Countermeasure Strategies for Pedestrian Safety

Transit and Pedestrian Safety

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Vanasse Hangen Brustlin (VHB)

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Today’s Presentation

- **Introduction and housekeeping**
- **Audio issues?**
  Dial into the phone line instead of using “mic & speakers”
- **PBIC Trainings and Webinars**
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- **Questions at the end**
TRANSIT STOP IMPROVEMENTS
MODULE OVERVIEW

• Types of transit
• Common transit considerations
• Resources/sources for guidance
• Selected transit modules

- Bus (local)
- Bus rapid transit (BRT)
- Light rail
- Commuter rail
- Streetcars
LOCAL BUS SERVICE

- Most common transit type and focus of previous course
- Typically lower average travel speeds
- Operates with general traffic
- Frequent stops (.10 - .50 miles apart)
- Stops along the curb (primarily)
OTHER TRANSIT TYPES

- Streetcars
- Bus Rapid Transit
- Light Rail
- Commuter Rail
STREETCARS

- Operate on rails within the street, sometimes with traffic, at urban automobile traffic speeds (7-12 mph)
- Connects multiple local destinations with fixed route and local service
- Frequent stops based on passenger calls (similar to local buses)
- Convenient for short trips and transit connections
- Sense of permanence from use of rails and stations, compared to local bus service
BUS RAPID TRANSIT

• Lower infrastructure costs vs. light rail transit
• Level boarding
• Exclusive running way
• Off-board fare collection
• Increased station spacing
• Transit signal priority
BUS RAPID TRANSIT

- Lower infrastructure costs vs. light rail transit
- Level boarding
- Exclusive running way
- Off-board fare collection
- Increased station spacing
- Transit signal priority

Challenges in meeting “Gold” standard
**LIGHT RAIL**

- Operates on fixed rail guideways, often separate from automobile traffic
- Operates at higher speeds than streetcars
- Fixed stations and off-board fare collection
- Provides relatively frequent and reliable service
COMMUTER RAIL

- Exclusive rail right-of-way corridors
- Primarily used for commuting
- Greater station spacing
- Greater capacity
- Reduced service frequency
GENERAL CONSIDERATIONS FOR TRANSIT ACCESSIBILITY
The primary goal of transit is to carry passengers between residences, employment, and other destinations in a safe, efficient, and reliable manner.

The physical safety of ALL passengers is vital to the success of any transit system- not only to retain riders, but to encourage new riders.
...THERE ARE NUMEROUS COMPETING NEEDS

- Increases in ridership
- Crashes
- Amenities
- TCDs
- Conditions
- Vehicle needs
- Stop characteristics
- Capacity
- Security concerns
- Real time information
- Customer information
- Roadwork/Construction
- Transit plans
- Enforcement
- Private development
- Driver needs
- Special needs
- Funding
AGENCY CONSIDERATIONS

Transit vs. DOT Responsibility:

DOT Responsibility

Transit Stop

Transit Route

Transit Responsibility
Focus resources on areas of need

- **High-Use Locations** (ridership)
  - Busy Corridors
  - Busy Stops near key generators or high transfer activity

- **Infrastructure Gaps/Needs**
  - Sidewalks
  - Crossings
  - ADA compliance

- **Safety**
  - High incident locations
• Transit ridership
• Transit stop inventory (ADA compliance and other design elements)
• Crashes
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• Transit ridership
• Transit stop inventory (ADA compliance and other design elements)
• Crashes
SOURCES FOR GUIDANCE

- MUTCD
  - Part 2 - Signs
  - Part 4 – Highway Traffic Signals
  - Part 8 – Traffic Control for Railroad and Light Rail Transit Grade Crossings
- ADA Standards for Transportation Facilities
  - Part 1190 – Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG)
- Transit Agency Documents
- Other Documents
BUSES: TOPICS

- Design criteria
- Major safety considerations:
  - Bus stop location
  - Bus stop design
  - Accessibility
  - Lighting
- Areas of Caution:
  - Bus operations
  - Desire lines
  - Passenger demand
<table>
<thead>
<tr>
<th>Bus Stop Type</th>
<th>Considerations</th>
<th>101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus Bulb/Nub</td>
<td>- Can be applied near or far side</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>- Far side should have two lanes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Should be length of bus</td>
<td></td>
</tr>
<tr>
<td>Bus Bay</td>
<td>- Ability of bus to re-enter traffic</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>- Effect of open bus bay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Sidewalk space (width)</td>
<td></td>
</tr>
<tr>
<td>Queue Jumper</td>
<td>- Two types: with acceleration lane and without accel. Lane (see TCRP Synthesis 83)</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>- Used to give transit priority through intersection (transit signal priority-TSP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Potentially confusing signal phasing</td>
<td></td>
</tr>
</tbody>
</table>
## BUS STOP LOCATION REVIEW

<table>
<thead>
<tr>
<th>Stop Location</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Far-Side Stop</td>
<td>- Encourages peds to cross behind bus</td>
<td>- Sight distance issues for crossing vehicles and pedestrians</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near-side Stop</td>
<td>- Allows passengers to access bus closest to crosswalk</td>
<td>- Sight distance issues for veh to right of bus and crossing peds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Obscures curb signals and peds</td>
</tr>
<tr>
<td>Mid-Block Stop</td>
<td>- Min sight distance problems for vehicles and pedestrians</td>
<td>- Encourages midblock crossing.</td>
</tr>
<tr>
<td></td>
<td>- May reduce congestion at passenger waiting areas</td>
<td>- Increases walking distance for peds crossing at intersections</td>
</tr>
</tbody>
</table>

Mid block bus stops may create demand and encourage mid-block crossings.
LOCATING BUS STOPS

- Locating bus stops at intersections encourages crossings at the intersection.

- Placing the stops diagonally may better align with ridership and other pedestrians generators.
This bus transfer location forces pedestrians to cross the street.
The bus transfer location would be better in the same quadrant of the intersection.

This bus transfer location allows pedestrians to transfer without crossing the street or entering the intersection.
• Driveways are common along roadways in urban areas.
• Placement of bus stop should avoid driveway entrances.
Driveways

- In some instances, driveways may be unavoidable.
- Consider possible driveway movements and sight distance considerations.
In some instances, driveways may be unavoidable.
Consideration of access points to a site, service frequency, and traffic volumes may enable placement of a stop near/at a driveway.
Design of the bus stop can depend on a number of factors

- ADA
- Amenities
- Travel Patterns/Flows
  - Traffic
  - Bus
  - Pedestrian
- Vehicle Type
BUS STOP DESIGN

ADA Standards – Boarding & alighting, shelters

Source: U.S. Access Board
ADA Landing Pad/Passenger Waiting Area

- Connected to the curb
- 5’ wide (parallel to the roadway) by 8’ deep (perpendicular to the roadway)
- Free from obstructions

**Bus Stop Design**

- 5’ x 8’ accessible landing pad
- Bus stop sign should designate where to access wheelchair lift
**BUS STOP DESIGN**

**Expanded Landing Pad**

- Minimum 40’ for standard bus
- Minimum 62’ for articulated bus
- 8’ deep pad should be maintained for length of bus
Bench

- Can be freestanding or part of a shelter design
- Recommended where headways are longer than 15 minutes
- Should be away from 5’ x 8’ landing pad
Passenger Shelter

- Recommended for stops with 50 or more daily boardings
- Shall contain a clear area (2.5’ x 4’) – if seating is provided, clear space shall be located either at end of seat or shall not overlap the area within 1.5’ from front edge of seat.
- The 5’ x 8’ landing pad can be located either within or outside shelter
- The shelter should not obstruct sidewalk
- Never place closer than 2’ from the curb
Trash Receptacles

• Should be provided at stops served by enhanced bus service and stops in proximity to fast food establishments
• Should resemble other publicly owned and maintained trash receptacles along the corridor
Potential Bike Rack Locations

- Potential locations:
  - Right of passenger shelter
  - In front or rear of expanded landing pad
  - Behind sidewalk opposite the 5’ x 8’ landing pad
- Should be away from 5’ x 8’ landing pad
Provide adequate lighting for safety and security
These features can be incorporated at various bus stop types:
Crosswalk with ramp located near stop
Accessible Route

Accessible shelter

Landing

Crosswalk with ramp located near stop
BUS AREAS OF CAUTION OPERATIONS

- Number and frequency of buses
- Time at stop
- Combination with other factors
BUS AREAS OF CAUTION

DESIRE LINES

- Off-street facilities can be key generators
- Provide direct routes including crossing enhancements
Bus areas of caution desire lines

- Bus stacking can create additional desire lines
- Degree of concern depends on context
  - Provide wayfinding, use channelization, and consider relocating stops to mitigate midblock crossings on high-speed roadways
BUS AREAS OF CAUTION
PASSENGER DEMAND

- Can exceed designated space
- Consider effects on following:
  - Pedestrian zone
  - Position of bus
  - Loading time
- Define zones
- Driver training
Additional effects include diverting pedestrians, sight distance obstruction, and unexpected conditions.
You should be able to:

- Describe considerations in finding specific locations for bus stops
- Illustrate how the different elements fit into the design of a bus stop
- Describe the specific areas of caution when planning bus stops
  - Desire lines, bus stacking, passenger demand, complex and unfamiliar designs
BUS RAPID TRANSIT (BRT)
BRT: TOPICS

- Resources
- Local bus service vs. BRT
- Platform location and design
- Areas of Caution:
  - Platform access
  - Speed differential
  - Crossing away from marked crossings
  - Transfer activity
  - Transit signal priority
BRT RESOURCES

Design Criteria

- ADA
  - Vehicle
  - Stop
- Standards and guidance
  - TCRP Reports 90 and 118
  - Characteristics of Bus Rapid Transit for Decision Making
- MUTCD
  - Part 2 - Signs
  - Part 8 – Traffic Control for Railroad and Light Rail Transit Grade Crossings
- American Public Transit Association
- Local Agency
BRT stops may look like a curb side stop served by a local bus route.

These stops need to be designed on local bus route principles.
However, BRT stops may differ from local bus service in that:

- Fare collection space is needed.
- Pedestrian facilities at stops may be separated, once the off-board fare is collected.
- Boarding area may be elevated to expedite boarding/alighting process.
Fare collection space + ridership = larger platform

Platform length
- 50-60 feet for standard 40 foot bus
- 65-70 feet for an articulated bus

Platform width
- 10 feet wide curbside
- 20 feet wide median
BRT PLATFORM DESIGN

ADA Standards – Platforms

Max slope of 1:48 in all directions.

Edges must be protected by platform screens, guards, or have detectable warnings along the full length of the public platform access.

Source: U.S. Access Board
Max slope of 1:48 in all directions.

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Source: U.S. Access Board
BRT PLATFORM DESIGN

ADA Standards – Ramps

Running slope < 1:12

Cross slope < 1:48

Change in direction:
BRT PLATFORM DESIGN

- BRT platforms need to accommodate users with all types of abilities.
- Elements to consider include ramps and protection from raised curbing.
**BRT PLATFORM DESIGN**

- Fencing and bollards used to restrict undesired pedestrian movements.
- Low-level plantings used to channelize pedestrians.
- Pedestrian pushbutton.
Running way location (median or curb), the number of lanes (one or two lanes), and direction of flow (concurrent or contra) impact safety considerations.
BRT RUNNING WAY

Running way location (median or curb), the number of lanes (one or two lanes), and direction of flow (concurrent or contra) impact safety considerations.

Pedestrians may not expect changes in direction of travel.
Median platforms may be center or split design and require passengers to cross from either side of the street to access the platform.

Pedestrians must cross from either side of the street to access the platform.
Median platforms may be center or split design and require passengers to cross from either side of the street to access the platform.

These areas should provide pedestrian refuge for pedestrians to wait to cross or if signalized, access a push button.
Median platform crossing with no refuge

- Greater distance to cross
- Change in direction of travel
- Speed differential between general traffic and buses may be confusing to pedestrians
Median platform crossing with refuge \textit{(Better)}

- Allows for multi-stage crossing
- Separation of speed differential
- Still allows for direct crossing

BRT Platform

General Traffic Lanes

BRT Lane

BRT Lane

General Traffic Lanes
Median platform

Z-crossing  *(Better)*

- Allows for multi-stage crossing
- Separation of speed differential
- Channelizes pedestrians and orients pedestrians to approaching traffic/transit lanes
Treatments should direct pedestrians to cross the street and busway where intended.

Provide supplementary signage to inform pedestrian of crossing condition
BRT AREAS OF CAUTION
PLATFORM ACCESS

Crossing away from marked crosswalks.
• Due to platform length, pedestrians may cross midblock.

Signage with limited effectiveness
You should be able to:

• Identify the differences in local bus service and BRT
• Describe methods to access BRT platforms
• Describe design features of BRT that should be considered to address pedestrian safety
• Understand the critical areas of caution with respect to designing for pedestrians
LIGHT RAIL TOPICS

• Resources
• Design Details
• Safety Considerations:
  • Platform location and design
  • Accessibility
  • Crossings
• Areas of Caution:
  • Intersections
    • Vehicle & LRT conflicts
    • Vehicles & pedestrians crossing against signals
• Crossing the Tracks
  • Crossing away from marked crosswalks


**LIGHT RAIL RESOURCES**

- Safety
  - Research
- Design Criteria
  - MUTCD
    - Part 8
- ADA Standards
- FRA Standards
  - Provide a min. of 20 seconds of warning time with active devices deployed fully for 5 seconds before arrival
- **Safety Criteria for Light Rail Pedestrian Crossings** - TriMet
- TCRP Reports 17, 69, & 137

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**TABLE 3.3 Use of Warning Devices at Pedestrian Crossings**

<table>
<thead>
<tr>
<th>Pedestrian Crossing Location</th>
<th>Typical Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Visual* Audible</td>
</tr>
<tr>
<td>Isolated Pedestrian or Bicycle Path</td>
<td>LRV-Activated LRT Warning Signs Bell</td>
</tr>
<tr>
<td>Parallel to Roadway along Sidewalk (Semi-Exclusive, Type b.1)</td>
<td>Red Flashing Light Signals Bell</td>
</tr>
<tr>
<td>Across Roadway in Marked Crosswalk — Adjacent to an Intersection (Semi-Exclusive, Type b.2)</td>
<td>Pedestrian Signals Audio Pedestrian Device</td>
</tr>
</tbody>
</table>

* Alternative visual device is a Second Train Approaching sign for two or more tracks.
* The LRV-activated LRT warning sign (the W10-7 sign as depicted in Figure 3-37) is an alternate to using red flashing light signals at LRT-only crossings. At crossings with both LRT and railroa, the W10-7 sign may be installed as a supplement to red flashing light signals and illuminated when LRVs approach.
* The LRV-activated LRT warning sign (W10-7) may be used to supplement standard pedestrian signals to warn pedestrians of the increased risk associated with violating the primary regulatory device (the pedestrian signal).
* "Chirp-chirp" or "coo-coo" sound provided during WALK indication.

ADA Standards – Rail platforms & crossings

Track Crossings:

Max slope of 1:48 in all directions.

Edges must be protected by platform screens, guards, or have detectable warnings along the full length of the public platform access.

Source: U.S. Access Board
ADA Standards – Ramps

Running slope < 1:12

Cross slope < 1:48

Change in direction:
LRT Platforms should not block general pedestrian activity and should be well defined with a sufficiently sized waiting area and paths that access the waiting area.
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LRT Platforms should not block general pedestrian activity and should be well defined with a sufficiently sized waiting area and paths that access the waiting area.
Detectable warning

Pedestrian Zone
LRT platforms need to accommodate different modes. Sometimes different waiting areas are assigned to provide accessibility.
Pedestrian crossings should be clearly marked with pedestrian signals linked to the signals for the light rail and general traffic.
LIGHT RAIL CROSSINGS

Signs can provide warnings to pedestrians about LRT operation crossings.
Flashers or gates may be used to warn pedestrians and bicyclists of approaching trains or to prevent crossings.
LIGHT RAIL AREAS OF CAUTION: CROSSINGS

Crossing the Tracks

- Larger platforms mean pedestrians may cross midblock
- Low-speed environments—pedestrians cross with infrequent conflicts
- High-speed environments—crossing reinforcements may be used to provide pedestrians guidance about where to cross.
LIGHT RAIL AREAS OF CAUTION: CROSSINGS

Crossing away from marked crosswalks
LIGHT RAIL AREAS OF CAUTION: CROSSINGS

Crossing the Tracks

- Larger platforms mean pedestrians may cross midblock
- Crossing reinforcements may be used to provide pedestrians guidance about where to cross.
You should be able to:

- Describe design features of pedestrian access to light rail
- Describe the design elements of light rail access
- Describe the areas of caution for pedestrians accessing light rail
COMMUTER RAIL
COMMUTER RAIL TOPICS

• Resources
• Platform Accessibility and Design
• Major design considerations:
  • Station access
  • Convergence of modes
  • Rail crossings
• Areas of Caution:
  • Lighting
  • Pedestrian Surges
  • Distractions
COMMUTER RAIL RESOURCES

• Safety
  • Research
    • 2008 – Illinois Commerce Commission looked at 33 pedestrian incidents between 2000-04
    • Commuter Rail Safety Study, FTA, 2006

• Design
  • FHWA Railroad-Highway Grade Crossing Handbook
  • TCRP Report 17
  • MUTCD
  • AREMA Communications and Signal Manual
  • CFR 49 Part 234
  • State and Local
COMMUTER RAIL DESIGN CONSIDERATIONS

- Characterized by a convergence of modes
- Most have parking facilities at or near stations
- Pedestrians may have to cross tracks at grade-separated or at grade locations
Station Access

- How are people accessing the station?
- Is parking integrated?
- Is the street appropriate given ped/bike activity?
- Provide connectivity to surrounding network, particularly transit transfers.
At-Grade

- **Land Use**– a crossing near a pedestrian generator may warrant additional safety treatments.

- Similarly, pedestrian paths with higher activity may warrant more robust treatments.
At-Grade crossings not located within a street or highway (PROWAG).
COMMUTER RAIL AREA OF CAUTION – AT-GRADE CROSSINGS

- Darting or crossing tracks
  - Gates (automatic or swing) can physically prevent pedestrians from crossing tracks in high risk areas

- Approach of a second train
  - Active signs

Transit Cooperative Research Report 17
COMMUTER RAIL AREA OF CAUTION – AT-GRADE CROSSINGS

• Failing to look both ways
  • Z crossing channelization used where pedestrians are likely to cross unimpeded

• Lighting

![Image of people walking on a platform with a diagram of a rail crossing nearby]
You should be able to describe:

- Accessibility requirements for commuter rail
- Station area access features
  - Convergence of modes, parking facilities at stations, pedestrians tracks crossings
- Commuter rail areas of caution
  - Crossing tracks, lighting
STREETCARS
STREETCAR TOPICS

• Major safety considerations:
  • Alignment
  • Track crossings

• Areas of Caution:
  • Crossings
    • Track and Cyclist Interaction
  • Accessibility
  • Warning Devices
  • Distractions

Source: Washington Post
Similarities to local bus, BRT, and light rail

Edges have detectable warnings along the full length of the public platform access.
STREETCAR PLATFORM ACCESS

Max. 2 1/2" Gap

2' min. 6' min.
MEDIAN PLATFORM DESIGN

- ADA tactile warning strip
- Possible shelter location
- Ramp
- Direction of travel
• Streetcar platforms should not block general pedestrian activity and should be well defined with a sufficiently sized waiting area and paths that access the waiting area.
• Pedestrian crossings should be clearly marked with pedestrian signals linked to the signals for the streetcar and general traffic.
You should be able to:

• Understand the differences and similarities of streetcars and other forms of transit

• Describe the platform design elements
You should be able to:

- Determine if stops are properly placed
- Determine if stops are properly designed
You should be able to:

- Determine if stops are properly placed
- Determine if stops are properly designed

You should also know:

- The differences between local bus service and other forms of transit.
- Methods and countermeasures to address these differences.
Thank You!

- Archive at www.pedbikeinfo.org/webinars
  - Downloadable/streaming recording and presentation slides
- Questions?
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