multiple directions, noting any features or issues from a pedestrian's perspective.
- Discussed the treatments with station personnel, transit riders, non-riding pedestrians, and others as available and appropriate.
- Recorded comments and observations.

Site Visit – Meetings

The meetings were guided by a list of questions to ensure coverage of predetermined critical issues and questions. In addition, the research team asked questions based on notes prepared upon completion of the crossing investigations. The meetings were not, however, limited to those questions, allowing for probing and follow-up on unanticipated elements in the discussion.

Post-Site Visit

In addition to the largely spontaneous real-time comparisons of observations and impressions between project team members, a more formal de-briefing was performed at the end of each regional visit. These sessions consolidated and documented the observations from the site visit, thus minimizing the loss of data due to the inherently coarse nature of field notes, as well as avoiding confusing the sites and regions. Following the trip, the research team members:

- Transcribed key written notes into typed documents.
- Stored, labeled, and shared site photos.
- Conferred with other members of the travel team to assemble and synthesize notes and observations from the site and from the agency discussions.

Institute of Transportation Engineers Annual Meeting

The timing of the site visit to Boston also permitted the research team to attend one of the sessions held at the Institute of Transportation Engineers (ITE) annual meeting. The session was on pedestrian issues and safety initiatives in railroad corridors. As noted during the ITE Session, Utah has a new ordinance that prohibits crossing a railroad grade crossing while distracted (*41*). The examples of distraction listed in the ordinance include talking on a cell phone, texting, having earphones or ear buds in both ears, attending to personal hygiene or grooming, or reading. The penalty for this offense is a $50 civil fine; repeat offenses carry a $100 fine. The new ordinance is Chapter 5.14, Section 1M.

BOSTON SITE VISIT

Meetings in Boston

During the trip, the research team met with the Massachusetts Bay Transportation Authority (MBTA), Massachusetts Bay Commuter Railroad Company (MBCR), pedestrian advocates, and orientation and mobility specialists.

Site Visit in Boston

The Boston MBTA light rail system had several different alignments:

- Semi-exclusive alignment category b.1 separate right-of-way; see example in Figure 12 (Green Line: D-branch). Semi-exclusive alignments have in-station crossings.
- Semi-exclusive alignment category b.3 shared right-of-way, protected by barrier curb – Median-running and side running; see example in Figure 13 (Green Line: B-branch). Pedestrians cross within crosswalks, mostly at roadway intersections, with a few pedestrian-only crossings. The pedestrian-only crossings had traffic signals for the motor vehicles to stop for pedestrians crossing on a designated roadway crosswalk.
- Non-exclusive alignment category c.1 mixed traffic operation – street running; see example in Figure 14 (Green Line: E-branch). Pedestrians cross the outside roadway lane to enter/exit the light rail vehicle that is being operated within the inside roadway lane.
- The Boston MBTA commuter rail system had semi-exclusive alignment category b.1 separate right-of-way; see example in Figure 15.

source: Fitzpatrick

Figure 12. Example of an in-station pedestrian crossing.

source: Fitzpatrick

Figure 13. Example of a median-running train approaching a pedestrian and roadway crossing.

source: Fitzpatrick

Figure 14. Example of a street running train approaching a pedestrian crossing.

source: Warner

Figure 15. Example of commuter rail.

The research team visited more than 25 pedestrian-rail crossings within the light rail and the commuter rail systems. For the light rail system, the team rode the light rail and alighted at stations of interest or walked between stations to review examples of pedestrian-rail crossings that occurred away from a station. For the reviews of the pedestrian-rail crossings of the commuter rails, MBTA generously provided a staff member to drive the research team to the suggested locations.

During the visits to the pedestrian-rail crossings, the research team used a checklist to assist in gathering information. Not all items on the checklist were relevant at all pedestrian-rail crossings, and in many cases the research team could not definitively state whether an item was present, for example, sufficient street lighting, due to the limited time the team was present. The initial checklist was developed from roadway safety audit guidelines, which is a more exhaustive review of a location than the method being used in this study. The checklists were modified for the regions visited in Phase II to better align with the study methodology being used for these site visits. While the checklists were more extensive than needed, they did assist the research team in considering several components of the rail crossing design.

Observation Development for Boston

During the week in Boston, each team member independently developed a list of key observations based on the site visits and the meetings. These lists were exchanged and then the team members conducted a conference call to review and expand upon the observations. The following sections summarize the observations grouped within broad categories that were envisioned to be used with the presentation of treatments within the *Guidebook*.

General Observations for Boston

The following are general observations for Boston:

- Because of the number of segments traveled, and the fact that these segments often involve different transit agencies, the entire door-to-door trip for a pedestrian using transit can vary greatly along the way with regard to usability and safety features. One of the pedestrian advocates indicated that better consistency is needed in signing, markings, and other treatments between the rail segment and the road segment of a multimodal trip.
- Pedestrians take the shortest path regardless of where the markings are or how the station is designed, unless there is a barrier directing them to a preferred crossing location. An example of the shortest path observation is when the train stopped near but not at an intersection. When the doors opened, the travelers exited the train and then continued in a straight path across the road. In some cases, this was several hundred feet from the signalized intersection or in a median where the patron had to step off a curb. Another example is that although there were signs forbidding travelers to cross light rail tracks in a station, many alighting passengers took the shortest route to the exit, preferring to negotiate the elevation changes and roughness of crossing the track bed closer to the train instead of traveling down the platform to the marked (and smoother) crossing.
- A shift in color and/or texture at a rail crossing could be a better approach at communicating the crossing location than signs, especially considering where a pedestrian is looking when walking. A concern in the northern areas is that snow may cover the color change.

Observations Related to Traffic Control Devices – Markings and Detectable Warnings for Boston

The following are observations related to markings and detectable warnings:

- Use of pavement markings at the pedestrian-rail crossings of the light rail system largely consisted of solid yellow painted crosswalks (see Figure 16 and Figure 17). White pavement markings were used on the roadway approaches to the rail crossings (see Figure 18 and Figure 19). In a few cases the solid yellow was supplemented with white lines (see Figure 20). The research team observed different signing and markings when the train stopped within the middle of a street without a station (i.e., trolley service). Figure 21 shows that the roadway white continental pavement markings are also used across the rail crossing. In some cases no pavement markings were present at the pedestrian-rail crossing (see Figure 22 and Figure 23).
- Several light rail crossings were marked with yellow paint for the entire crossing surface (see Figure 16 and Figure 17). Crossings that are solidly painted in a color contrasting with the pavement are more conspicuous and more likely to be visually identifiable to pedestrians with low vision than crossings that are discontinuous, such as transverse or diagonal markings. However, solidly painted areas may become slippery when wet and they require considerable maintenance; although when asked about this potential condition the transit agency noted that multiple complaints about a slick surface have not been received.

- Yellow paint may also be used to indicate the dynamic envelope of trains (see Figure 24 and Figure 25). The message to passengers is not to travel beyond the yellow stripe because they will be in danger of being struck by the side of a train.
- Yellow detectable warnings, whether used at a platform edge (see Figure 26), used to indicate the dynamic envelope of trains, or used to mark the bottom of curb ramps, indicate to all travelers, including those with visual impairments, where they should stop because there is vehicular danger immediately beyond the tactile surface.
- Using yellow paint for the dynamic envelope and solid yellow paint for the pedestrian crossing of the tracks can result in mixed messages. For example, the yellow is being used to communicate two messages: yellow for the dynamic envelop means “do not stand here” or “there is a hazard beyond this line” while the solid yellow on the crossing of the track means “cross here.” Figure 24 shows an aerial view of a crossing in Boston that illustrates how the yellow is being used both for the crossing and as a warning for the edge of the train. Another interpretation of the meaning of the yellow in both places is that it presents a message that pedestrians should not stand or stay for long while on the marked section.
- A challenge with narrow medians is the minimal space available for storing waiting pedestrians or bicyclists. As illustrated in Figure 25, the bicyclist is waiting on the solid yellow markings for the WALK indication.
- Platforms were frequently marked with wide yellow paint (example shown in Figure 25) or with tactile strips (example shown in Figure 26).
- Detectable warnings were used at many platform edges and curb ramps.
- Where pedestrians should stop and wait in the median area near a crossing when a train is approaching was not always clear.

source: Fitzpatrick

Figure 16. Example of solid yellow markings used at pedestrian-rail crossing near a pedestrian-roadway crossing.

source: Fitzpatrick

Figure 17. Example of solid yellow markings used at pedestrian-rail crossing within a station.

source: Fitzpatrick

Figure 18. Example of crosswalk markings for roadway and rail; note the lack of curb ramp between the roadway and the median.

source: Warner

Figure 19. Another example of crosswalk markings for roadway and rail. In addition, note the lack of curb ramp between the roadway and the median.

source: Fitzpatrick

Figure 20. Example of combining both yellow and white markings at a pedestrian-rail crossing.

source: Fitzpatrick

Figure 21. Example of pavement crosswalk markings used with mixed traffic.

source: Fitzpatrick

Figure 22. Example of no pavement markings or detectable warnings for pedestrian-rail crossing and solid red bricks within white transverse lines for the nearby pedestrian-roadway crossing.

source: Fitzpatrick

Figure 23. Another example of no pavement markings or detectable warnings for pedestrian-rail crossing and solid red bricks within white transverse lines for the nearby pedestrian-roadway crossing.

source: Google Earth

Figure 24. Pedestrian crossing of roadway and tracks for light-rail being operated in the median; note differences in how the pedestrian crossing is marked for the roadway (white continental markings) and the rail (solid yellow markings).

source: Fitzpatrick

Figure 25. Example of challenges in waiting area within narrow median – bicyclist is waiting in area painted yellow. Also example of yellow paint used as warning for edge of train.

source: Fitzpatrick

Figure 26. Example of detectable warning strip used at edge of platform.

Observations Related to Traffic Control Devices – Signs for Boston

The following are observations related to signs:

- At several locations a non-MUTCD sign with the words LOOK BEFORE ENTERING TRACK AREA was installed (see Figure 27). These signs are orange in color. The location and height varied between installations, perhaps reflecting limitations at a crossing. Some were posted on the fence between the tracks, which could be several feet away from the pedestrian-rail crossing, while others were posted on existing street light or power poles.
- An example of the sign used when the train stops within the middle of a street without a station is shown in Figure 28.
- Signing needs to be reviewed for both directions for the pedestrian. While signing for a one-way street may only need the Crossbuck Assembly on the one approach for vehicles, the Crossbuck Assemblies are needed for both directions for pedestrians. Figure 29 shows an example where the face of the Crossbuck Assemblies is only visible from the roadway approach.
- A number of pedestrians were observed walking and texting. These pedestrians may never see signs because they are not looking up and forward. Signs on the pavement or close to the pavement such as on a fence or barrier, are likely to be seen by pedestrians even while texting. Signs on pavement (also known as horizontal signing) may need to be supplemented in regions with snow.
- Traffic control devices were also used along the tracks, for example, a Stop sign was used within a station to indicate that train operators should stop prior to reaching the pedestrian-rail crossing (see Figure 30). Another example of a sign assumed to be for the train operators is a sign warning of a downstream pedestrian-rail crossing (see Figure 31).

source: Fitzpatrick

Figure 27. Sign used at several pedestrian-rail crossings.

source: Fitzpatrick

Figure 28. Example of sign used with mixed traffic operations.

source: Fitzpatrick

Figure 29. Example where the back, but not the front, of the crossbuck assemblies are present for the pedestrian approach.

source: Fitzpatrick

Figure 30. Example of a stop sign used between tracks to indicate train operators should stop train prior to the pedestrian-rail crossing.

source: Warner

Figure 31. Example of a warning sign used to inform train operators that a pedestrian-rail crossing is ahead.

Observations Related to Active Traffic Control Devices – Signals or Audible Warning Devices for Boston

The following are observations related to signals or audible warning devices:

- Exclusive style of pedestrian phasing (i.e., the WALK signal is on for all approaches at the same time) can result in long waits for pedestrians, especially at complex intersections with many turning vehicles. At these intersections, pedestrians were frequently crossing within the DON'T WALK phase.
- The audible warning and red flashing message on the Amtrak station platform warned of an approaching train.
- One site was at an intersection where the major roadway had multiple lanes along with a parallel collector-distributor road. This configuration resulted in several turning vehicles moving between not only the major and minor approaches, but also the collector-distributor road. In addition, exclusive pedestrian phasing was used so there were long waits for the pedestrian WALK signal. Several pedestrians were observed crossing against the DON'T WALK signal at this site. These pedestrians would travel to intermediate islands and then judge the traffic flow on the next section to make their decision on whether to cross.
- At some locations with rail operations in the median, pedestrian signals seemed designed to permit the pedestrian to reach the center median where the pedestrian could either enter the station platform or wait for the next pedestrian signal to proceed across the remaining lanes of vehicle traffic. Pushbuttons were provided at the median.

Observations Related to Active Traffic Control Devices – Automatic Gates for Boston

The following are observations related to automatic gates:

- Automatic pedestrian gates across sidewalks on both sides of the track were used along the commuter rail system. Figure 32 shows a photo of an automatic gate being used for both roadway and sidewalk. Figure 33 shows a shorter automatic gate used for the sidewalk while the longer automatic gate is used on the vehicle approach.
- One possible contribution to the frequent use of automatic pedestrian gates is that many of the commuter lines are in quiet zones where the train horn is not utilized at pedestrian-rail crossings during normal operations. The federal train horn rule allows for using the horn if a safety concern is present, such as observing a pedestrian walking along the tracks or a car stopped on the tracks. Another possible contribution to the use of automatic pedestrian gates is where sight distance issues created by vegetation or other obstructions were present.

source: Warner

Figure 32. Example of single automatic gate for both sidewalk and roadway.

source: Fitzpatrick

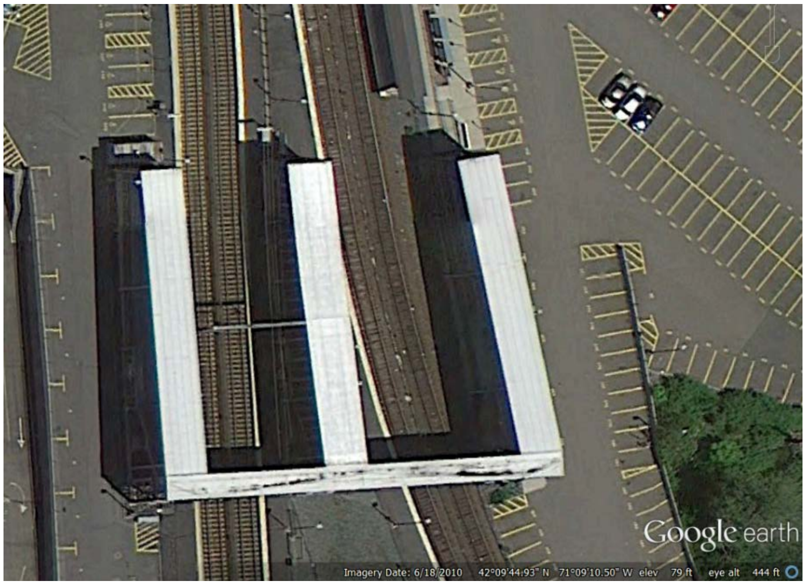
Figure 33. Example of automatic pedestrian gates.

Observations Related to Design of the Crossing for Boston

The following are observations related to design:

- For median-running and side-running light rail operations, the pedestrian storage and platform waiting areas were often very tight. In some cases, these tight storage areas did not specifically provide dynamic envelope markings or any other indication where not to stand when a light rail vehicle is approaching.
- When the train is in the middle of the road on a raised median, the waiting area for the pedestrian between the road and the train can be very narrow, perhaps uncomfortably narrow, especially if there are several patrons waiting to board the train. A misstep could place the pedestrian onto the active roadway or onto the train tracks. A barrier between waiting area and the road can help with keeping pedestrians off the roadway.
- The combination of small refuge area, wide crossing, and unfavorable signal timing for pedestrians creates an uncomfortable waiting experience. At one location pedestrians had a long wait in a small refuge area while several cars moved past them at a high speed.
- It is more difficult for a wheelchair to maneuver across the tracks when the pedestrian crossing is at an angle to the train tracks. The front casters of a wheelchair may become trapped in the flangeway preventing forward movement, and sometimes backward movement, of the wheelchair. If the person is traveling at speed, entrapment can result in propelling the person forward onto the tracks.
- Grade separation of the pedestrian crossing and the rail provides a situation where the potential conflicts between pedestrians and trains are minimized. Unfortunately, the resulting structure can require an extensive, and expensive, structure that may not be overly pedestrian friendly (see Figure 34 and Figure 35). The conditions at the site shown in Figure 34 and Figure 35 have significant pedestrian and train volumes along with

higher speed operations to justify having a grade separation of the crossing. The novel design of this structure permits pedestrians who can manage stairs to travel a shorter route. While the structure may seem to provide an accessible route for people who cannot manage stairs, perhaps a majority of people who use manual wheelchairs would find it too long and exhausting to negotiate. Furthermore, landings are not at adequate intervals. The *ADA Standards for Transportation Facilities* (*16*) require level landings every 30 feet. At less demanding sites, having a well-marked at-grade crossing could be better than a grade separation, because the at-grade crossing would require less walking and no grade change for the pedestrian along with fewer structures for the transit agency to construct and maintain.



source: Google Earth

Figure 34. Example of grade separated pedestrian crossing, aerial view.

source: Warner

Figure 35. Example of grade separated pedestrian crossing, side view.

Observations Related to Orientation and Mobility for Boston

The following are observations related to orientation and mobility:

- Consistent wayfinding cues help blind pedestrians. Natural cues like grass lines or curbs can provide good wayfinding information for travelers with visual impairments who are familiar with a station, but may not help those who are unfamiliar with a station.
- Pedestrians with visual impairments have difficulty negotiating across uneven walking surfaces. This is primarily because of concomitant conditions such as loss of sensitivity and control of ambulation as a result of diabetes or stroke, and other conditions associated with aging such as difficulty with balance, difficulty in adjusting gait to accommodate for different distances between preferred smoother areas, and decreasing contrast sensitivity and need for high levels of illumination.
- In addition to illustrating the pavement markings at a crossing, the photographs in Figure 18 and Figure 19 also provide examples of missing curb ramps at the median for pedestrians. Because of the grade changes shown in Figure 18, a pedestrian in a wheelchair would have to move to the left of the crosswalk markings, into the parallel vehicular way, to cross the tracks. The pedestrian-rail crossing shown in Figure 19 has no ramps between the roadway and the median and is thus inaccessible to pedestrians who are unable to step up and down on curbs.
- High ambient sound makes it difficult to hear light rail vehicles and to determine when it is safe to cross tracks.
- Pedestrians who travel with the aid of a long white cane often follow the detectable warning surface at a platform edge to find the crossing. When there is not a drop-off at the platform edge, which can form the borders of the crossing, it can be difficult to determine where the crossing begins. Pedestrians who are visually impaired may travel past the crossing without recognizing it.

Observations Related to Crossing Surface for Boston

The following are observations related to crossing surface:

- Material is added between the tracks and on either side of the track to facilitate pedestrian and vehicle crossing of the rails. The material needed is a function of the type and speed of the train. Rubber panels are appropriate for light rail but will buckle with heavy rail. Asphalt is a common treatment while some locations use concrete.
- When the supplemental crossing material is broken along a track, or heaved up, it can result in a very uneven crossing that becomes a tripping hazard as well as being difficult for people using wheeled mobility aids to negotiate (see Figure 36 as an example).
- How that material is marked with crosswalk pavement markings appeared to vary by location. Having these crossings marked with pavement markings would assist those with low vision to make the crossing. Visually impaired pedestrians who travel with the aid of a long white cane may find the edge of the crossing surface and use that as a guide. In some cases, this edge could be several feet away from where it would be preferred for the pedestrian to be crossing. Figure 37 shows an example of the uneven ends of a crossing. Using rubber panels on an angle crossing creates a crossing path with uneven ends that could present a confusing path for a pedestrian (see Figure 38 for an example). Figure 39 shows an example where the edge of the pedestrian-rail crossing is straight.

- When the tracks cross at an angle to the roadway, additional challenges are presented with communicating the desired path and with respect to wheelchairs or bicyclists being able to cross the rail at right angles (to minimize the chance of a wheel being caught in the flangeway gap). A crossing was redesigned to relocate the bicycle path so that the cyclists would cross the tracks at a near-right angle. Figure 40 shows an aerial view of the layout with Figure 41 showing a ground level view of the approach. Figure 42 shows a sign used near the crossing.
- Maintaining a good surface between the tracks and a minimal gap at the track appeared to be challenging at some of the pedestrian-rail crossings. Vertical differences between the rail and the adjacent surface need to be kept to a minimum so that the uneven surface does not cause the swivel casters of a wheelchair to turn sideways and drop into the flangeway gap.
- Several locations had flangeway fillers as shown in Figure 43 and Figure 44.

source: Fitzpatrick

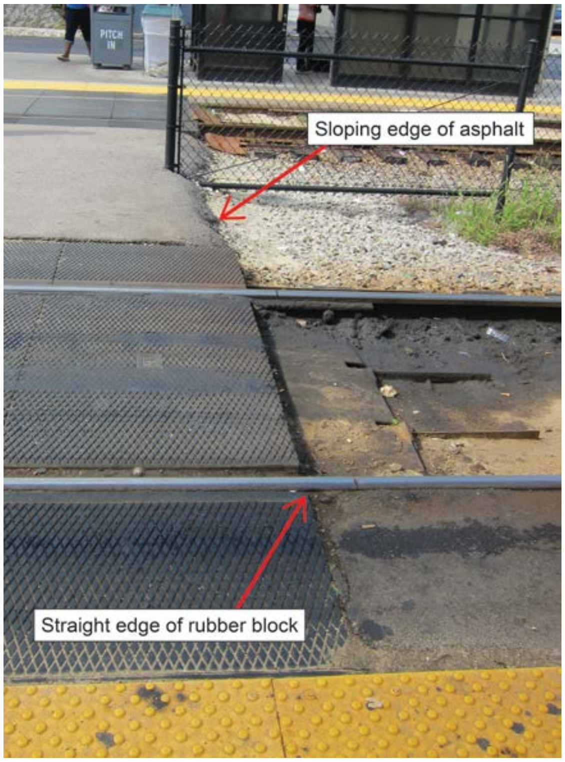
Figure 36. Example of uneven surface.

source: Fitzpatrick

Figure 37. Example of uneven edges between the rubber panel used within the tracks and the asphalt used outside the tracks that make it difficult for pedestrians who are blind to follow the edge all the way across the crossing.

source: Fitzpatrick

Figure 38. Example of rubber panels providing a distinctive edge of crossing, however, an uneven edge because of the nature of the panels and the angle crossing at this location.



source: Fitzpatrick

Figure 39. Example of straight edge for crossing.

source: Google Earth

Figure 40. Aerial view of bike path crossing of a rail.

source: Fitzpatrick

Figure 41. Approach to bike crossing of railroad tracks.

source: Fitzpatrick

Figure 42. Signs used at bike crossing.

source: Fitzpatrick

Figure 43. Example of flangeway filler used in a crossing.

source: Fitzpatrick

Figure 44. Another example of flangeway filler.

Observations Related to Fences and Barriers for Boston

The following are observations related to fences and barriers:

- Both the light rail and commuter rail systems utilized fencing to direct pedestrians to designated crossing locations and along desired pathways (path lines).
- Figure 45 shows an example of a fence between a sidewalk and the tracks. The light rail system also maintained fencing between two tracks to direct pedestrians to designated pedestrian-rail crossings along some routes as shown in Figure 46 and Figure 13.
- Figure 47 shows the decrease in height of the fence located between two tracks near a pedestrian-rail crossing to improve sight distance to crossing pedestrians for the train operator, and to the train for pedestrians.

- In some cases, the fence or a barrier was used between two tracks to completely restrict pedestrian-rail crossings. Examples are shown in Figure 48.
- Fences or railings along or across a possible path of travel should have cane-detectable lower crossbars. The lower crossbar enables a person who is traveling with the aid of a long white cane to detect the fence or railing with the cane before contacting it bodily. A good height is 15 inches as required by PROWAG (*17*).
- Signs or station information displays mounted between posts should also have a lower edge at 15 inches. While these signs or displays may not be in the typical path of travel, the addition of cane-detectable features should be considered if the item is located in a possible path of travel. Pedestrians who do not have vision are more likely than others to travel on paved areas along or near tracks, but not in the direct path of travel used by most travelers, because they do not have perceptible information about the direct path of travel.
- The commuter rail roadway crossings with sidewalks had chain-link fencing outside the roadway right-of-way to prevent pedestrians from leaving the sidewalk to walk around the arm and mechanism of a lowered gate.
- For a pedestrian-only crossing, there was an orange sign for train operators indicating they are approaching a pedestrian-only crossing (see Figure 31). At that crossing the fencing between the tracks was reduced in height on both approaches to the pedestrian crossing. When observing an approaching train, the body of the train was visible above the fencing a good distance away. Pictures taken from the light rail vehicle approaching a pedestrian-only crossing show that the height reduction assists in seeing a person walking across the crossing.

source: Warner

Figure 45. Example of fence between sidewalk and tracks prior to a crossing.

source: Fitzpatrick

Figure 46. Example of fence used between two tracks within a station that ends prior to a marked pedestrian crossing.

source: Fitzpatrick

Figure 47. Example of change in fence height prior to pedestrian crossing to improve sight distance.

source: Fitzpatrick

Figure 48. Example of fence used to restrict pedestrians walking across the rails and a pedestrian grade separate structure to accommodate the need to move from one station platform to the other.

Observations Related to Train Operations for Boston

The following are observations related to train operations:

- Commuter rail operates in both a pull (locomotive in front) and push (locomotive in rear) configuration, so the locomotive may not be at front of an approaching train. In the push configuration, the front cab car does have the federally required light configuration and horn, like the front of a locomotive.
- MBCR, the operator of commuter rail in Boston under the MBTA, has an operating rule that a commuter train is not allowed to enter select stations when there is a train sitting in the station. This hold out rule applies to stations with pedestrian-rail crossings and is a way of mitigating the second-train problem.
- Mirrors were present at one of the stations to assist the train operator to detect pedestrians moving toward the train within the station (see Figure 49).
- One of the commuter rail grade crossing locations with two tracks had an island detection system that would alert an approaching train of a vehicle present within the crossing.

source: Fitzpatrick

Figure 49. Example of mirror in a station.

Observations Related to Other Features for Boston

The following are observations related to other features:

- Each of the light rail vehicles was equipped with a bell used when coming into and exiting a train station, or when a conflict situation presented itself. They also were equipped with a loud train horn observed to be used when vehicles were inappropriately turning into the path of the train or attempting to pass the train while stopped in the street running portion of the system.
- For the street running operations, the door of the light rail train was painted red with the word STOP stenciled on it to emphasize that vehicle drivers should stop for exiting/entering patrons (see Figure 50). Stenciling also included the words “state law.”
- The lights on the front of the light rail vehicles were solid red while at stations, changing to white when moving. Some of the newer light rail vehicles had green lights while moving. This provided a visual cue to pedestrians and motor vehicles as to whether the train was stopped or moving.
- In the conversation with MBTA personnel, they mentioned pedestrians getting “clipped” by the train. They noted that most pedestrian conflicts were a result of a pedestrian trying to beat the train into (or out of) the station and trying to stop the doors from closing resulting in hand fractures.
- The MBTA is updating and standardizing their training so that it is more consistent and efficient along with being able to track which of their staff have completed the training.
- The research team was told that several of the universities and colleges in the Boston area have “safety pairs” where a current student works with new students to educate them regarding the rail system.

source: Fitzpatrick

Figure 50. Example of train doors showing stop, state law message.

PORTLAND SITE VISIT

Meetings in Portland

During the trip, the research team met with the Tri-Met, Portland Bureau of Transportation, and mobility advocates/specialists.

Site Visits in Portland

The Portland-area rail system consists of streetcar, light rail, and commuter rail systems operating within a variety of alignments, from non-exclusive alignments within the downtown area to semi-exclusive alignments for both the light rail and commuter rail. Intercity passenger rail operated by Amtrak also serves Portland through Union Station in downtown Portland.

The research team visited more than 20 pedestrian-rail crossings within the transit rail systems. Tri-Met generously drove the research team the first day, in which 12 crossing locations were reviewed. The research team walked within downtown and took the light rail and streetcar systems to investigate other locations.

Observation Development for Portland

During the site visit in Portland, each team member independently developed a list of key observations based on the site visits and the meetings. While on the site visit, several brainstorming sessions occurred in which general observations were noted. The following sections summarize the observations grouped within broad categories.

General Observations for Portland

The following are general observations for Portland:

- The agency has a focus on providing consistency throughout the system, with plans to update older crossings. It was stated that there is more demand for improvements because of expectations; however, it is a challenge to install safety improvements on existing alignments. Redoing the safety design at an existing crossing is a bigger challenge than new construction for several reasons including the need to adjust existing behaviors.
- The agency uses significant levels of channelization at crossings in order to redirect pedestrians. The redirection of pedestrians provides the opportunity to generate more awareness of the surrounding conditions that is not present when pedestrians cross completely unimpeded.
- There is active involvement with Committee on Accessible Transportation (CAT), and there seems to be an agency-wide ADA awareness. The CAT has been in place for more than 30 years. With the agency-wide ADA awareness, they can spend a greater proportion of their time on being more customer-focused.
- The agency is willing to test and try new ideas and have a procedure in place to assess the potential treatment. Pilot projects go through their Safety Committee as part of a design, review, and approval process before a treatment is placed in the field.
- People with disabilities are concerned with trains and may alter their movements to avoid interaction with the tracks. A CAT member, and wheelchair-user, indicated that when she needs to go to the doctor adjacent to the Gateway Transit Center, she prefers to pass the Gateway Transit Center station in one direction, exit at the next station and then return to the Gateway Transit Center from the other station. This allows her to only cross one set of tracks instead of the full three sets of tracks.
- With the upgrade of crossings along existing lines, the management of pedestrians during construction was a significant issue, especially for people with disabilities. Additionally, the management of pedestrians around other construction activities is an issue, as observed with the construction of a new building in the downtown area. Figure 51 shows the sign placed to manage pedestrian flows for the construction site. Figure 52 shows pedestrians improperly walking along the track to pass by the construction site. It was perceived that train operators may have a difficult time seeing pedestrians that might be improperly passing around the construction site.

source: Fitzpatrick

Figure 51. Sign informing pedestrians of construction-related disruptions.

source: Fitzpatrick

Figure 52. Pedestrians walking near construction site.

- Several of the areas that the Tri-Met light rail system serves are experiencing significant growth and development. This development or impending development necessitates improvements to the existing safety system at the crossing. The Tri-Met Real Property Department is notified of possible development, which then alerts other areas of Tri-Met that improvements may be needed to accommodate changing conditions.
- In addition to growth along existing alignments, there is current construction on extensions to both the streetcar and light rail systems.
- Tri-Met always reviews behavior to see if adjustments worked as planned or if additional improvements are needed. They feel that there is a constant need to improve. For example, while viewing crossings during the site visit an inappropriate gap between fencing and guardrail was observed at a recently updated crossing (see Figure 53). The Tri-Met representative reported to the appropriate department that additional fencing was required to close the gap.
- Treatments need to be built with durability in mind, so people cannot bypass the treatment by altering or destroying it. During the meeting discussion, it was highlighted that at one location they had installed incrementally more significant barriers only to have people destroy them; finally they installed large pipes filled with concrete.

source: Fitzpatrick

Figure 53. Example of gap between guardrail and barrier fencing where pedestrians could bypass safety treatments. Situation was immediately reported when observed by a Tri-Met representative.

- Transit centers appear complex and present the challenge of a rush of people transferring to make connections with other transit options.
  - Gateway Center Transit Center has many bus connections, three rail lines at three platforms, a medical establishment next door, and an adjacent bike path. Recent upgrades include the installation of extra safety treatments, such as bedstead barriers, signs, and markings, along with extensive fencing to direct people to the appropriate crossing locations.
  - The Rose Quarter Transit Center has many buses at several different locations, two separate train stations located several hundred feet apart, the professional basketball arena, and a bike path.
  - Bus stops are also usually present adjacent to other train stations, creating a similar issue at a smaller scale.
- Several station locations involved bike or multi-use paths through the area, which can bring additional complexity to crossing designs and pedestrian movements. Locations observed or mentioned include the Gateway Center Transit Center (see Figure 54), Rose Quarter Transit Center, and Gresham Central Transit Center.

source: Fitzpatrick

Figure 54. Multi-use path crossing at the Gateway Center Transit Center.

Observations Related to Traffic Control Devices – Markings and Detectable Warnings for Portland

The following are observations related to markings and detectable warnings:

- Pavement markings and detectable warnings were observed throughout the system. The concept for detectable warnings discussed was that the truncated domes strips would be provided to indicate pedestrians are entering or leaving a hazard area (i.e., entering or leaving the roadway crosswalk or prior to or clearing the rail track). For example, detectable warning at the sidewalk ramp indicates entry into the crosswalk across lanes of vehicle traffic. Figure 55 demonstrates the detectable warning for a pedestrian crossing of a rail.
- The Portland system used STOP HERE pavement stop bars (white lettering on solid red bar) behind detectable warning strips (see Figure 55) and also behind swing gates (see Figure 56). In some locations, the STOP HERE pavement marking was present without the detectable warning, as demonstrated in Figure 57.

source: Warner

Figure 55. Example of detectable warning at station pedestrian crossing.

source: Fitzpatrick

Figure 56. Example of STOP HERE pavement marking in conjunction with a swing gate.

source: Fitzpatrick

Figure 57. Example of STOP HERE pavement marking without detectable warning.

- At locations where it may appear that there is sufficient space between tracks for people to wait, DON'T WAIT HERE pavement markings were placed between the tracks (example shown in Figure 58).
- Figure 59 shows wide transverse pavement lines indicating the limits of the crossing.

Source: Fitzpatrick

Figure 58. Pavement markings in Portland informing pedestrians to DON'T STAND HERE.

source: Fitzpatrick

Figure 59. Crossing containing DON'T STAND HERE marking and transverse crosswalk lines.

Observations Related to Traffic Control Devices – Signs for Portland

The following are observations related to signs:

- There is extensive use of signs with black LOOK BOTH WAYS letters throughout the system. There were three different designs noticed: oncoming trolley with the Tri-Met logo (see Figure 60), side profile of a trolley (see Figure 61), and oncoming commuter rail train (see Figure 62). In addition, the white with black lettering LOOK sign included within the MUTCD was also noted (see Figure 63).
- The agency is working with the Oregon DOT to include their black on yellow diamond sign in the Oregon MUTCD. Tri-Met believes their design is more effective than the general LOOK sign currently within the Oregon MUTCD.
- In some cases, larger signs (from 18 to 24 inches) with larger lettering are being used to be more visible for wider crossings.
- The placement location of these signs varied, most likely a result of considerations at each crossing.
- The signs were used both parallel and perpendicular to the tracks.
- At one location two signs were stacked on top of each other, with the lower sign presenting the LOOK BOTH WAYS message in Spanish (see Figure 60).
- STOP signs were also used in conjunction with LOOK BOTH WAYS signs. One example was a multi-use path crossing (see Figure 64). Another station had STOP signs at the pull gates (see Figure 65).
- An example of the use of the MUTCD-compliant LOOK sign, in conjunction with the crossbuck assembly is shown in Figure 63).

source: Fitzpatrick

Figure 60. Example of oncoming trolley sign with Tri-Met logo.

source: Fitzpatrick

Figure 61. Example of oncoming trolley sign with side view of trolley.

source: Fitzpatrick

Figure 62. Example of oncoming commuter rail train.

source: Fitzpatrick

Figure 63. Example of MUTCD LOOK sign (left side) and Tri-Met LOOK BOTH WAYS sign (right side) used at a Portland crossing.

source: Fitzpatrick,

Figure 64. Example of STOP sign on multi-use path.

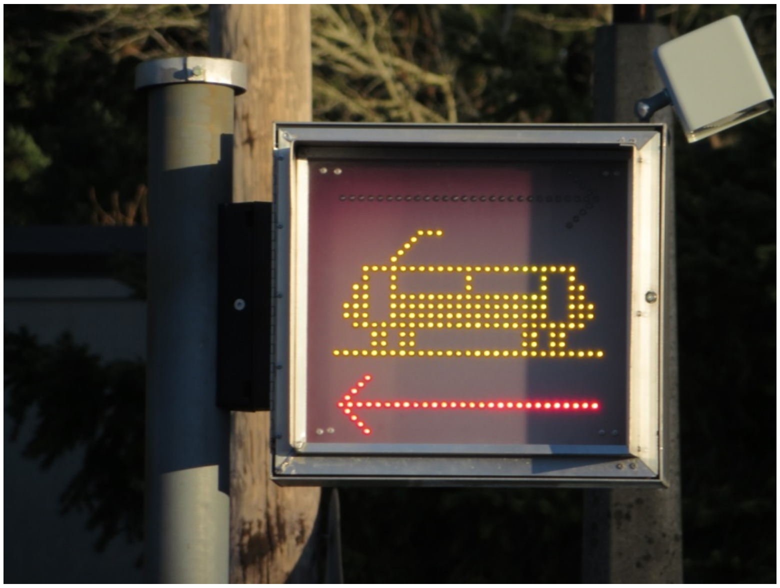
source: Fitzpatrick

Figure 65. Example of STOP sign with swing gates.

Observations Related to Active Traffic Control Devices – Signals or Audible Warning Devices for Portland

The following are observations related to signals or audible warning devices:

- The active blank out signal directing pedestrians to look both ways was used at several locations. It provides a white silhouette of a trolley car with red arrows alternating in opposite directions. While it has been compared to a second train coming signal, it does not direct the pedestrian that a second train is approaching but is designed to encourage people to always look in both directions upon traversing tracks. Figure 66 shows an observed active blank out signal with audible warning speaker on top.
- Discussed at the meeting that included the Portland Bureau of Transportation members was changing the signal timing at the Rose Quarter Transit Center from accommodating the pedestrian crossing of the street/rail from one stage to two stages. The City standard is to provide one stage crossings, but in this case a longer clearance interval resulted in fewer opportunities to cross (more delay) for pedestrians. Also revealed was a high number of pedestrian crossing when the signal showed the raised hand (i.e., do not walk) probably due to the long cycle length present as a result of the long crossing times. Implementation of a two stage crossing is beneficial for most of the people at this particular location because the majority of users are traveling to the median. Rather than having a phase with a long crossing time that would permit the crossing of the entire street/rail, they timed the signal so pedestrians could cross to the median. The pedestrian would then need to push the pedestrian button in the median to obtain the walk signal for the second stage crossing. The two-staged pedestrian signal timing has a shorter pedestrian flashing DON'T WALK interval resulting in a shorter cycle. A shorter cycle allows the pedestrian walk signal to occur more times within a given time period.
- Noted during the meeting was that pedestrian push buttons should be present when the train station is located in the median, otherwise a pedestrian could be stranded in the median.
- The agency maintained two designs for active pedestrian flashing light assemblies (see examples in Figure 67 and Figure 68). With a beacon height of approximately 5 ft, these lower height flashing light assemblies are perceived to draw the pedestrian's attention better than the beacon mounting heights used for roadside assemblies (7.5 ft to 9.5 ft). The design at the recently upgraded Orenco/231st Station includes the new pedestrian crossbuck with flashing light assembly. This assembly has the crossbuck, LOOK sign, flashing red lights, and an audible speaker on top (see Figure 67). The use of the pedestrian LOOK BOTH WAYS sign along with red flashing lights was observed at several locations. These assemblies also have an audible warning speaker on the top (see example in Figure 68).



source: Fitzpatrick

Figure 66. Example of active blank out signal with audible warning.

source: Fitzpatrick

Figure 67. Example of the pedestrian flasher with crossbuck sign.

source: Fitzpatrick

Figure 68. Example of the pedestrian active signal system with LOOK BOTH WAYS sign.

Observations Related to Active Traffic Control Devices – Automatic Gates for Portland

The following are observations related to automatic gates:

- No automatic pedestrian gates were observed during the site visit. It was indicated that they maintain these at one location but prefer the use of the swing gates over the pedestrian gate arms. Figure 69 provides an example of the use of channelization and swing gates at a location with active vehicle warning devices.

source: Fitzpatrick

Figure 69. Example of the use of swing gates at location with active vehicle warning devices.

Observations Related to Design of the Crossing for Portland

The following are observations related to design:

- The crossings for streetcar and downtown in-street running light rail operations generally involve traffic control signals with pedestrian signal heads and detectable warnings. Median-running and higher speed operations generally involve a design to impede movement through the crossing by utilizing a Z-crossing, bedstead barriers, or pedestrian swing gates.
- Streetcars had curbside platforms, similar to light rail platforms but generally shorter.
- The observed pedestrian-only crossings were a Z-crossing configuration. These locations provide crossing locations beyond the major roadway intersections. Two slight differences in the Z-crossing configuration were observed, one with the perpendicular path across the tracks and one with a skewed path across the tracks. An example showing how pedestrians are not allowed to travel straight through the crosswalk and across the track is demonstrated in Figure 70. Figure 71 and Figure 72 provide examples of straight and diagonal crossing designs.

source: Fitzpatrick

Figure 70. Example of a pedestrian-only crossing configuration for a median-running train.

Source: Fitzpatrick

Figure 71. Example of a straight pedestrian-only crossing.

source: Fitzpatrick

Figure 72. Example of a diagonal pedestrian-only crossing.

- Portland utilized a split station design at a few locations. It was explained that limited right-of-way availability may require split stations since this configuration requires less right-of-way width compared to a station with both platforms together. One advantage is if a train overruns the station it will not slide into an intersection. Several disadvantages seem to exist for pedestrians, however, for a split station configuration. The most notable is the potential for patrons to exit the train and cross behind the train they just exited toward the second track. A train traveling in the other direction heading for the platform on the other side of the intersection could be traveling through on the second track creating the second-train hazard.

- Midblock street crossings to a median-running rail line provide either access to a station entrance or the opportunity to cross to the other side of the roadway without walking a significant distance to cross at an intersection. For visually impaired individuals, midblock street crossings could be more difficult to find, may not have pedestrian signals, and may not have other pedestrians to guide their actions. The pedestrian-only crossings outside a major intersection typically utilized the Z-crossing configuration.
- Both the streetcar and light rail trains had low entry vehicles, which utilize low platforms that are generally open from both directions.

Observations Related to Orientation and Mobility for Portland

The following are observations related to orientation and mobility:

- Consistency benefits the blind and physically disabled communities and is one of the major themes for Portland; however, unique site conditions affect the design implemented at a station.
- Some of the median station locations could be difficult for a blind person to find where to enter a station. A blind pedestrian may not be able to locate the station entry after crossing the street because the blind pedestrian may not know when to turn to enter the station.
- The bedstead channelization system used throughout the Tri-Met system could present an issue for a blind person using long white canes because they could hit several different barriers and may not become properly aligned to cross the track. The use of a guide dog may not present a similar problem, as indicated by a CAT member who utilizes a guide dog.
- An issue identified by the Orientation and Mobility Specialist was that a visually impaired person not already familiar with stations may be confused by the different configurations, including split platforms, center platforms, and triple platforms.
- The Orientation and Mobility Specialist highlighted Tri-Met's helpline as being a very good resource for individuals, specifically complimenting the patience displayed by Tri-Met personnel when dealing with those that call.
- Loud ambient noise near crossing locations, such as those from a freeway, can make crossings and stations more challenging for vision impaired individuals because of the interference with their normal audible cues or the audible systems at the crossing, such as warning systems or those that are part of the pedestrian signal systems.
- The agency currently has a few locations in which they provide channels (also called tracks) to direct blind pedestrians. The pedestrian-only crossing at Interstate and Wygant on the Yellow Line has remnants of previous efforts (see Figure 72) to provide guidance, such as yellow raised bars; however, the raised bars are no longer being distributed. Portland is investigating a metal product; however, the metal nature of the product causes

challenges with installation and presents a concern for stray current, which could shock a guide dog. They are exploring an epoxy to break the seal with the ground to minimize the shock potential. They also are looking at other products.

source: Fitzpatrick

Figure 73. Example of an apex ramp in downtown Portland.

- Consistency in placement of fare machines is currently under review.
- There were several observed issues related to the large counterweight on the vehicle active warning system protruding into the pedestrian way. Specific efforts were undertaken at other locations to protect against the counterweight (see Figure 74).

source: Fitzpatrick

Figure 74. Example of protection from the counterweight.

- When the flashing red lights within a pedestrian flashing light assembly are mounted lower than 7 ft (as they are in Portland) the lights should be 2 ft from sidewalk.
- Tri-Met does provide audible signal at bus and rail stations.

Observations Related to Crossing Surface for Portland

The following are observations related to crossing surface:

- Crossing surfaces were generally smooth and in good condition.
- Several downtown locations presented challenges due to the number of tracks and the angles of the track to the pedestrian crossing. The multiple tracks and angles caused difficulties for wheelchair users. Example photos are presented in Figure 75 and Figure 76.
- Several crossing surfaces are used; for example, Figure 71 shows an example of a red rubber slab surface being used between the tracks at a pedestrian-only crossing.

source: Fitzpatrick

Figure 75. Example of multiple tracks arraigned at different angles.

source: Fitzpatrick

Figure 76. Example of pedestrian crossing tracks while train is present.

Observations Related to Fences and Barriers for Portland

The following are observations related to fences and barriers:

- The agency extensively uses fencing and barriers to direct people to the proper crossing location (i.e., bollards with chains between the tracks, along the outside of a track alignment, and channeling to pull gates) and to positively direct pedestrian movement across the tracks (i.e., bedstead, Z-crossing configurations, and pedestrian swing gates).
- Shrubs are used in lieu of fencing at some locations.
- Handles were utilized to prevent people from walking between the track and channelization (see Figure 77) and to prevent people from stepping around channelization to enter a street (see Figure 78). Handles were also used between light/catenary poles and fencing (see Figure 79) for similar reasons.
- The agency looks for worn trails to determine where people are walking along and over the tracks in order to determine proper fencing or barriers. One discussion highlighted a time they went out after it had snowed to look for tracks in the snow that indicate

locations where people were bypassing existing fencing. They identified several locations for corrective measures with this technique.

source: Fitzpatrick

Figure 77. Example of handle barriers between track and channelization.

source: Fitzpatrick

Figure 78. Example of handle barriers between channelization and street.

source: Fitzpatrick

Figure 79. Examples of handle barriers between pole and fencing.

- Fence and barrier design is often dictated by the jurisdiction in which the system is running. For example, one jurisdiction may require a more architectural looking barrier. Observed barrier designs include chain-link fencing, bedstead or tubular fencing (see Figure 80), bollards with chains (see Figure 79), and others considered more architectural in nature.

- The pedestrian swing gate design stops momentum, requiring the pedestrian to stop and look before entering the track space. They are used throughout the Tri-Met system but were characterized as one of the tools in the toolbox and are an item of last resort due to maintenance issues and reliability concerns. Specifically mentioned is the difficulty in keeping the spring tensions optimized (see Figure 81). The agency indicates they are removing some of the existing gates in favor of one of the channelization designs. Several bicycle users were observed passing through swing gates, which required them to walk their bikes through the crossing.
- An idea discussed and observed is to provide channelization farther upstream of the crossing to have the pedestrians within the barrier before they can easily step into the roadway to bypass the crossing safety treatments.
- Along the streetcar alignment, the research team observed barriers being used at several stations to direct pedestrians to the platform or the appropriate street crossing at the end of the platform (see Figure 82). For example, at a location where the streetcar made a right turn while traveling adjacent to the sidewalk, fencing exists between the sidewalk and street/rail line to keep people from entering the street except at the designated crosswalk (see Figure 83).
- The agency also utilizes temporary fencing or barriers, with one example being at the Rose Quarter Transit Center (see Figure 84), where the adjacent arena periodically generates high transit usage.

source: Fitzpatrick

Figure 80. Example of tubular fencing.

source: Fitzpatrick

Figure 81. Swing gate being pushed open by wind.

source: Fitzpatrick

Figure 82. Example of barrier guiding pedestrians to crossing.

source: Fitzpatrick

Figure 83. Example of barrier preventing crossing other than at designated spot.

source: Fitzpatrick

Figure 84. Temporary barriers at the Rose Quarter Transit Center.

Observations Related to Train Operations for Portland

The following are observations related to train operations:

- Trains reduce their operating speeds down to 20 mph at several locations near school zones (see Figure 85).
- The train system will override the train operator if the train is going too fast on an approach to an intersection when the train signal system requires the train to stop prior to the intersection.
- The trains were equipped with several different audible warning devices including bell and whistle sounds.
- Training and involvement of train and bus operators for pedestrian safety appeared to be significant within Tri-Met as part of an effort to heighten awareness throughout the agency. Train operators are taught to use their eyes to spot hazards by turning their heads to keep peripheral vision wide open.
- The individual who is in charge of train and bus operator training also has ADA compliance responsibilities.
- The agency has been using video cameras suction-cupped to lead train vehicles to record all alignments. These videos are used in training sessions.
- Tri-Met has an online page that staff can use to note safety issues or other needs such as tree trimming. In addition, train operators, if requested, can go into the field and provide input into safety concerns and possible solutions.

source: Fitzpatrick

Figure 85. Example of trains entering/exiting a marked school zone.

Observations Related to Other Features for Portland

The following are observations related to other features:

- It was noted at one station that classical music was played over speakers at the station, with the theory to calm people at the station and/or drive people away who are loitering.
- Some of the in-street operations in the downtown Portland area had a different surface than the neighboring vehicle lanes to show visually and tactually where the train operates. Figure 86 shows the brick-pattern surface for vehicles with the smooth concrete surface for the train in downtown Portland. Figure 87 also shows a different color line between train and vehicle lanes to indicate the dynamic envelope for the train. None of these differences in color or texture would be highly detectable to people with visual impairments, however.
- Portions of the Yellow/Green light rail line in downtown operated within the middle of the street, with a bus lane on one side and vehicle lane on the other. On approach to station platforms, the track switched to curbside. These alignments always maintained separation from vehicular traffic (see Figure 88 for a photo of this alignment with associated traffic sign shown in Figure 89). Other areas operated adjacent to the sidewalk area but remained separated from vehicular traffic. Portions of the Red/Blue line examined through downtown that operated adjacent to the sidewalk had the brick pavement within the path of the train (see Figure 87).
- The observed streetcar alignments generally had parking between the sidewalk and the streetcar lane, which is shared with vehicular traffic. An example is presented in Figure 90.

source: Fitzpatrick

Figure 86. Example of using smooth concrete for train as compared to the brick pattern in neighboring lanes.

source: Fitzpatrick

Figure 87. Example of surface treatments and a dynamic envelope surface treatment involving brick.

source: Fitzpatrick

Figure 88. Example of rails separate from vehicle traffic at the boarding location.

source: Fitzpatrick

Figure 89. Sign indicating lane only for light rails.

source: Fitzpatrick

Figure 90. Example of streetcar operations along with vehicles in downtown Portland.

LOS ANGELES SITE VISIT

Meetings in Los Angeles

The research team visited with several individuals during meetings held at the LA Metro office and at orientation and mobility specialists' offices.

Site Visits in Los Angeles

The team visited 15 light rail grade crossings in the LA Metro system, some at stations adjacent to a motor vehicle crossing, some adjacent to a motor vehicle crossing (no station), some within stations, and some pedestrian-only crossings. Crossings were visited on the Gold, Blue, and Expo lines. These lines have a mix of semi-exclusive alignment with both separate and shared right-of-way. A LA Metro employee graciously drove the research team to each of these crossings and provided very helpful background information on each line, station, and crossing. Team members alighted at each crossing to make personal observations, notes, and photographs.

The team visited four commuter rail grade crossings on the Metrolink system, one on the Green Line, and three on the Orange Line. The Metrolink system has semi-exclusive alignment, protected for much of its length by barrier fences. It is side running. The team visited Metrolink crossings either on foot from their hotel or by rental car.

Observation Development for Los Angeles

During the three and one-half days in Los Angeles, team members took time periodically to collaboratively list key observations based on the site visits and meetings. The following sections summarize the observations grouped within broad categories that may be used with the presentation of treatments within the *Guidebook*.

General Observations for Los Angeles

The following are general observations for Los Angeles:

- LA Metro, Metrolink, and the City of Los Angeles DOT work collaboratively to address problems at shared or adjoining properties, recognizing that many rail grade crossings are accessed via public rights-of-way and that treatments need to be well-coordinated.
- LA Metro, Metrolink, and the City of Los Angeles DOT are very conscious of both pedestrian safety and the need to make rail grade crossings accessible to people with disabilities. The *Manual on Uniform Traffic Control Devices* (*4*), the *Americans with Disabilities Act Standards for Transportation Facilities* (*16*), and *California Title 24* (*42*) are all used in making engineering decisions.
- LA Metro has an Access Advisory Committee and also consults with the Braille Institute regarding accessibility issues and treatments.
- LA Metro is willing to experiment with novel devices, for example the 2nd train sign shown in Figure 91 and Figure 92.
- Throughout the LA Metro system, extensive use is made of fencing between roadways and tracks (Figure 93). In some locations curbs are used (see Figure 94). Fencing is also

commonly used to prevent pedestrians from crossing rails where no crossing is intended (see Figure 95).

- Most of the LA Metro light rail system operates under 35 mph, with the Blue Line mid-corridor section operating above 35 mph.
- LA Metro has “between-car barriers,” on the platforms consisting of safety-yellow break-away flexible delineators, closely spaced, approximately 24 inch high, and approximately 2 inch diameter, that are intended to span the full opening between rail cars, including any tapering at the ends of vehicles when trains are stopped at indicated locations (see Figure 96). These between-car barriers are intended to prevent passengers with visual impairments from mistaking the gap between cars for the entrance to a rail car and potentially falling between cars.
- The high platforms of the LA Metro light rail system stations allow for the stations to have limited entrance and exit points. Low-platform stations viewed in Portland and Boston tend to allow pedestrians to more freely cross the track or access the platforms.
- In almost all locations, both LA Metro and Metrolink utilize pre-existing railroad rights-of-way. Integrating light rail and commuter rail into existing rights-of-way means that space for providing optimal and accessible access to rail crossings and to the platform is quite limited, resulting in compromises. In some locations, rails carrying freight are still in use parallel to light rail.
- Perhaps because of the use of pre-existing railroad rights-of-way; treatments are more standardized across individual lines than was seen in Boston or Portland. Nonetheless, crossings vary by number of pedestrians, geometry, signalization, and movement patterns of vehicles at adjacent intersections. Therefore, while there are design standards and preferred treatments, no one set of treatments is appropriate for all crossings, even along a single line.
- In general, crossing surfaces, markings, signs and other treatments were in good condition. All LA Metro and Metrolink lines are relatively recent, and the climate is not characterized by freezing and thawing.
- Along some LA Metro lines there is multiple line ownership, including freight, resulting in some conflicting policies about design features such as the use of automatic pedestrian gates with or without swing gates.
- Plans are currently being undertaken to update the LA Metro Blue Line to the current standards.

source: Fitzpatrick

Figure 91. The pictogram within this blank out sign shows a side view of a train approaching from the left.

source: Fitzpatrick

Figure 92. The pictogram within this blank out sign shows a side view of a train approaching from the right.

source: Fitzpatrick

Figure 93. Fencing between roadway and tracks.

source: Fitzpatrick

Figure 94. Curbing between roadway and tracks.

source: Fitzpatrick

Figure 95. Fencing prevents pedestrians from crossing at the corner and leads to the swing gates at crossing location.

source: Fitzpatrick

Figure 96. Flexible delineators between ends of rail cars prevent visually impaired travelers from falling between cars.

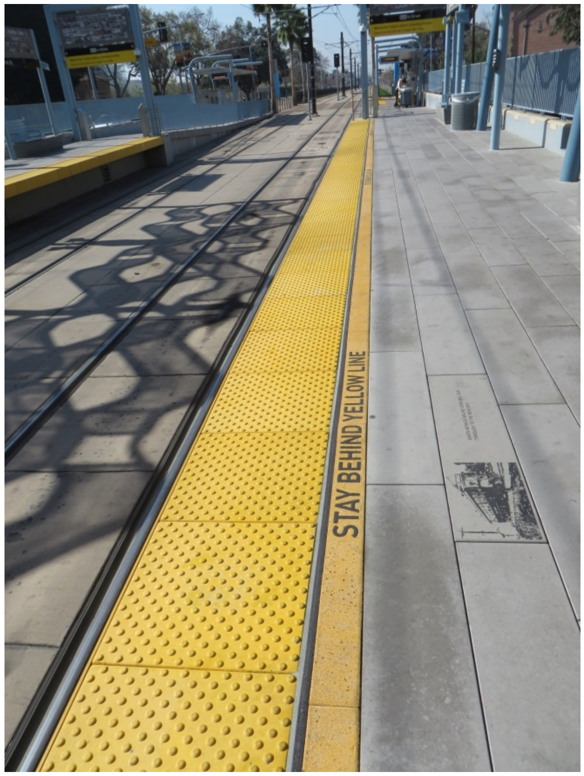
Observations Related to Traffic Control Devices – Markings and Detectable Warnings for Los Angeles

The following are observations related to markings and detectable warnings:

- When detectable warnings are used consistently, their presence on a curb ramp or blended curb indicates the location of a pedestrian crossing, their presence on islands and medians indicates the location of a refuge (between a set of detectable warnings), and their presence on transit platforms indicates a safe distance to wait for a train. *California Title 24* (*42*) requires detectable warnings that are 24 inch deep along transit platform edges and 36 inch deep in the direction of travel in all other locations. Detectable warnings were widely used at both LA Metro and Metrolink crossings where there were pedestrian refuges, but were not used on pedestrian grade crossings where there was no refuge. Detectable warnings are not intended to serve as direction indicators because it is not possible for most pedestrians who are visually impaired to establish a good direction based on the domes. They are for safety not wayfinding.
- Twenty-four inch deep truncated dome detectable warnings complying with the *Americans with Disabilities Act Standards for Transportation Facilities* (*16*) were observed along the full length of platforms and boarding areas (see Figure 97). Most platform edge detectable warnings were yellow, complying with *California Title 24* (*42*), but a few were white or black.
- Detectable warnings were common on curb ramps from sidewalks to crosswalks that crossed rails. These were typically 36 inch deep in the direction of travel and yellow, as required by *California Title 24* (*42*), which is more stringent than the *Americans with Disabilities Act Standards for Transportation Facilities* (*16*). However, in some older neighborhoods there has been no recent work on curb ramps and there were no detectable warnings on those ramps.
- When a refuge or platform within a street crossing is not present, detectable warnings are not required at the rails within the street. However, if there is platform access to a center-running rail line, a pedestrian who is blind or visually impaired may not be able to locate the median and platform area if detectable warnings are not provided on the edges of the median island.
- At crossings within stations, detectable warnings were usually on each side of the rails to identify the rail crossings as seen in Figure 98, or to identify a refuge between rails as seen in Figure 99.
- Figure 100 is an example of detectable warning with a pedestrian gate arm. The yellow truncated dome surfaces, varying from 24 inch deep to 36 inch deep, were placed across the full width of the pedestrian way and typically extended away from the gate arm on the side opposite the rail. A pedestrian who is visually impaired who detects the truncated domes in the vicinity of a rail crossing is expected to understand that if a train is approaching, they should stand behind the truncated domes to avoid both being too close to the track when a train crosses and being struck by a descending or ascending gate arm.
- Detectable warnings were also sometimes observed where there were swing gates, where they were typically placed immediately preceding the swing gates on the side away from the tracks as in Figure 101 but might also be placed on the rail side as in Figure 99 or extending on both sides of swing gates as in Figure 102. Detectable warnings, when used, should be on the side of the gate away from the tracks. In general, detectable warnings

are placed on a pedestrian way to indicate that immediately beyond them, there is a hazard. Pedestrians who are visually impaired usually wait behind detectable warnings. Figure 101 is a good example of the preferred use of detectable warnings preceding a swing gate and also at the beginning of the median where there is a small refuge between the roadway and the gate.

- In some locations, detectable warnings appeared to have been installed to indicate to pedestrians who are visually impaired that they could be walking into an area where they could be struck by the counterweight of either a pedestrian or vehicular gate arm (see Figure 104). However, at other locations where pedestrians with visual impairments were clearly at risk from counterweights, there was no indication (see Figure 105). A better solution to protecting pedestrians from counter weights is to provide a barrier, as is done in Portland.
- At several LA Metro crossings, diagonal black and yellow striping was used in the vicinity of rail crossings to indicate the dynamic envelopes of rail cars, as seen in Figure 106. This treatment was not observed at Metrolink rail crossings.
- Of particular interest was solid red paving observed at two stations on the Gold Line (see Figure 107). Both of these stations adjoined intersections where other crosswalks were similarly marked. Most of the width of the crossing was stamped in a grid pattern; however, an area approximately 6 feet wide and the full length of the crossing had no stamped pattern. This would enable pedestrians who had difficulty traversing bumpy surfaces to travel on a smooth surface with the exception of crossing the rails themselves.
- Also observed at two stations on the LA Metro Gold Line were approximately 3 inch diameter raised white dome markers along the edges of the crossing. These are understood to have been installed as a deterrent to traveling outside the crossing, especially for persons on bicycles. However, they would also be a good indication to pedestrians who are visually impaired who were familiar with those locations that they were at the edge of the crossing (see Figure 107).
- Pavement markings along observed street-running sections of Metrolink were transverse crosswalk lines. In-station rail crossings were unmarked but edges of crossing itself, as seen in Figure 98, may provide good guidance to pedestrians who are visually impaired.
- WAIT HERE pavement word markings (see Figure 108) were commonly used on LA Metro rail crossings to indicate where pedestrians should wait when trains are approaching.
- Figure 109 is a photo of a station in Los Angeles where the no pedestrian symbol was added to the pavement to inform pedestrians that they should not be in that area. The pavement marking supplements the sign located on the nearby fence. In addition to the symbol, the words NOT A WALK was provided on the yellow crossing edgeline. Raised white buttons were also installed in the area. They provide a tactile warning that the pedestrian or bicyclist has strayed from the appropriate path.



source: Fitzpatrick

Figure 97. Detectable warning along full length of platform edge with an adjacent yellow line that has STAY BEHIND YELLOW LINE word marking.

source: Fitzpatrick

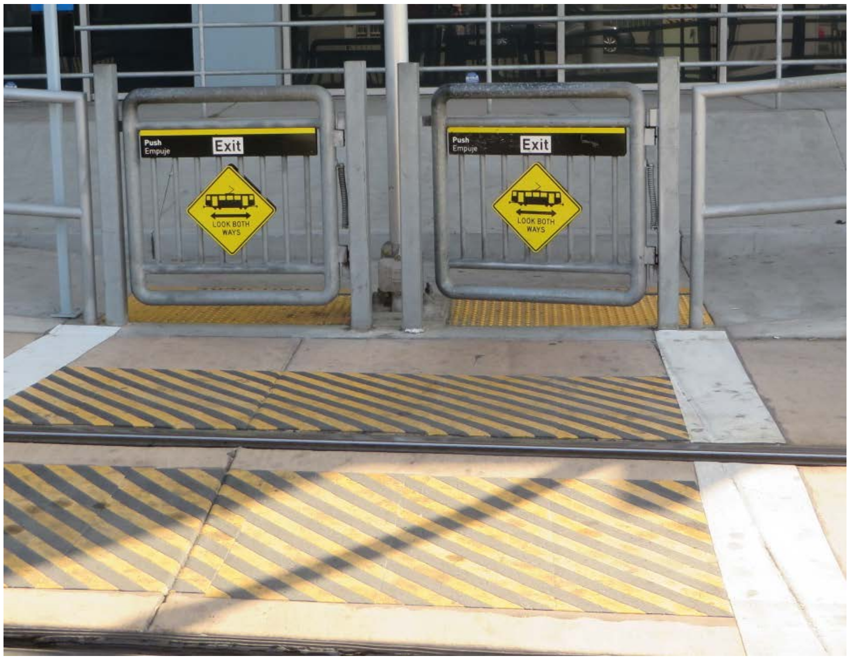
Figure 98. In-station pedestrian crossing.

source: Fitzpatrick

Figure 99. Detectable warning installed inside swing gates.

source: Fitzpatrick

Figure 100. The detectable warning is placed on the side of the gate arm opposite the rail.



source: Fitzpatrick

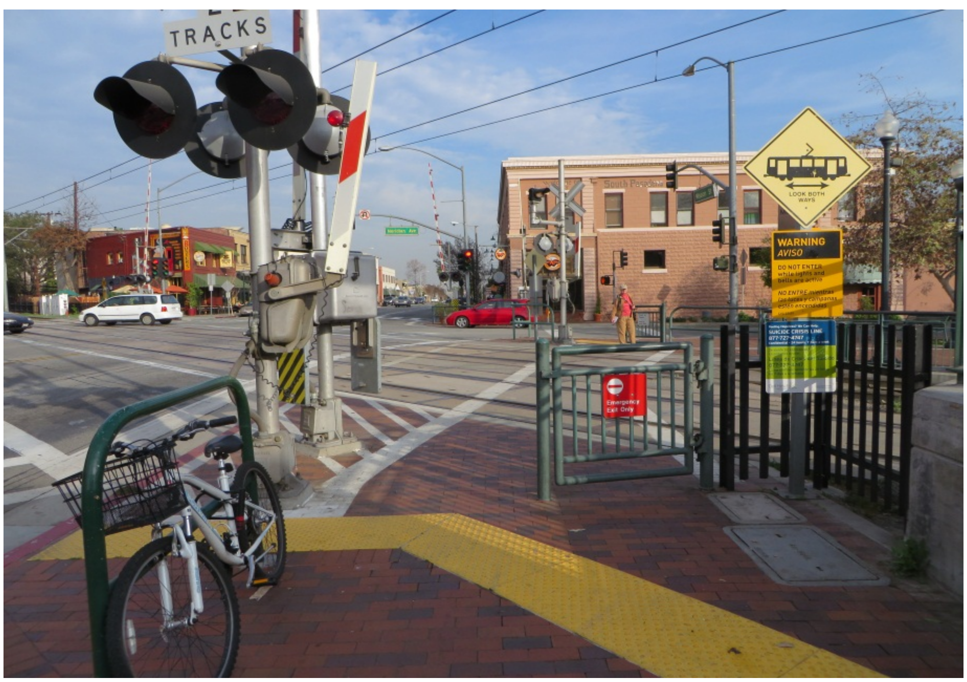
Figure 101. Detectable warning at swing gate on side opposite rails.

source: Fitzpatrick

Figure 102. Detectable warning extending on both sides of swing gate.

source: Fitzpatrick

Figure 103. Preferred use of detectable warnings on curb ramp along with swing gate.

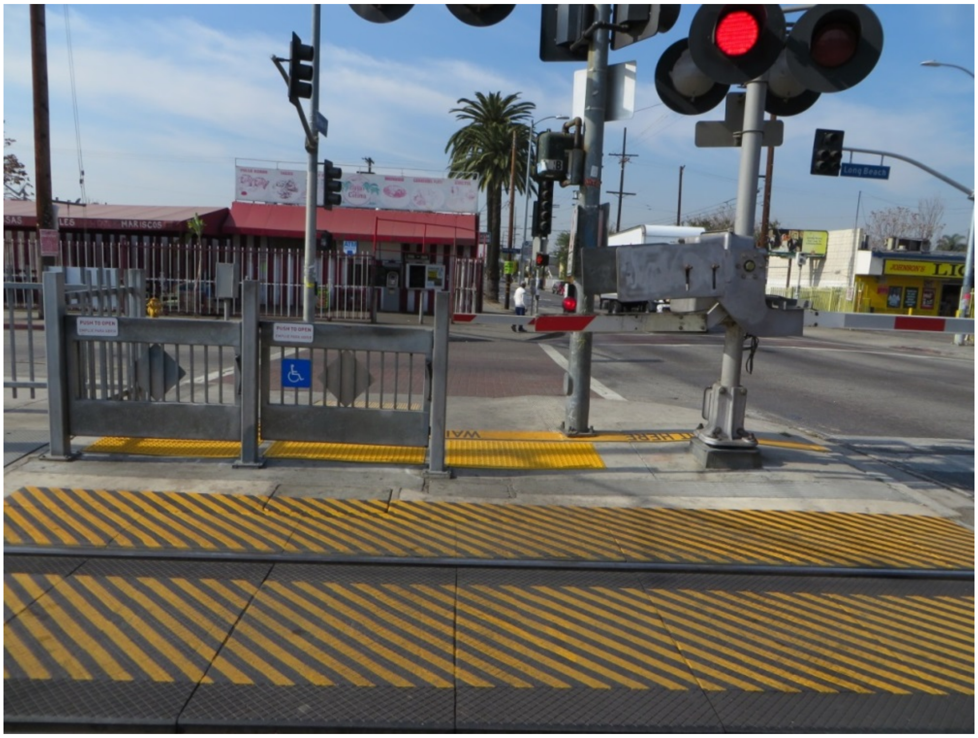


source: Fitzpatrick

Figure 104. Detectable warning surface installed to inform pedestrians who are visually impaired of overhead gate arm hazard.

source: Fitzpatrick

Figure 105. Visually impaired pedestrian has no warning of hazardous counterweight ahead.



source: Fitzpatrick

Figure 106. Diagonal black and yellow striping used in the vicinity of rail crossings to indicate the dynamic envelopes of rail cars.

source: Fitzpatrick

Figure 107. Smooth area within stamped crosswalk provides ADA compliant surface for pedestrians in wheelchairs.

source: Fitzpatrick

Figure 108. Diagonal striping indicates dynamic envelope of train cars; photo shows location of detectable warning and stop line also.

Source: Fitzpatrick

Figure 109. Symbol and word pavement markings supplementing signs to indicate where pedestrians should not be walking.

Observations Related to Traffic Control Devices – Signs for Los Angeles

The following are observations related to signs:

- Pavement markings and vertical signs (words and pictograms) were used to indicate that pedestrians should not walk outside the designated crossing (see Figure 110). These signs were mounted on poles or fences, or sometimes painted on the pavement.
- Swing gates typically had signs about pushing the gate to exit and LOOK BOTH WAYS signs; see examples in Figure 111 and Figure 112. They also sometimes had the international wheelchair symbol. Many signs were in Spanish and English; in Tokyo station, some signs were in Japanese and English.
- At some Metrolink crossings, swing gates were intended to be used only for emergency exiting. They were labeled EXIT ONLY, as approached from the side away from the rails; however they were capable of being pulled open using the top of the gate, as seen in Figure 113. The PUSH GATE TO OPEN sign on the side of the gate facing the tracks is shown in Figure 114.
- In some stations a non-MUTCD rectangular sign with the words RAMP UP, a pictogram of a train, the international wheelchair symbol, and an arrow direct pedestrians to ramps up to platforms (see Figure 115).
- LA Metro platform edges were marked with a 6 inch wide yellow stripe on the side away from the platform edge, with the message STAY BEHIND YELLOW LINE (see Figure 97). A sign used to reinforce this message is shown in Figure 116.
- Suicide crisis signs providing a number to call were installed at crossings on LA Metro (see Figure 118).

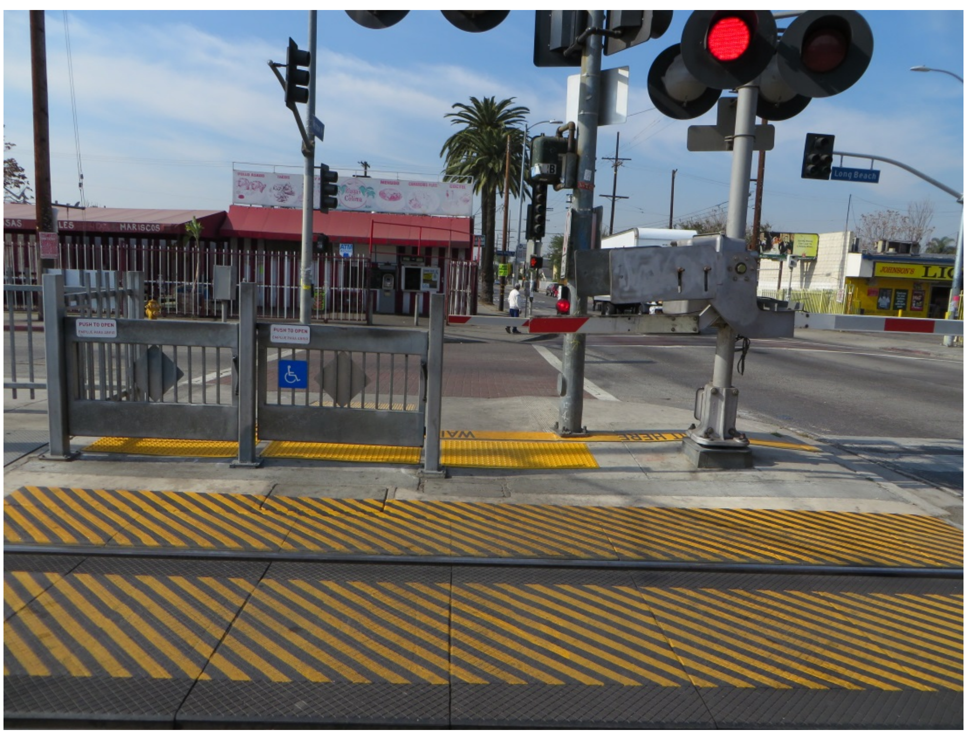
- On grade crossings not associated with stations, the only sign was typically a yellow diamond sign with the message LOOK BOTH WAYS, (see Figure 117 for roadway application and Figure 111 for swing gate example).
- Several white rectangular signs were observed. These signs said:
    - "Railroad crossing Pedestrians and bicycles only."
    - "No pedestrian crossing when lights flash."
    - "Stop here when flashing."
- At some locations, blank-out signs showing a front view of a train when a train was approaching or present were placed next to the pedestrian signal heads so that pedestrians would see them before entering a crossing (see Figure 119, Figure 121, Figure 120, and Figure 122).
- Only installed at a few locations, additional blank-out signs have a pictogram of a train moving with a pedestrian looking both ways (see Figure 91 and Figure 92). Originally conceived to alert users of the direction of an approaching train, recent changes to the operation of this device have it pointing in both directions alternately in order to encourage users to look both ways before crossing the tracks.
- Crossbuck signs accompanied by alternately flashing red lights were used in many locations.
- In quiet zones along Metrolink lines, a rectangular yellow sign with a NO TRAIN HORN message was mounted so that it faced approaching pedestrians. Below this sign was a rectangular white sign with a double-ended arrow saying LOOK, as shown in Figure 123.

source: Fitzpatrick

Figure 110. Pedestrian prohibition signing and pavement marking.

source: Fitzpatrick

Figure 111. Example of swing gate.



source: Fitzpatrick

Figure 112. Another example of swing gate next to automatic pedestrian gate arm.

source: Fitzpatrick

Figure 113. Example of swing gate for emergency exit.

source: Fitzpatrick

Figure 114. Example of swing gate for emergency exit from rail side.

source: Fitzpatrick

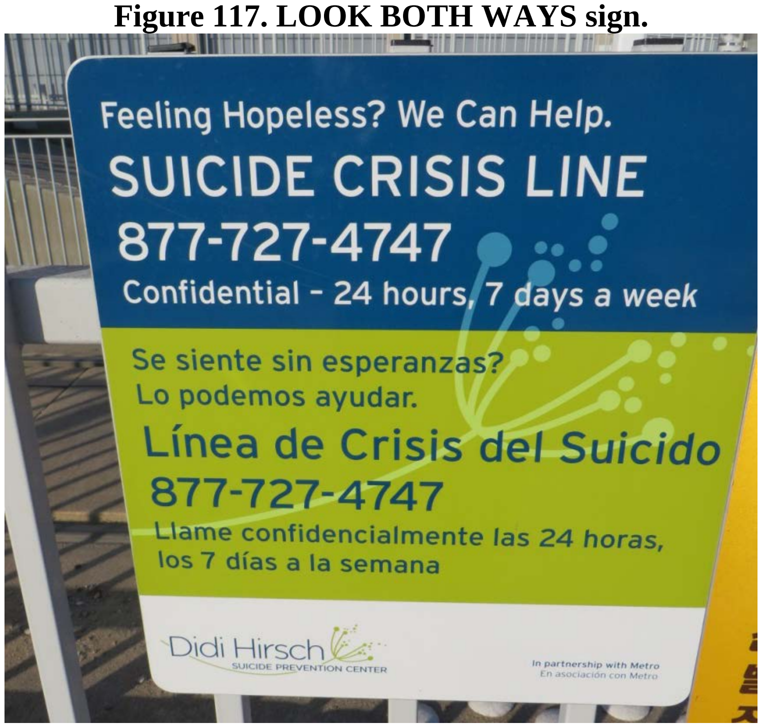
Figure 115. Sign directing pedestrians to the ramp to the boarding platform.

source: Fitzpatrick

Figure 116. Example of sign used at a Metrolink station to reinforce the pavement marking message of staying behind yellow line.

source: Fitzpatrick

Figure 117. LOOK BOTH WAYS sign.



source: Fitzpatrick

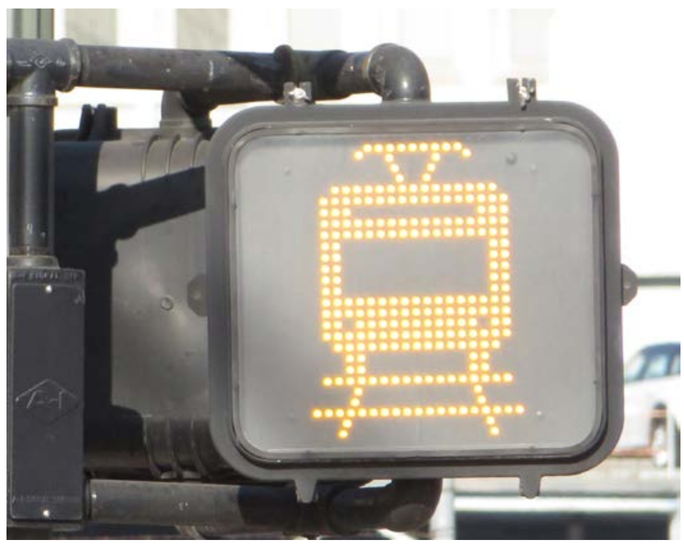
Figure 118. Suicide crisis sign.

source: Fitzpatrick

Figure 119. Example of pedestrian signal head used at a pedestrian crossing near a station in Los Angeles; note the addition of the blank-out sign showing the train (close-up shown in Figure 121) placed next to the solid upraised hand symbol (see close-up shown in Figure 120) indicating that pedestrian should not start a crossing.

source: Fitzpatrick

Figure 120. Close-up of countdown indication used in conjunction blank-out sign.



source: Fitzpatrick

Figure 121. Close-up of blank-out sign used in conjunction with pedestrian signal head.

source: Fitzpatrick

Figure 122. Another example of train blank-out signs mounted next to pedestrian signal head since that is the area where pedestrians should be looking.

source: Fitzpatrick

Figure 123. Signs used at quiet zones.

Observations Related to Active Traffic Control Devices – Signals or Audible Warning Devices for Los Angeles

The following are observations related to signals or audible warning devices:

- All grade crossings observed at signalized intersections had concurrent pedestrian phasing, in which pedestrians cross at the same time that vehicular traffic is moving parallel to the crosswalk. The LA Metro preference is to allow clearance time for pedestrians to cross the full width of the roadway, including the rail right-of-way.

- All pedestrian signals at grade crossings or boarding platforms were pushbutton-actuated. There was widespread use of pushbutton-integrated accessible pedestrian signal (APS) at these crossings, with audible and vibrotactile indications and pushbutton locator tones, as specified in the MUTCD 2009 (see Figure 124). All APS were well located, on separate stub-poles if need be, so they were in reach for a pedestrian who was waiting to cross within the width of the crosswalk, and reachable from a level surface for easy actuation by persons using wheelchairs (see Figure 125).
- At grade crossings leading to a boarding platform, where there was always at least a small refuge. Additional pushbuttons were provided at the refuge to enable pedestrians who had alighted from trains to request a pedestrian signal to cross the roadway (see Figure 126).
- Standard grade crossing flashing light signal assemblies exist throughout both the LA Metro and Metrolink system, both with and without gate arms. The flashing light signal assemblies without gate arms were often seen at pedestrian-only station crossings.
- Bells were sounded when trains were arriving and departing, but not when trains were stopped and pedestrian arms were down. Orientation and Mobility Specialists would prefer that bells sound throughout the time the train is in the station so approaching pedestrians who are visually impaired would anticipate encountering a pedestrian arm.
- At one LA Metro station visited, there was an audible announcement before the arrival of a train: “Northbound [or Southbound] train is arriving. Please stand clear of the track.”

source: Fitzpatrick

Figure 124. Pushbutton-integrated accessible pedestrian signal with sign emphasizing where to wait.

source: Fitzpatrick

Figure 125. Fencing channelizes pedestrians to crossing location; figure shows well-located APS.

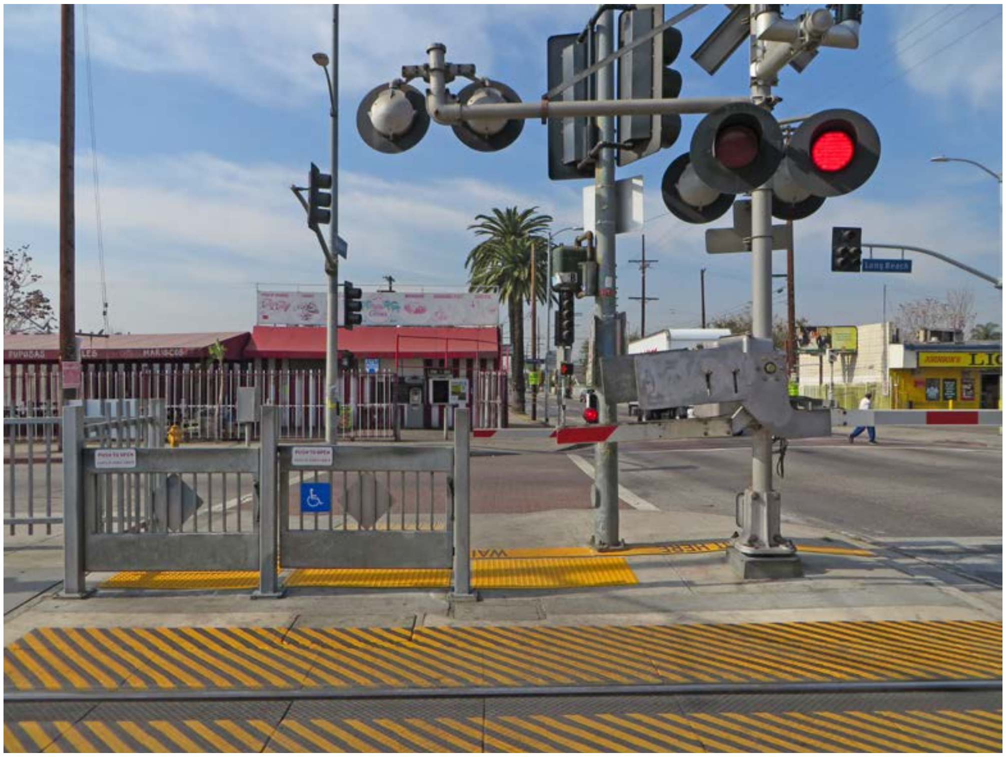
source: Fitzpatrick

Figure 126. APS at bottom of ramp from platform.

Observations Related to Active Traffic Control Devices – Automatic Gates for Los Angeles

The following are observations related to automatic gates:

- The design now preferred by LA Metro includes both four-quadrant automatic pedestrian gates and swing gates opening away from the track, where there is sufficient right-of-way as shown in Figure 127. Where there is insufficient room, swing gates alone may be used. Where both automatic pedestrian gates and swing gates are used, the swing gates are intended to be used for emergency egress. However, where swing gates are used without automatic pedestrian gates, they are intended to provide access to the crossing and emergency egress.
- Where they are used in combination, the swing gates, which always open away from the tracks, allow pedestrians who are crossing rails, as automatic gates descend and block their passage, to escape using a gate so that they are not trapped on the rail side of a gate as a train passes by. A challenge in this design, however, is that pedestrians who are visually impaired may encounter the automatic gate arm and not know that an escape route exists or in which direction to look for it.
- At one Metrolink grade crossing that was not at a station, the escape gate was located in a pocket angling away from the automatic gate (see Figure 128 and Figure 129). This design might be especially confusing to pedestrians who are visually impaired.
- The design to update the Blue Line mid-corridor segment where trains operate over 35 mph dictates the use of automatic pedestrian gates with emergency exit gates.



source: Fitzpatrick

Figure 127. Four-quadrant automatic pedestrian gates and swing gates.

source: Fitzpatrick

Figure 128. Crossing with automatic pedestrian gate arm with LED flashers at pedestrian-only crossing.

source: Fitzpatrick

Figure 129. Closer view of crossing with automatic pedestrian gate and swing gate for emergency egress; swing gate labeled for exit only. It has no kick plate for wheelchair users.

Observations Related to Design of the Crossing for Los Angeles

The following are observations related to design:

- Design of crossings and platforms is constrained by the fact that in most cases, LA Metro and Metrolink use old rail rights-of-way that are median- or side-running and that in many places are characterized by narrow sidewalks and relatively narrow streets. The available width of center platforms on center-running lines is 16 feet. With 4 feet of the width of the platform marked with detectable warnings, where passengers should not be standing, this leaves only 12 feet of available platform for waiting passengers. With platform furnishings, which are minimal, and relatively narrow, there is little room for maneuvering a wheelchair or for pedestrians with dog guides on platforms, as can be seen in Figure 130. With the increasing use of scooters as mobility aids, there will be increasing need for passengers to jostle around each other on narrow platforms to enable people using wheeled mobility aids or dog guides to use transit.
- Where narrow platforms intersect a grade crossing perpendicular to the tracks, there is little room for a refuge, as shown in Figure 131. Maximizing the refuge is needed to accommodate passengers exiting trains during rush hour who must wait within the refuge for a pedestrian phase before they can cross to a sidewalk.
- Where trains are center-running, the side of the pedestrian crossing closest to a motor vehicle crossing is often marked with flexible delineators that serve to indicate to pedestrians, including pedestrians who are visually impaired, the edge of the crossing closest to the intersection (see Figure 132 and Figure 133). For blind pedestrians, these also clearly indicate the need to turn to cross the street when exiting from the station. Another benefit of the flexible delineators is to reduce the likelihood of left-turning vehicles striking pedestrians in the crossing.
- The high-platform design of the LA Metro light rail system stations allows for the stations to have limited entrance and exit points. This compares to some other cities where low-platform stations can, in some cases, allow pedestrians to more freely cross the track or access the platforms. As a result of the high platforms, a great difference in elevation between the boarding platforms and the sidewalk used in association with stations, users have to use a lengthy set of ramps, stairs, or elevators.
- Some station entrances were located between the two rails at one end of the station, while other station entrances required users to enter from one side. In this side scenario a user coming from the other side of the street along the crosswalk may have to cross both sets of tracks, walk to the station entrance, and then cross the track again.
- In one unusual location shown in Figure 134, a pedestrian-rail-only crossing occurs where the roads meet and create an X-shaped crossing, The bicycle crossing was separated from the pedestrian crossing. Pedestrians were well-channelized by curbing in a Z-crossing (see Figure 135) having swing gates on either side of the tracks.
- Orientation and Mobility Specialists observed that there were accessible crossings and continuous accessible routes to boarding platforms from one end of some platforms, typically the end closest to a motor vehicle crossing but not at the opposite end, which might be the desired route for some travelers using wheelchairs who would then have to go far out of their way to reach the platform. At one such station where there is limited right-of-way to construct a ramp at the end of the platform farthest from the vehicle

crossing, but close to the entrance to a large housing complex, installation of a platform lift is planned to provide access instead of a ramp.

- A pedestrian planner also observed that where two boarding platforms for the same station are on opposite sides of a motor vehicle crossing, passengers who need to reverse direction have to travel a long way, which may be difficult for elderly or disabled passengers.

source: Fitzpatrick

Figure 130. Narrow center platforms allow little room for wheelchairs or pedestrians using guide dogs.

source: Fitzpatrick

Figure 131. Pedestrian refuge too small to hold many pedestrians.

source: Fitzpatrick

Figure 132. Flexible delineators on end of median refuge.

source: Fitzpatrick

Figure 133. Another example of the flexible delineators.

Source: Google Earth

Figure 134. X-shaped crossing at Expo and Grammercy.

source: Fitzpatrick

Figure 135. Z-crossing with bollards but not a detectable warning at the edge of the median refuge.

Observations Related to Orientation and Mobility for Los Angeles

The following are observations related to orientation and mobility:

- LA Metro boarding platforms are 3.25 feet above the rail and are primarily accessed by ramps or sloped walkways. Walkways having a slope of 5 percent or less are not considered ramps (*16*). Walkways greater than 5 percent are considered ramps and must comply with requirements for handrails and landings every 30 feet. Ramps greater than 8.33 percent are not permitted (*16*). All ramps or sloped walkways had fencing, which would prohibit any pedestrian from falling off the edge. Many had attached handrails at an accessible height. In general, observed ramps and sloped walkways were continuous, with no level landing, for at least 50 feet (see Figure 136 and Figure 137). Long ramps and sloped surfaces require a great deal of upper body strength to be negotiated by people who use wheelchairs and are taxing for pedestrians who are elderly or who have other mobility challenges. Therefore frequent landings benefit many travelers, and slope should be as little as possible.
- However, decreasing slope and including level landings increases the right-of-way needed, and right-of-way is often limited. Because of limited right-of-way, a platform lift is planned to provide access from new, high-density, housing to the closest end of the boarding platform at one Blue Line station.
- Ramps or sloped walkways are also used to provide accessible routes between platform level and street level or an elevated roadway (see Figure 138 and Figure 139).

- Channelizing fencing can help guide travelers who are visually impaired to appropriate crossing locations; however, the quantity of fencing could also be confusing. Figure 140 shows an example of pedestrian fencing used to guide pedestrians along a long ramp needed to achieve needed elevation change.
- Visually impaired pedestrians needing to cross to the platform on the opposite side of the rails, even if they were relatively familiar with the station, might become confused by the plethora of railings when the same type is used as barriers, handrails at stairs and ramps, and channelizing devices (see Figure 141).
- Where a crossing in a station is paved and the trackbed beside the crossing is crushed stone at a slightly lower elevation, the edge of the crossing serves as an excellent guide to pedestrians who are visually impaired (as seen in Figure 98).
- Wayfinding cues are needed for pedestrians with visual impairments in locations where the angle of grade crossings is different than the direction of approach. For example, as can be seen in Figure 142, pedestrians who are unable to see the marked crosswalk lines at this grade crossing, which bend sharply to the right to cross the tracks at 90 degrees, are likely to travel straight ahead on the same trajectory as that on which they approached the crossing resulting in their traveling far outside the crosswalk.
- Figure 143 shows a crossing at an offset intersection at which pedestrians who are visually impaired who are not very familiar with this crossing would have no indication that the crossing was diagonal to the right and would go straight, ending up in the center of the intersection.

source: Fitzpatrick

Figure 136. Ramp without attached ADA compliant handrails.

source: Fitzpatrick

Figure 137. Ramp with attached ADA compliant handrails.

source: Fitzpatrick

Figure 138. The long and winding walkway in this photo connected the platform with the street approximately 40 feet below.

source: Fitzpatrick

Figure 139. Ramp from station level to street above.

source: Bentzen

Figure 140. Fencing to guide pedestrian to crossing.

source: Fitzpatrick

Figure 141. Abundance of identical handrails at this station would be confusing to pedestrians who are visually impaired who are trying to find the crossing, which is out of view to the left.

source: Fitzpatrick

Figure 142. Inadequate cues for direction of crosswalk, which angles to the right away from previous direction of travel.

source: Fitzpatrick

Figure 143. Diagonal crossing at an offset intersection.

Observations Related to Crossing Surface for Los Angeles

The following are observations related to crossing surface:

- Crossing surfaces varied in material; in both LA Metro and Metrolink crossings, cement was quite common, but asphalt and rubber composite panels were also observed. Cement could be either poured or modular precast panels. See Figure 144 for an example of the use of precast concrete panels.
- Most crossing surfaces were well-maintained having openings for railcar wheel flanges that did not exceed 2 ½ inches, the maximum permitted by the *Americans with Disabilities Act Standards for Transportation Facilities* (*16*) and *California Title 24* (*42*). There were a few exceptions.

source: Fitzpatrick

Figure 144. Precast concrete panels.

Observations Related to Fences and Barriers for Los Angeles

The following are observations related to fences and barriers:

- Fencing was commonly used to channelize pedestrians to grade crossings at both LA Metro and Metrolink stations, as well as to limit their access to non-pedestrian areas.
- Figure 145 shows fencing across a sidewalk to prevent pedestrians from crossing rails where there was no crosswalk on one side of an intersecting street.
- Figure 146 shows fencing to prohibit crossing tracks where crossing is not intended.
- Figure 147 shows fencing that is both a barrier between rails and the roadway, and a barrier against pedestrians crossing the trackbed.
- Figure 148 shows fencing that is a barrier between rails and the roadway, a barrier between a parking lot adjoining a station and the rails where no crossing is permitted, and a channelizing device to guide pedestrians to the ramp up to a boarding platform.
- Fencing along both sides of ramps between the crossing level and the platform level was routinely used to guide pedestrians along ramps. On most of these ramps, there was an ADA compliant handrail attached to the fencing on both sides of the ramp as seen in Figure 137. An ADA compliant handrail is between 34 inch and 38 inch in height above the walking surface, and is continuous and unobstructed along the top and sides. All handrails observed were circular in cross section and had an outside diameter between 1 ¼ inches and 2 inches.
- Figure 149 shows barriers that nicely channelize pedestrians to the center of a crossing.

source: Fitzpatrick

Figure 145. Fencing along with the signs clearly indicates there is no pedestrian crossing at this location.

source: Fitzpatrick

Figure 146. Fencing to prevent pedestrians from crossing trackbed.

source: Fitzpatrick

Figure 147. Fencing between rails and street.

source: Fitzpatrick

Figure 148. Extensive fencing channelizes pedestrians.

source: Fitzpatrick

Figure 149. Channelization that guides pedestrian to appropriate crossing location.

Observations Related to Train Operations for Los Angeles

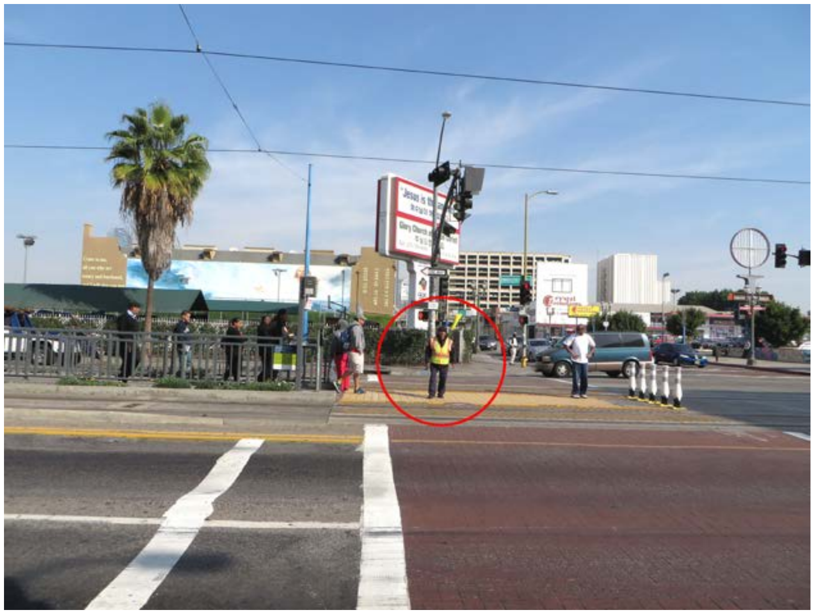
The following are observations related to train operations:

- Along the Blue Line mid-corridor segment where trains operate at speeds greater than 35 mph, train operators have reduced their station approach speed to 25mph. The transit agency has noticed an improved level of safety as a result of this adjustment.
- Operators are required to sound the train horn and come to a stop if a person is observed standing on the detectable warning surface or standing within the dynamic envelope of the train.
- Operators are required to stop in precise locations at boarding platforms so that between-car barriers (see Figure 96) will effectively block a person with a visual impairment from mistakenly attempting to board a train between the cars.

Observations Related to Other Features for Los Angeles

The following are observations related to other features:

- Originally conceived as a short-term educational tool for the opening of new light rail alignment, the Rail Safety Ambassador Program now is regularly utilized throughout the light rail system. The Ambassadors act as the eyes and ears on how users are responding to the crossings. For the opening of a new line, the assistance to the public and interpretation of any safety concerns provides valuable input into any possible safety enhancements at the crossing. Use of Ambassadors on an existing line reinforces proper behavior and provides a continual review of perceived safety concerns that could be addressed by the agency. Ambassadors are trained to blow a whistle, explain the improper behavior, and instruct travelers in the appropriate behavior required to safely traverse the system. Figure 150 and Figure 151 contain examples of Ambassadors (in reflectorized vests) positioned to assist transit users. LA Metro originally utilized the Ambassadors 6 months before and 6 months after the opening of a new line but now maintain 44 working Ambassadors that can work up to 30 hours per week. They are safety trained every 2 years and are equipped with radios for immediate response.



Source: Fitzpatrick

Figure 150. Example of Ambassador positioned in the median at a station entrance.

Source: Fitzpatrick

Figure 151. Example of Ambassador stationed at a crossing.

CHAPTER 7: SUMMARY

This chapter provides a summary of the work for the TCRP project. The objective of the research was to develop a *Guidebook* for treatments for pedestrian crossings of public transit rail services, including light rail, commuter rail, and streetcar services. The *Guidebook on Pedestrian Crossings of Public Transit Rail Services* is available from TCRP (*1*). The following section summarizes the contents of the *Guidebook.* The other section summarizes key findings from the research.

SUMMARY OF *GUIDEBOOK ON PEDESTRIAN CROSSINGS OF PUBLIC TRANSIT RAIL SERVICES*

The *Guidebook on Pedestrian Crossings of Public Transit Rail Services* is organized into the following chapters:

- **Chapter 1: Introduction**. Provides an overview and the scope of the document.
- **Chapter 2: Transit Rail Services**. Presents an overview of the types of transit rail services.
- **Chapter 3: Pedestrian Safety**. Provides an overview of key pedestrian safety issues associated with public transit rail services along with providing an introduction into pedestrian characteristics.
- **Chapter 4: NEPA-Related Issues**. Discusses pedestrian crossing issues associated with the *National Environmental Policy Act of 1969* (NEPA) after presenting an overview of NEPA.
- **Chapter 5: Accessibility/ADA Considerations**. Presents an overview of the key documents regarding the *Americans with Disabilities Act* (ADA).
- **Chapter 6: Treatment Selection**. Summarizes readily available decision flowcharts used to make decisions regarding pedestrian treatments at rail crossings.
- **Chapter 7: Treatment Overview**. Introduces the sections used within Chapter 8.
- **Chapter 8: Pedestrian Treatments**. Presents information for 34 pedestrian treatments used at rail crossings.
- **Chapter 9: Case Studies**. Includes four case studies that examine specific decisions with respect to pedestrian-rail crossings.
- **References**. Lists the references included in the *Guidebook*.

Within each pedestrian treatment discussion the following sections are used:

- **Description.** Provides a short overview of the treatment.
- **Applications.** Discusses why this particular treatment would be installed (e.g., higher speed train operation, large number of pedestrians on an intermit basis). Discusses where it would be appropriate or not appropriate to use this treatment. Limitations with the treatment are also discussed in this section.
- **Implementation.** Discusses how the treatment function and if there are any installation concerns. Provides examples of where the treatment has been installed and if there are any known lessons learned regarding the treatment.

- **Benefits.** Documents benefits (or disbenefits) of the treatment. Also includes any known effectiveness (safety, operations, motorist, or pedestrian behavior) of the treatment.
- **Cost.** Provides a typical cost for the treatment.

The *Guidebook* discusses the following pedestrian treatments:

1. Channelization.
2. Barriers – general.
3. Barriers – offset pedestrian crossing.
4. Barriers – pedestrian fencing.
5. Barriers – between cars at transit platform edges.
6. Barriers – temporary.
7. Design – clearly defined pedestrian crossing.
8. Design – smooth and level surface.
9. Design – stops and terminals.
10. Design – sight distance improvements.
11. Design – stops and terminals.
12. Design – illumination.
13. Design – flangeway filler.
14. Design – pedestrian refuge.
15. Design – on-road bollards.
16. Design – sidewalk relocation.
17. Signs – passive.
18. Signs – warning messages.
19. Signs – warning signs for enforcement.
20. Signs – blank-out warning.
21. Signals – timing considerations near railroad crossings.
22. Signals – flashing light signal assembly.
23. Signals – in-pavement flashing lights.
24. Pavement markings – stop lines.
25. Pavement markings – detectable warnings.
26. Pavement markings – word or symbol.
27. Pavement markings – dynamic envelope markings.
28. Infrastructure – audible crossing warning devices.
29. Infrastructure – pedestrian automatic gates.
30. Infrastructure – pedestrian automatic gate with horizontal hanging bar.
31. Infrastructure – pedestrian swing gates.
32. Operations – required stop.
33. Operations – reduced speed.
34. Operations – rail safety ambassador program.

SUMMARY OF RESEARCH FINDINGS

Rail Characteristics

The systems considered in this research—light rail, commuter rail, and streetcar transit systems—represent 58 unique transit rail systems that operated a total of 4,475 route-miles of service in 41 different urban areas of the United States. In 2011, more than 950.9 million unlinked passenger trips were made on these 58 systems, with trips covering more than 13.6 billion miles. The magnitude of these figures suggests that the transit rail systems within the scope of this research are important parts of the multimodal transportation system of the communities in which they operate.

Pedestrian Characteristics

Pedestrians, as a vehicle type, possess certain unique characteristics and behaviors that must be considered in the planning, design, and operation of pedestrian crossings for public transit rail services. Some of these characteristics include the following:

- Pedestrians are slow.
- Pedestrians are flexible.
- Pedestrians are fragile.
- Pedestrians are sensitive to their surroundings.
- Pedestrians may be inattentive.

Pedestrian Crossing Treatments

The purpose of pedestrian crossing devices is to make pedestrians aware of the presence of the train and/or to prevent pedestrians from crossing at inappropriate times. Several types of crossing treatments or devices are used at rail crossings. Some of the crossing treatments fit within a traffic control device category while others, such as fencing, are part of the infrastructure provided at the crossing. A single crossing treatment or device will not be sufficient; rather, a combination of devices is needed to communicate appropriate crossing locations and crossing times. Information about specific pedestrian crossing treatment obtained from the literature is available in Chapter 3 while a general overview of the characteristics and effectiveness of the relevant treatments is included in the *Guidebook*.

Several documents provide suggestions on items to be considered during treatment selection including:

- Federal Railroad Administration in *Compilation of Pedestrian Safety Devices in Use at Grade Crossings* (*5*).
- TCRP Report 69 (*22*).
- *SCRRA Highway-Rail Grade Crossing Recommended Design Practices and Standards Manual* (*24*).
- *Pedestrian-Rail Crossing in California* (*33*).

Crashes

Collisions between streetcar, light rail, or commuter rail trains and pedestrians are not common, but when they do occur the consequences are often very severe. This is demonstrated by the analysis of light rail vehicle collisions that found that while only 4 percent of all injuries as a result of light rail vehicle collisions were pedestrians, approximately 41 percent of fatalities were pedestrians.

Crashes happened throughout the rail system, including where pedestrians should not be walking, such as along the rail track. However, crashes between pedestrians and transit trains also occur at designated crossing locations. The ability to determine where crashes may happen and under which circumstances is not fully identified by analyzing the available data sources alone, but these data sources do provide some general trends that can act as a component of a more in-depth safety evaluation.

Surveys

The results of the online survey and the phone survey indicated that a variety of treatments are currently in use. The results also indicated that there are some treatments used in more locations and other treatments that are rarely used, although each treatment was selected at least once by the respondents to the online survey.

A common theme raised by survey respondents was that there was not a predominant set of standards or guidelines for applying specific treatments to specific situations. Consequently, one important aim of this research was to provide consistent guidelines based on good engineering judgment and consideration of site conditions as a useful tool for practitioners to use. In addition, even though transit agencies may use treatments and strategies based on prevailing conditions and existing guidance, their use does not negate the need for pedestrians to exercise personal responsibility or the need for some level of enforcement.

Most of the phone interview participants acknowledged the difficulty in measuring the effectiveness of treatments. In large part, this difficulty is due to each crossing being unique and the fact that most do not identify with just a single treatment but with a system of treatments. In discussing particular issues, line of sight was the most significant issue identified, with several transit agencies actively working to identify and improve sight distance issues at grade crossings along their rail lines. In general, the transit agencies appear to be active in their interaction with people with disabilities and concerned with the mobility and safety of all potential system users or those that interact with it.

Site Visits

Members of the research team visited several public transit rail services crossings within select regions as part of this research. These visits provided the opportunity to observe the challenges faced by pedestrians at public transit rail services crossings. The observations were not intended to be a judgment on the condition of the rail systems. Rather, the observations helped with the development of the *Guidebook*. Therefore, post-site visit, the observations were grouped within broad categories that were used with the presentation of treatments within the *Guidebook*. The observations also influenced the discussions included within the *Guidebook*, so to emphasize how to analyze conditions at a crossing with respect to the needs of pedestrians.

The research team visited several crossings within the following three regions:

- Boston, MA.
- Portland, OR.
- Los Angeles, CA.

The site visits generated several key observations and findings for specific treatments that affected the presentation within the *Guidebook*. Rather than repeating those key treatment observations here, the reader should review the appropriate section of the *Guidebook.* Following is a brief, broad (i.e., non-treatment specific) overview of key findings from this research:

- A task force within the National Committee on Uniform Traffic Control Devices has developed figures for potential inclusion in the *Manual of Uniform Traffic Control Devices*. Several figures show potential sidewalk placements. Debates were held within the National Committee regarding whether these figures on the sidewalk geometrics should be included in a manual focused on traffic control devices. One of the comments made was the need for this type of information to be located in a national reference document, and currently there is no such national document. This story illustrates the need for the type of *Guidebook* being developed within this TCRP study. Relevant figures were incorporated into the *Guidebook*.
- The types of treatments used are related to the type of service (e.g., light rail or commuter) along with the roadside development (e.g., retail, residential) and the age of the rail lines. Train services integrated into an established, developed area or train lines that have been in service for many years typically have less space and more restrictions in the crossing and station designs. Retrofitting these lines to current accessibility requirements or to provide more pedestrian amenities is complicated and expensive.
- Those interviewed or met during the site visits seem to understand that the old standards may not be adequate given current conditions and are periodically updating system design standards. In addition to constructing new transit rail lines that utilize current standards, they are actively working to bring older transit rail system lines up to current safety design standards.
- Other variables that can affect decisions regarding pedestrian-related treatments at a crossing include frequency of the trains, vehicles, or pedestrians along with the speed of the trains and the available sight distance. Because of the number of variables to consider at a crossing, the treatments or set of treatments to use cannot be standardized. Guiding principles can be used to aid in the selection process; however, the analysis is unique for each crossing and engineering judgment is needed to make the decisions on what should be installed.
- Pedestrians take the shortest path regardless of where the markings are or how the station is designed, unless there is a barrier directing them to a preferred crossing location. For example, although signs are present forbidding travelers to cross light rail tracks in a station, many alighting passengers took the shortest route to the exit, preferring to negotiate the elevation changes and roughness of crossing the track bed closer to the train instead of traveling down the platform to the marked (and smoother) crossing.
- General approaches to pedestrian safety at crossings include restricting the pedestrians to cross at designated locations and having the pedestrians look both ways before crossing rail tracks.
- Treatments need to be built with durability in mind, so people cannot bypass the treatment by altering or destroying it.
- Providing consistency within a region is challenging, especially when there are multiple systems or multiple line ownerships, including freight. Having a formal mechanism for communication between departments can address some of the challenges.

- Regular involvement of an advisory committee of transit users with disabilities in planning grade crossings and other pedestrian facilities can help to assure that facilities not only comply with the ADA but that they are user-friendly.

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