High-Level Station Platforms and Passenger Safety

Gus Da Silva, PE
Sr. Manager                   718-558-3731    gvdasil@lirr.org
Long Island Rail Road
Jamaica, NY 11435

and

Carl M. Berkowitz, Ph.D., PE, AICP
Professor (Retired)       631-878-7419   cmberkowitz@hotmail.com
Safety Consultant
Moriches, NY

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ABSTRACT

In the late 2000s decade, LIRR initiated a review and system modifications of high-level platforms at many of its 124 stations in the system. The paper will review before and after modifications and improvements examples, including clearances between passenger trains and platforms and several wide-ranging measures that were taken to reduce the horizontal and vertical gaps and generally improve passenger platform safety throughout the LIRR system. Pictures and drawings will be used to illustrate the remediation. Furthermore to be covered is the subject of American with Disabilities Act (ADA) regulations; recent Federal Register notices pertaining to the car-platform interface for commuter trains and AMTRAK operating in the national passenger railroad system (i.e. the Federal Railroad Administration); and international standards for the platform interface.

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1. INTRODUCTION TO PLATFORM SAFETY

This paper reviews the subject of platform safety, with a focus on the gap, for systems in the United States. In Part 1, we discuss elements of platform safety in general from the perspectives of the space between the railcar and the platform, i.e., the gap; crowding conditions that affect passenger safety; and indicators of platform safety that can be applied for assessing needs, tracking trends, predicting effectiveness and measuring effectiveness after improvements are made. In Part 2, design considerations for new or reconstructed platforms must prioritize safety and adhere to existing and upcoming regulations and best practices. In Part 3, a recent past situation is presented to illustrate urgent modifications and improvements made on the LIRR as result of a fatal and unfortunate customer incident at Woodside Station, NY, on August 5, 2006.

1.1 Platform Gap to Railcar

Injuries from this type of accident, although rare, can be very serious and even fatal. There are two aspects to the platform gap: the vertical difference between the railcar door threshold and platform surface elevation and the horizontal separation of the railcar from the platform. Today’s modern railcars use mechanical and automatic car floor systems to maintain the floor nearly the level of the platform. This is an important safety feature because when the railcar floor is above the platform it creates a hazard for passengers boarding the vehicle; and when the railcar floor is below the passenger platform, it is a hazard for passengers exiting the railcar. Most gap falls are initially precipitated by a trip and, if there is a wide gap, the extension of the passenger’s leg might fall through the horizontal gap.

It is generally recognized by the rail passenger industry that the gap between a passenger railcar and the passenger platform is a critical interface where a passenger fall can occur.

Table 1 summarizes the mechanics that lead to a typical gap accident.
### Table 1. Mechanical Sequence of a Gap Fall from the Platform

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Passenger approaches the door threshold.</td>
<td>Approximately, 1 to 1½ Seconds</td>
</tr>
<tr>
<td>Two</td>
<td>Passenger prepares to enter or exit the railcar.</td>
<td></td>
</tr>
<tr>
<td>Three</td>
<td>Passenger prepares to step into railcar or onto the platform.</td>
<td></td>
</tr>
<tr>
<td>Four</td>
<td>Passenger does not fully recognize the large horizontal or vertical gap.</td>
<td>Unexpected Event</td>
</tr>
<tr>
<td>Five</td>
<td>Passenger begins to lose balance because of the gap.</td>
<td>Approximately, ½ Second</td>
</tr>
<tr>
<td>Six</td>
<td>Passenger tries to regain balance (attempts to recover).</td>
<td></td>
</tr>
<tr>
<td>Seven</td>
<td>Passenger loses balance (insufficient time to recover from the loss of balance).</td>
<td></td>
</tr>
<tr>
<td>Eight</td>
<td>Passenger falls into the gap.</td>
<td></td>
</tr>
</tbody>
</table>

With appropriate design and construction of platforms, together with proper maintenance, leveling devices can attain vertical and horizontal gap clearances, which make it unlikely that a passenger will trip on the doorsill or platform, or that a passenger’s foot will pass between the railcar and the platform. However, the need to accommodate passenger trains and freight trains in mixed operations, necessitates wider platform clearances than in closed transit systems.

### 1.2 Crowding and Overcrowding

On large railroads, overcrowding (large concentrations of passengers) will frequently occur at busy terminals usually without any grave consequences. Unfortunately, on occasion, passenger capacity inadequacies can combine with other factors and result in serious injuries and fatalities. Overcrowding results in passengers losing movement control; and raises concern for passengers, including the personal impact of the crowd, the decision-making information, the physical space available to them, the architectural features that constrain movement and the duration of the overcrowding. Overall this may also contribute to gap related accidents as the obstructions encroach on the edge of the platform.

While motor vehicles are usually confined to roadways, rail passengers are capable of moving in any direction subject to their own physical limitations, and are able to accelerate and decelerate at a very high rate. While motor vehicles are fixed to lanes on the roadway, passengers can expect interactions from all directions, and can reverse their direction in the identical travel path and exit the same way they entered. It is difficult to articulate the intense psychological and physiological pressures—such as fear—faced by passengers in an overcrowding situation when their movement is severely restricted. Most overcrowding situations can be prevented by applying simple management strategies, design modifications and planning. There are many factors that affect overcrowding:

### Train Platforms

The dimensions of passenger areas, such as train platforms, are a key factor in overcrowding, as well as the lack of stairway capacity that causes passengers to bunch at the access point to the stairs. After disembarking from the train, passengers surge toward the staircase and bunch around the area closest to the platform edge. This condition makes the platform increasingly
hazardous because passengers become frustrated as they try to exit and are faced with queuing-related delays when they want to reach the stairs and exits.

The platform serves different functions during the departure and arrival of trains. For the arrival, the platform must have sufficient area and vertical access facilities for passengers to move through the area. During the departure, the platform serves as a storage area for passengers waiting for a train and as a movement space for passengers distributing themselves along the platform.

In particular, all passengers must step over the gap between the platform and vehicle. But the platform area also serves other functions, including circulating along the platform, queuing at the platform edge while waiting for the next train, transferring between trains, waiting for the following train, queuing (stairways, escalators and elevators), and waiting at benches and information kiosk. The disruption of train service can also lead to unsafe overcrowding of the platform with the risk of passengers falling onto the tracks. Because of this complex and often conflicting characteristics, overcrowding on the platform creates potentially dangerous situations where passengers are crowded along the platform edge and in danger of falling into the tracks. The station platform presents challenges for the circulation of passengers, including the fact that linear queues for stairways must mix with less flexible bulk queuing for boarding that may extend laterally across the platform. In addition, disembarking passengers have to compete with boarding passengers in the areas along the length of the platform, which coincides with the queuing space for the stairways. Furthermore, the platform serves the needs of loading and unloading (sometimes two platforms at the same time), and for the disabled, sidewalks and other references are not available for location and safety.

1.3. Safety Performance Indicators for the Platform

The propensity for passenger falls from the platform onto the track results in accidents of the greatest severity, very frequently fatal. Researchers, safety experts and regulators look at system-wide transit plans as in Safety Management Systems (SMS) and System Safety Programs (SSP) discussion of MAP-21 and RSIA 2008, respectively. However, to identify the performance specific to components at the station platforms of railway systems requires a more focused study effort of data collection, analysis and improvements.

The National Transit Database collects personal casualty fatalities and incidents for major modes of transit. Table 2 reports select data for the most recent five-year period available.

**Table 2. Five-Year U.S. Transit Passenger Personal Casualties (/)**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Type</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commuter Rail</td>
<td>Injuries and fatalities</td>
<td>1,534</td>
<td>1,560</td>
<td>1,789</td>
<td>1,928</td>
<td>1,802</td>
</tr>
<tr>
<td>Heavy Rail/Rapid Transit</td>
<td>Injuries and fatalities</td>
<td>4,625</td>
<td>6,958</td>
<td>5,563</td>
<td>6,852</td>
<td>4,632</td>
</tr>
<tr>
<td>Light Rail</td>
<td>Injuries and fatalities</td>
<td>460</td>
<td>678</td>
<td>559</td>
<td>442</td>
<td>349</td>
</tr>
</tbody>
</table>

Note: Totals does not include derailments, collisions, or fires

These data largely represent the safety record of the passenger-rail operating environment comprising the station access, internal circulation, platform, and in-vehicle riding.
These data are useful in getting a preliminary understanding of the magnitude of the problem and needs to also be analyzed by computing exposure rates using passenger-miles, or ridership levels. In addition, more detailed analysis is warranted by railroads and transit systems based on carefully selected Safety Performance Indicators (SPIs) to assess the safety of the most important part of a railway station: the platform and its elements. Studies from the United Kingdom (2) and Japan (3) specifically identify and quantify potential causal factors jeopardizing platform safety and develop mitigation measures and procedures further discussed in the second and third parts of this paper.

In this type of incident, a passenger on the track is almost always passed over by a train, as in the fatality presented in Part 3. These incidents mostly result in death, but major injuries usually result in a few instances, including on-track loss of one or more limbs. A person may have entered an active track before a train approaches the station; or, as the train is entering the station, a person may fall through the gap, be pushed, or jump to the tracks. In other cases, patrons may be victims of an assault and thrown or pushed onto the tracks. These crimes typically occur during late-night periods when stations are deserted or in the daytime in low-use stations during off-peak times. Furthermore, people who move close to the platform edge to check on an approaching train may faint, collapse on to the tracks, or get pushed by others or, in some cases, attempt suicide. Other direct or contributing causes include illness, drunkenness, influence of drugs, or slip/trip and fall.

A number of factors can contribute to the severity of a passenger on the track accident. In addition to the actions of the passenger, other factors include the lack of barriers along the platform edge; excessive train speeds at the point of earliest perception by the operator, and excessive perception-reaction time by the operator, which delays the emergency application of the brakes and increasing the severity of the impact.

2. DESIGN CONSIDERATIONS FOR SAFETY – NEW OR RECONFIGURED FACILITIES, RULES, REGULATIONS AND BEST PRACTICES

There are extensive rules, regulations and best practices promulgated by a myriad of groups, agencies and special interests. In this part we review the most important and the legal requirements in the Code of Federal regulations.

2.1 Platform Gap to Railcar
With appropriate design and construction of platforms, together with proper maintenance, mechanical leveling devices in modern railcars can attain acceptable vertical and horizontal gap clearances, therefore achieving level boarding. This type of boarding makes it unlikely that a passenger will trip on the threshold plate or platform, or that a passenger’s foot will pass between the railcar and the platform.

Beyond benefiting passengers, level boarding can lead to significant improvements in service delivery by reducing station dwell times, upgrading safety and creating opportunities to
improving crew efficiencies. The platform/vehicle interface has a strong influence on passenger experience and boarding speed. Level boarding minimizes the vertical gap between the platform edge and vehicle door threshold. This speeds boarding for all patrons and also allows wheelchair users to enter the vehicle without a lift or other assistance. For wheelchair access on fixed guide-way systems, the ADAAG (4) allows a maximum vehicle floor-to-platform gap of 3 inches horizontally and 5/8 inch vertically.

In the past, one of the obstacles to attain acceptable clearances had been the concern for freight railroads that operate over track shared with the passenger trains. The freight railroad operators maintain a full horizontal dynamic clearance envelope allowing for unrestricted operations of freight cars, which require larger side clearances from right-of-way obstructions. These concerns often limited the door to platform interface necessary for minimum horizontal gap. The FRA (5) and AREMA (6) promote guidelines and best practices for station platform clearances in mixed passenger and freight service.

The Architectural and Transportation Barriers Compliance Board (ATBCB) has developed gap requirements as part of the Americans with Disabilities Act. These standards were developed through an open public hearing process and included comments and recommendations by the rail passenger industry. The resulting standards are considered fully representative of the current state-of-the-art and are now the standards of practice for designing rail fixed guideway systems. These standards (7) require a horizontal gap of no greater than 3 inches and a vertical difference within plus or minus 1.5 inches under normal passenger load conditions.

The International Association of Public Transit, the organization that represents most of the rail transit companies around the world, issued a “Core Brief” (2002) that focuses on access, vertical and horizontal gaps. The Brief states:

“…particular attention must be paid to the information provided to the users of…” metro “…facilities, be it through oral or written messages, etc. Small gaps can be overcome by ramps of suitable gradual slope…” “Be it for a new line or an existing line, the vertical gap between the platform and the train carriage shall be no more than 3.15 inches in height. If it is not the case, the platform will be adopted accordingly. The horizontal gap shall be between 2.36 and 3.94 inches…” “…In cases where these values are exceeded, station staff should have the possibility of deploying a manual ramp on the platform in response to demand.”

Studies conducted in the United Kingdom, and Europe recognized that boarding and alighting trains where there is a gap between the platform and rail vehicle is a significant challenge to passengers with disabilities. These studies investigated accessibility utilizing a variable platform gap to identify the implications for passenger boarding and alighting times and personal effort and safety. A full-scale model of a rail vehicle was used and a platform that could be adjusted in the vertical and horizontal planes designed and installed to allow testing of different vertical step heights and horizontal gaps.

The participants were timed boarding and disembarking the rail vehicle. They were also questioned on the physical effort involved and their perception of personal safety for each trial setting. The results of the study showed that an acceptable step into the train should not
exceed 7.87 inches when the step height from the platform (h), and the gap width (v) are added together. A secondary step was considered necessary in providing assistance in boarding when the step height and gap width are excessive. The conclusion from the tests was that the acceptable Stepping Distance P parameter should not exceed 7.87 inches (h + v) and that Stepping Distance P of 11.81 inches is unacceptable. (8) See Figure 1.

Figure 1 Railcar Gaps Acceptable, Undesirable and Unacceptable


The various standards and guidelines discussed above and required by accessibility provisions of the ADA, as well as samples of gap measurements taken at various railroads and transit systems, are summarized in Table 3 and Table 4.
Table 3 High-Level Platform Gap Guidelines and Goals for Rapid Transit and Light Rail on Tangent Track  (1 inch = 2.56 cm)

<table>
<thead>
<tr>
<th>Location</th>
<th>Transit Agency</th>
<th>Horizontal Gap Goal (Inches)</th>
<th>Vertical Gap Goal (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlanta (Rapid Transit)</td>
<td>MARTA</td>
<td>3.5</td>
<td>Level</td>
</tr>
<tr>
<td>Baltimore (Rapid Transit)</td>
<td>MTA</td>
<td>4.0</td>
<td>Level</td>
</tr>
<tr>
<td>Boston (Rapid Transit)</td>
<td>MBTA</td>
<td>4.0</td>
<td>Level</td>
</tr>
<tr>
<td>Cleveland (Rapid Transit and Light Rail)</td>
<td>GCRTA</td>
<td>4.0</td>
<td>Level</td>
</tr>
<tr>
<td>Los Angeles (Light Rail and Rapid Transit)</td>
<td>LACMTA</td>
<td>4.0</td>
<td>Level</td>
</tr>
<tr>
<td>Miami-Dade (Rapid Transit)</td>
<td>MDTA</td>
<td>3.25</td>
<td>Level</td>
</tr>
<tr>
<td>New York/New Jersey (Rapid Transit)</td>
<td>PATH</td>
<td>4.00</td>
<td>Level</td>
</tr>
<tr>
<td>New York/New Jersey (Light Rail)</td>
<td>AirTrain</td>
<td>3.00</td>
<td>Level</td>
</tr>
<tr>
<td>Puerto Rico (Rapid Transit)</td>
<td>Train Urbano</td>
<td>4.0</td>
<td>Level</td>
</tr>
<tr>
<td>Washington, DC (Rapid Transit)</td>
<td>WMATA</td>
<td>1 1/8 to 2 3/4</td>
<td>Level</td>
</tr>
</tbody>
</table>

**Standard/Guideline**

<table>
<thead>
<tr>
<th>Standard/Guideline</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>49CFR37, Appendix A, 10.3.1(9)</td>
<td>For exceptions see also end note “Gap to Platform in Railcar Doorways for Railway Systems, 49 CFR 38.53, 49 CFR 38.73, 49 CFR 38.93, and 49 CFR 38.113.”</td>
</tr>
<tr>
<td>USDOT</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>US Access Board, Subpart C 1192.53 Rapid Transit Vehicles &amp; Systems; Subpart D 1192.73 Light Rail Vehicles &amp; Systems; 49 CFR 38.53.</td>
<td>Retrofitted Vehicles</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>International Association of Public Transit</td>
<td>International</td>
</tr>
<tr>
<td>Stepping Distance Studies (Horizontal and Vertical Gap)</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>
Table 4 High-Level Platform Gap Guidelines and Goals for Commuter and Intercity Rail on Tangent Track (1 inch = 2.56 cm)

<table>
<thead>
<tr>
<th>Location</th>
<th>Railroad Agency</th>
<th>Horizontal Gap Goal (Inches)</th>
<th>Vertical Gap Goal (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National (Intercity Rail)</td>
<td>AMTRAK</td>
<td>4.00</td>
<td>Level</td>
</tr>
<tr>
<td>New York (Commuter Rail)</td>
<td>LIRR</td>
<td>4.00</td>
<td>Level</td>
</tr>
<tr>
<td>New York (Commuter Rail)</td>
<td>MetroNorth</td>
<td>4.00</td>
<td>Level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard/Guideline</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>49CFR37, Appendix A, 10.3.1(9)</td>
<td>For exceptions see also end note “Gap to Platform in Railcar Doorways for Railway Systems, 49 CFR 38.53, 49 CFR 38.73, 49 CFR 38.93, and 49 CFR 38.113.”</td>
</tr>
<tr>
<td>US Access Board, Subpart E 1192.93 Commuter Rail Cars &amp; Systems; Subpart F 1192.113 Intercity Rail Cars &amp; Systems; 49 CFR 38.93.</td>
<td>Retrofitted Vehicles New Stations – 4.0 Existing Stations – 4.0 (one door) New Station – 2.0 Existing Station – 2.0</td>
</tr>
<tr>
<td>Stepping Distance Studies (Horizontal and Vertical Gap)</td>
<td>United Kingdom Horizontal plus Vertical Gap ≤ 7.87 Horizontal plus Vertical Gap ≤ 7.87</td>
</tr>
<tr>
<td>Joint Passenger and Freight Track Operations – Without Platform Gap Mitigation</td>
<td>Commuter and Intercity Railroads</td>
</tr>
</tbody>
</table>

Where passenger rail operates in mixed traffic with freight railroads, Table 4, a minimum clearance of at least seven (7) inches is usually required between the railcar and the level-boarding platform; this requires the gap to be closed by special means to meet ADA.

In situations where meeting ADA gap requirements is infeasible, commuter and intercity rail operators still may often be able to provide full length, level, entry boarding to all accessible railcars by using a high-level platform in conjunction with short bridge plates that provide access to each car. Rubbing boards, railcar door threshold extender plates, other platform extender techniques can be employed as well as car-borne lifts, platform bridge plates and ramps, mini-high platforms, and station-based lifts.

New 2015 FTA Circular in Draft About the ADA and the Platform Gap - The horizontal and vertical gap goals of tables 3 and 4 are driven by requirements of the U.S. Department of Transportation’s Americans with Disabilities Act (DOT ADA) of 1990 and Section 504 of the Rehabilitation Act of 1973, as amended. The Federal Transit Administration is proposing a new guidance document designed to help transportation providers understand the (DOT ADA) regulations which are codified at 49 CFR parts 27, 37, 38, and 39. This new guidance, expected in 2015, does not alter, amend, supersede or otherwise affect the DOT ADA regulations themselves or replace or reduce the need for detailed information in the regulations. Its format, however, is intended to outline basic requirements with references to the applicable regulatory sections, along with examples of practices used by transit providers to meet the
requirements and will be titled FTA’s “Americans with Disabilities Act: Circular C 4710.1.” The ADA circular chapters include Chapter 3 Transportation Facilities, Chapter 6 Fixed Route Service. Also included is additional text on monitoring practices, published as addenda to Chapter 2 General Requirements and Chapter 4 Vehicle Acquisition. The gap subject area will be referred to as “Platform Coordination with Vehicle Floor.”

Partially in response to accidents on the national railroad system caused by the gap between the railcar door threshold and the platform, the Federal Railroad Administration (FRA) formed a Rail Safety Advisory Committee, General Passenger Safety Task Force to look at a broad spectrum of passenger safety concerns. Most of the national railroad system operates in mixed freight and passenger rail traffic, and the gap safety issue fell within this group.

The “Approach to Managing Gap Safety” (9) is a document designed to help railroads reduce accidents caused by the gap between the edge of a station platform and threshold of a passenger-train door. This standard describes the steps that railroads should take to maintain a consistent nominal gap and to reduce injuries due to that gap. This standard helps railroads incorporate gap safety considerations during the construction of new station platforms.

To determine the most effective way to manage gap safety requires adopting a comprehensive program to manage gap hazards and establish and maintain uniform gap and boarding conditions.

2.2 Crowding and Overcrowding
The available platform area is determined by deducting the 2-foot safety edge (tactile strip) along the length of the platform and the footprint areas of any stairs, columns, or other space-consuming features of the platform (plus an 18-inch buffer). The location of the stairs will affect the distribution of passengers on the platform, and it is known from various studies that passengers will cluster around platform access stairways. The effective platform area required is based on maintaining a minimum level of service for queuing and for passenger circulation. The platform as designed and operated has a critical passenger holding capacity, which if exceeded, could result in passengers being pushed into the track area. The Americans with Disabilities Act (ADA) also affects the operation of the platform, including the platform edge treatment. The ADA does not directly affect the overall area or width required for a platform, but an accessible route of at least 36-inches wide must be maintained along the platform. When the available route is next to the platform edge, the 24-inch edge treatment area is not included, so the clear width along a platform edge must be 60 inches.

2.3 Safety Performance Indicators for the Platform
The propensity for passenger falls from the platform onto the track results in accidents of the greatest severity, very frequently fatal. Virtually all the subject matter of design considerations discussed previously in this part of the chapter can and does contribute to mitigate and potentially prevent these types of falls. Also, in the first part of the chapter, the extent of this problem was identified and the concept of Safety Performance Indicators (SPIs) was introduced to assess the safety of the most important part of a railway station: the platform and its elements.
Researchers, safety experts and regulators look at system-wide transit plans as in Safety Management Systems (SMS) and System Safety Programs (SSP) discussion of MAP-21 and RSIA 2008, respectively, later in the chapter. However, to identify the performance specific components at the station platforms of railway systems requires a more focused study effort of data collection, analysis and improvements.

Railroads and transit agencies that are truly concerned with passenger safety from the most severe type must have conducted or should conduct a quantitative risk assessment of the platforms on their subsystems using a comprehensive set of causal factors. Such an assessment identifies problem platforms and is a first step to create a proactive program that prioritizes the allocation of scarce funds to where the greatest potential dangers exist. This is especially important for older and high-ridership systems experiencing subpar safety record, and often that were built nearly a century ago when design practices were less evolved and safety knowledge was in its infancy.

A safety study from Japan (10) builds on an earlier study from the United Kingdom studying the Safety Performance Indicators (SPI) of greatest relevance to explain past incidents and predict future passenger risks at, and leading to, platforms. SPI are more commonly referred to in the U.S. as Safety Management System (SMS) and Safety Performance Measurement System (SPMS).

The study from Japan provides an example how railroads can numerically score the safety of each station and platform with factors that have the most weight towards safety deficiencies and therefore merit the most need for targeted improvements. The following factors listed in Table 5 were found to be the most important to improve safety.

**Table 5 Results of Calculating the Relative Importance of 16 Safety Assessment Factors (11)**

<table>
<thead>
<tr>
<th>Major Factors (weight)</th>
<th>Minor Factors</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform Structure</td>
<td>(1) Length of narrow part</td>
<td>0.146</td>
</tr>
<tr>
<td></td>
<td>(2) Width of gap between platform and train</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td>(3) Platform shape</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>(4) Area of platform</td>
<td>0.155</td>
</tr>
<tr>
<td></td>
<td>(5) Platform curving in the middle</td>
<td>0.045</td>
</tr>
<tr>
<td>Passenger flow</td>
<td>(6) Crowding on platform</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>(7) Passenger flows crossing</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(8) Passenger flow outside white line</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>(9) Crowding at stairs and elevators</td>
<td>0.041</td>
</tr>
<tr>
<td>Train operation</td>
<td>(10) Number of trains passing and stopping</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>(11) Visual announcement of approaching train</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>(12) Audio announcement of approaching train</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>(13) Clarity of indicators of train approach direction</td>
<td>0.017</td>
</tr>
<tr>
<td>Passenger profile</td>
<td>(14) Number of drunken passengers</td>
<td>0.142</td>
</tr>
<tr>
<td></td>
<td>(15) Number of visually impaired passengers</td>
<td>0.049</td>
</tr>
<tr>
<td></td>
<td>(16) Number of elderly passengers</td>
<td>0.050</td>
</tr>
</tbody>
</table>

Important: Weights are based on data from rail stations in Japan and may not represent U.S. SPI.
3. LIRR PLATFORM GAP CRISIS

To conclude, we review an unfortunate incident that received the utmost media attention in New York City and that precipitated an urgent system-wide review and a program to address the crisis.

3.1 The Incident at Woodside, NY, August 5, 2006

On a summer afternoon, about 4 PM, a 5-foot 6-inch, 110 pound, 18-year old female passenger exiting the train at the Woodside station fell through an horizontal gap just short of 8 inches between the train and the platform and landed at track level. The train doors were still open and the conductor and friends in her group saw her go down, but she did not follow instructions to remain still and wait to be rescued. Instead, the woman crawled under the platform to the other track onto the path of an incoming train and was killed. Her blood alcohol level was 0.23 gram percent. (12)

Figure 2 Platform Gap at Woodside Station, August 2006, NTSB

The 7-7/8 gap in Figure 2 (from the NTSB report) was photographed and measured on the next day by investigators. They used the same car and platform location. The LIRR design guidelines for this platform in 2006 was 8 inches, therefore the gap was compliant. The design has since been reduced to 7 inches.

The remaining of the report – which was adopted by the NTSB in 2009 – is also an excellent summary of the actions that LIRR has taken to improve gap safety.

3.2 The Challenge to Minimize the Gap System-wide

The picture in Figure 3 below illustrate the problem. On a three degree curve, such as at the Port Jefferson station, the platform gap can be as wide as 12 ½ inches without special treatments such as the edge board and threshold plate. Per current practice, 11 ½ inch gap is acceptable on a platform that has track with a three (3) degree curve. Although there is no freight traffic at this location, it is part of the railroad system.
Figure 3 Port Jefferson Station Gap Measurements

(1 in = 2.56 cm)

Port Jefferson Platform

- 3° curve,
  + 1.5 inches extra of clear per 1°
  7 inches + 4.5 inches
- At corners = 7 inches
  3 ½ inch gap +
  3 ½ inch edge board
- At door up to 12 ½ inches
  6 ½ Inch gap +
  3 ½ inch edge board +
  2 ½ inch threshold plate
3.2 The Program Implemented by the LIRR

Port Jefferson station platform is within a three degree track curve. From an original 12 ½ inches of gap, one inch larger that design guidelines for a sharp curve, these treatments have reduced the gap substantially. LIRR has done similar treatments system-wide and also installed threshold plates on all railcars.

Since late 2006, (13) we have increased gap safety to within or in excess of the industry standards promoted by AREMA. We have over 1,100 railcars in diesel plus EMU service.

As of the beginning of 2007, we have also upgraded 24 platforms on 16 stations, as compared to 124 stations system-wide and we have 262 platform edges. But fortunately, like at Woodside station, many platforms are already compliant and did not require modifications.

This project implemented by LIRR to mitigate and control the gap is wide-ranging and includes:

- Physical Solutions
- Operational Solutions
- Mechanical Solutions
- System-wide Measurements, Every 12-months
- Customer Safety Committee Reviews
- Public Awareness Campaign

The relentless media spotlight following the accident required that a comprehensive program be put in place and solutions were developed in different areas because there is no one solution to the gap problem.

The first on this list is illustrated by the Physical improvements done at Port Jefferson platform. Operational and mechanical solutions mostly affect platforms with even sharper curves – fortunately these are very few.

We also measure platforms once per year to catch any shifts that may have taken place and make adjustments when needed.

A former customer safety committee now has enhanced responsibilities with gap accidents. They meet regularly to verify accuracy of accident reports and look out for trends or new danger locations.

Our most passenger mitigation measures in the public awareness campaign are exemplified by a gap video. (14)

To supplement the video, LIRR also developed other media to communicate with passengers and educate them on the dangers of the gap (See Figure 4):

- Warning signs on platforms and railcars
- Announcements onboard trains
- Pamphlets for seat drops
- Posters for railcars and station billboards

Figure 4 Elements of the Multimedia Campaign
Endnotes

6. American Railway Engineering and Maintenance-of-way Association (AREMA)

List of Tables

1. Mechanical Sequence of a Gap Fall from the Platform
2. Five-Year U.S. Transit Passenger Personal Casualties
3. High-Level Platform Gap Guidelines and Goals for Rapid Transit and Light Rail on Tangent Track
4. High-Level Platform Gap Guidelines and Goals for Commuter and Intercity Rail on Tangent Track
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1. Railcar Gaps Acceptable, Undesirable and Unacceptable
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Authors’ Biographies

Gus Da Silva, P.E.
Mr. Da Silva is Sr. Manager for the Long Island Rail Road, an agency of NY MTA. He has been manager with the LIRR since 1991 on a number of planning and other capital rail projects.

From 1980 to 1991, Mr. Da Silva worked in consulting and government agency projects for transit and roadways, including safety analysis of motor vehicle accidents to identify high risk locations. He has a BS in Civil Engineering from New Jersey Institute of Technology and a MS in Transportation Planning and Engineering from Polytechnic Institute of NY, now merged with New York University. Mr. Da Silva is a member of APTA and career-long member of the Institute of Transportation Engineers. He is a registered as professional engineer in New York State.

Carl Berkowitz, Ph.D., PE, AICP
Dr. Berkowitz has held various managerial and administrative positions in the transportation industry, government, private and academic sectors. Dr. Berkowitz has extensive multi-modal experience in planning, design, engineering, safety, security, construction, maintenance, operations and management.

He is a Professional Engineer in New York and New Jersey, and a member of the American Institute of Certified Planners, American Planning Association, American Society of Civil Engineers (Fellow), Association of Pedestrian and Bicycle Professionals, Institute of Transportation Engineers, American Society of Safety Engineers, American Railway Engineering and Maintenance of Way Association (Facilities and Structures Subcommittees), American National Standards Institute, ASTM International (Pedestrian/Walkway Safety Committee), Human Factors and Ergonomics Society, The Chartered Institute of Logistic and Transport (UK), American Society of Transportation and Logistics, National Association of Railroad Safety Consultants, and American Public Transit Association (Safety Committees).

Dr. Berkowitz holds a Bachelor’s Degree in Civil Engineering and a Master’s Degree in Business Administration from The City College of New York and a Master’s Degree in Transportation Planning and a Ph.D. in Transportation Planning and Engineering from Polytechnic University.
High-Level Station Platforms and Passenger Safety

By Gus Da Silva, PE,
Sr. Manager, Long Island Rail Road

And

Carl Berkowitz, PhD, PE, AICP,
Professor (Retired) & Safety Consultant

Passenger & Transit Breakout Session
10:30 AM, 10/6/2015

Note: Draft is longer than time allowed & final presentation will be reduced accordingly.
High-Level Platform Safety Elements

- Platform Gap to Railcar
- Crowding and Overcrowding
  - Train Platforms
- Safety Performance Indicators for the Platform

From Paper Table 2: Five-Year U.S. Transit Personal Casualties (1)

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High Level Platform Safety Elements

- Platform Gap to Railcar
- Tangent Track
- Railcar width
- LIRR CE-1 is 5 feet 7 inches, C.L. to Rubbing Board
- Railcar width 10 feet
- Tangent Track

Design Considerations

- LIRR CE-1 is 5 feet 7 inches, C.L. to Rubbing Board
- Railcar width 10 feet
- Tangent Track

Design Considerations

- Platform Gap to Railcar
- Passenger Safety
- Operational Efficiency
- Mixed Operations (Freight Clearances)

Design Considerations

- Platform Gap to Railcar

From Paper Table 4: High-Level Platform Gap Guidelines and Goals for Commuter and Intercity Rail on Tangent Track

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Design Considerations

- Platform Gap to Railcar

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Design Considerations

- Crowding and Overcrowding
  - Tangent Platform
  - Platform Edge 2 feet minimum
  - Queuing/Clustering Storage
  - Holding Capacity, 1,000 to 2,000 plus

- Safety Performance
  - 4 of 16 Factors High Importance

LIRR Platform Gap

- Woodside Station Tangent Platform
  - August 2006 Fatality
  - Compliant as 8-in at the time
  - Mixed Operations (Freight Clearances)

- Port Jefferson Station Curved Platform

- Gap Mitigation and Control Program
LIRR Platform Gap

- Woodside Station Tangent Platform

- Curved Platform at Port Jefferson Station

- Gap Mitigation and Control Program
  - Physical Solutions
  - Operational Solutions
  - Mechanical solutions
  - Annual Gap measurements
  - Customer Safety Committee
  - Public Awareness Campaign

Gap Mitigation and Control Program

- Syosset Station, 40 MPH MAS, Two Curves 3° 20’ each
- “Station” Conductor
LIRR Platform Gap
• Operational Solutions at Syosset Station

LIRR Platform Gap
• Gap Mitigation and Control Program
  – Public Awareness Campaign

LIRR Platform Gap
• Gap Mitigation and Control Program
  – Public Awareness Campaign

LIRR Platform Gap
• Gap Mitigation and Control Program
  – Public Awareness Campaign
  – Gap Safety Video
    http://mta.info/lirr/video/GapSafety
    – Great Neck Station
    July 2015 Incident