Streetcar Level Boarding- Background Memo

Introduction

This memo has been prepared by the APTA Streetcar Subcommittee and the Community Streetcar Coalition to facilitate industry discussion on the application of level boarding concepts to US modern streetcar systems. By conducting an industry-level discussion with a broad group of stakeholders that includes project sponsors, FTA, DOJ and the Access Board, all parties can gain a better understanding of the relevant regulations and the unique aspects of applying them to the streetcar mode. It is hoped that this discussion will in turn help remove uncertainty from the project design process, resulting in improvements in project design and more efficient project delivery.

On a related note, the APTA Streetcar Subcommittee is currently completing work on a draft Modern Streetcar Vehicle Guideline document. The Guideline document includes a chapter on vehicle / platform interface (some excerpts are included in this memo), but there are also broader issues outside of that document's scope which need to be addressed at the industry level. The intent of the Guideline chapter on vehicle / platform interface is not to recommend one specific means of achieving ADA compliance, but rather to clearly describe the advantages and disadvantages of the different approaches so that informed decisions can be made at the local level.

Streetcar Accessibility Timeline

The advent of modern low-floor vehicles greatly improved accessibility for urban transit, being applied to bus, streetcar and the light rail modes. In looking at a timeline of transit vehicle accessibility, it is noted that the ADA regulations pre-date the arrival of low-floor rail vehicles in the US.

First era: non-accessible

- 1890-1980 Non-accessible urban transit vehicles

Second era: high floor accessibility 1980's-90's

- High-floor / High-platform
- High-floor / Low-platform

Third era: low floor vehicles (low-floor / low-platform)

- 1984- Partial low-floor tramway vehicles debut in Europe
- 1990- 100% low-floor tramway vehicles debut in Europe
- 1990- ADA Regulations signed into US law
- 1997- Partial low-floor light rail vehicles debut in US
- 2001- Partial low-floor streetcars debut in US
- 2010- 100% low-floor streetcars debut in Canada
- 2013- 100% low-floor streetcars debut in US

Challenges for locating platforms in the streetcar environment

Although the streetcar is presently thought of largely as an urban circulator in the US, several forms are actually possible:

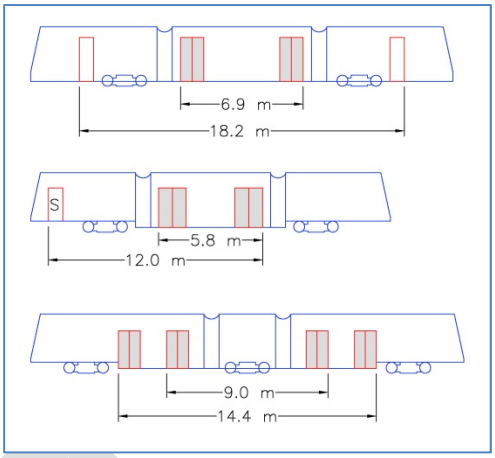
- Circulator Streetcar

- Rapid Streetcar
- Starter segment for future light rail system
- Light rail / streetcar interoperability (shared line segments)

Track alignment within the street will also vary, the options including side running, center running and median operation. Unlike LRT on reserved running, streetcar designers often have little control of the right-of-way. Streetcar track and platforms must typically be creatively squeezed into the urban environment. Streetcar platforms are often blended into the sidewalk, and design must consider not only the platform area itself, but the adjacent sidewalk / curbs / pedestrian paths, and the related transitions.

Streetcar platforms are a mixture of side, island and center types. Any platform must balance a variety of sometimes conflicting uses of the street- streetcar stop, automotive traffic, parking, crosswalks, buses, cyclists, pedestrians, utilities, business activities, etc. The required platform length will also vary depending upon capacity requirements and the door spacing used on the specific streetcar vehicle (**Figure 5**). Where sidewalk space is limited, side platforms can be especially challenging due to ramp slopes and drainage issues. The higher the platform becomes, the longer the ramps are and the greater the modifications to the existing sidewalk and streetscape.

Figures 1, 2 and 3- Streetcar platforms come in many shapes, sizes and locations, although in all cases they must be compatible with their surroundings, blending into the streetscape and/or sidewalk in a safe and integrated manner.



Figures 4 and 5- Integrating streetcar into the city requires flexibility **Left:** An unusually creative streetcar platform- accommodating multiple uses in a tight space. **Right:** illustration showing variation in door-to-door dimensions of several current US streetcar vehicles.

Streetcar and Bus Sharing a Platform

The nature of the streetcar mode is such that streetcar and bus routes may overlap. This may present opportunities for different types of vehicles to share stops (buses, different streetcar types, heritage trolleys). Shared stops can improve passenger convenience and reduce costs by facilitating transfers and saving space in dense urban settings. Depending on the nature of the transit services using the stop, separate stopping places may also be desirable for capacity or other reasons; a longer stop area, split stops (**Figure 8**), or adjacent stops (**Figure 9**) may be used to provide separate but proximate stopping places.

Implementing shared stops involves a number of variables centering on the height of the platform. Generally, as streetcar platform heights increase above 8 inches (203 mm), additional design coordination is required to ensure compatibility with buses. The ability of a transit bus to interface with a shared streetcar platform is dependent on several factors:

- **Platform location-** Other than special-purpose applications, transit buses generally have doors only on the curb side. Therefore, streetcars and buses can share certain types of side and island platforms but buses cannot use streetcar center platforms. Where center platforms are in use, the bus can use a separate curbside stop nearby, although any traffic impacts of having both a streetcar and a bus stopped simultaneously in this arrangement should be considered. Platform and trackway must also be compatible with any guidance system used by the bus.

- **Platform height**- sharing of stops is generally more compatible with the lower platform heights associated with the near-level platform concept. In some cases, a bus which can deploy its front door ramp without kneeling can interface successfully with a 10 inch (254 mm) platform. Above this height, additional mitigations are typically required[1].

- **Bus floor height -** floor heights vary for different models of low and high-floor buses. The floor height also varies based on passenger loading and kneeling features.

[1] Low-floor buses and light rail vehicles share a common 14 inch platform in the downtown transit tunnel in Seattle, Washington, but special measures have been applied. Buses using the tunnel are fitted with slightly larger tires, the pavement has been "ramped" slightly between the inside rail and the platform edge, and because there is only one lane in each direction, the buses are only maneuvering to and from the platform with a very minimal angle.

- **Bus door and ramp configuration-** configurations vary significantly between different types of buses:
    - Low-floor transit buses typically utilize an outward deploying ramp at the front door, designed to deploy onto a curb (nominal 6 inch (152 mm) height). In order to deploy the ramp onto a platform (8 inches (203 mm) and higher), the height of the bottom step on the bus cannot drop below the platform height (**Figure 10**).
    - Many transit buses use outward folding rear doors that can be blocked from opening or get stuck where platform height is above the bottom step height (**Figure 11**).
    - High-floor or express type buses typically use "over the road" vehicle designs with 3 to 4 steps for entry and a wheelchair lift that deploys from a special side door.
- **Any interlocking between the kneeling and ramp deployment features of the bus-** On some buses, in order to deploy the front door ramp, the bus's kneeling feature must be activated (the two features are "interlocked"). If kneeling the bus lowers the bottom step height below the height of the platform, the ramp will not be able to deploy onto the platform (**Figure 10**).
- **Approach and departure angles for the bus**- Where a platform is in use, it is particularly important that both the front and rear doors of the bus end up close to the platform. Where the streetcar and bus are sharing the same travel lane on approach to the stop, a bus can normally come straight in and get both the front and rear doors close to the curb/platform. Where it is not possible for the bus to make a straight approach to a platform, it should be remembered that buses need adequate clearance for suitable approach and departure angles. At stops where the platform is higher than 8 inches (203 mm) there is a risk that the bus (which has an overhang at the front and back of the vehicle) may contact the platform when it sweeps over the platform on approaching the stop or pulls away at an angle afterward.

  Use of a mountable curb, instead of a traditional barrier type, is another tool that can be employed in some situations to facilitate docking the bus as close to the curb as possible, while protecting tires and vehicle edges. Many European cities are using specially shaped curbs (e.g., Kassel Kerbs) for this purpose.

Figures 6 and 7- Having multiple vehicle types share a platform impacts both platform height and length. **Left:** Bus sharing a 10 inch near-level streetcar platform in Portland. **Right:** Buses and light rail sharing a 14 inch platform in Seattle where special mitigations have been applied (pavement ramp adjacent to platform edge and larger tires on bus).

Figures 8 and 9- Stop design is also impacted by the choice of lane for the streetcar alignment. **Left:** Track in curb lane, streetcar and bus stop separated into near side / far side stop arrangement. **Right:** Track in center lane, streetcar and bus stop separated but adjacent.

Figures 10 and 11- Common bus / platform interface challenges **Left:** Front door ramp blocked while deploying onto simulated 10 inch platform (the bus's kneeling feature has lowered door height below platform level) **Right:** Incompatibility between outward-folding rear doors on bus and 14 inch platform

Other issues

- The planning process for new streetcar systems should include consideration of whether the system may later be upgraded to, or interoperate with, light rail.

- Some light rail systems which share trackage with freight operations (e.g. San Diego) are precluded by state or other rail-related clearance regulations from constructing platforms higher than 8 inches.

- The most common floor height for new low-floor streetcar and light rail vehicles is 14 inches. However, if fully level boarding is to be applied to a system, it may be desirable to consider a slightly lower vehicle floor height (12.5 to 13 inches), as is done on some European systems.

Table 1 provides an overview of the many different styles of platform that have been used with streetcar systems throughout the world.

Table 1- Streetcar Platform Types (mixing and matching on the same system is not uncommon)

Type	Description	Application	Photos
Basic-Hump	"Hump" type platform. The length of the raised platform section accommodates only the accessible doorway(s). Hump is either 10 or 14 inches high. Remainder of platform is generally at curb height 6-8 inches. Can be shared with buses depending on overall length and location of the hump.	Circulator Streetcar	 14 inch hump  10 inch hump
Basic-Single Level	Single level platform. Length is just long enough to accommodate all doorways (varies depending on streetcar "door spread"). Height is generally 10 or 14 inches. 10 inch version can also be used by buses in some cases	Circulator Streetcar	 
Basic-Dip	Single level platform created by leaving sidewalk where it is and "dipping" the track. Length is just long enough to accommodate all doorways (varies depending on streetcar "door spread"). Height is generally 8-10 inches to minimize drainage impacts	Circulator Streetcar Rapid Streetcar	 

Type	Description	Application	Photos
Intermediate	Single level platform. Length accommodates full vehicle with some extra margin. Extra room on platform for passenger circulation as compared to basic platform. 10 inch version can also be used by buses in some cases	Circulator Streetcar Rapid Streetcar	 
High Capacity	Single level platform. Long enough to simultaneously accommodate more than one vehicle (e.g. streetcar and bus, two buses). Typically 8-10 inches. Can be 14 inches only with special mitigations (e.g. pavement ramping and larger bus tires as used in Seattle transit tunnel).	Rapid Streetcar Light Rail	 

Other Streetcar Platform Types (None currently in US)			
Type	**Description**	**Application**	**Photos**
Dynamic Stop	Raised traffic lane becomes a "sidewalk extension". Traffic controls added to halt auto traffic when streetcar is using stop. Typically 8-10 inches Used in Australia, Germany, France, Austria	Circulator Streetcar	 
Added "hump" on platform to eliminate bridge-plate	An additional raised section on platform (approximately 3 inches) is used instead of bridgeplate on vehicle. One door only on vehicle. Example from Strasbourg, France.	Circulator Streetcar Rapid Streetcar	

(Excerpt from draft APTA Streetcar Vehicle Guideline, revised 2/11/13)

TABLE 2-1

Advantages and Disadvantages of "Fully Level" Boarding

"Fully Level" Boarding: The vehicle floor and platform are at the same height [14 in. (355 mm)] nominal. Bridgeplates are unnecessary, but an active suspension (automatic load leveling) is required on the vehicle to maintain compliance with the ADA ±⅝ in. (16 mm) vertical gap requirement over the full range of passenger loading.

A streetcar vehicle is typically equipped with either load leveling *or* bridgeplates but not both. While it is technically possible to equip a vehicle for use with both boarding approaches, mixing the two has the potential to create confusion for passengers, and a consistent approach is therefore preferable. Attempting to install both features might also preclude the use of door threshold extensions (a common feature of fully level boarding) at doorways fitted with bridgeplates.

Advantages	Disadvantages
• The vertical step from the platform into the vehicle is eliminated; best passenger boarding experience. • Typically has better dwell time compared with bridgeplates, which becomes important in high-ridership applications. Although the impact on travel time may be negligible on a short initial line segment with only moderate ridership, future system needs should also be considered (especially where streetcars may be in the roadway's only travel lane). • Eliminates the need for bridgeplates, thus removing a high-maintenance item from an already complicated vehicle subsystem (doors).  	• More demanding on infrastructure, and therefore less flexible for application to an urban in-street environment. Precisely maintaining the ±⅝ in. (16 mm) vertical step and 3 in. (76 mm) horizontal gap requires a systems approach (it's not just a vehicle function). Platform height tolerance is a function of both vehicle characteristics (wheel wear and compensating shimming, suspension characteristics, operational range of the leveling system) and infrastructure (rail wear, type of construction, construction and maintenance tolerances). • A 14 in. (355 mm) platform (or section of the platform) is generally not compatible with buses, especially outward-folding doors. • 14 in. (355 mm) platforms, especially full-length platforms, may be more challenging to blend with sidewalks and streets. Typical "blending" issues include minimizing impacts on narrow sidewalks, maintaining the slopes required for ADA access, and compatibility with curb design criteria and drainage flows. • Locating a fully level platform on a curve is difficult at best, but is possible with the "near level" platform combined with bridgeplates. • Depending on the carbuilder, some vehicles may not have load leveling capability as a standard feature or option. • In a mixed fleet situation (both step-entry high-floor vehicles and low-floor vehicles), a 14 in. (355 mm) platform may not be compatible with older step-entry vehicles (which may have a first step that is lower than the platform). • In a situation where trackage may be shared with other rail services (typically applies only to light rail), clearance regulations may limit the height of the platform to 8 in.

TABLE 2-2

Advantages and Disadvantages of "Near-Level" Boarding

"Near Level" Boarding: Vehicle floor and platform are "near level"; 13 to 14 in. (330-355 mm) vehicle floor (may be slightly lower at doorways), 8 to 10 in. (203 to 254 mm) platform height. Requires bridgeplates for ADA compliance (see Section 2.5, "Bridgeplates [if used]").

Advantages	Disadvantages
• Much less demanding on infrastructure tolerances (the horizontal and vertical gap can vary somewhat) and thus more flexible with regard to where the platform can be located. Flexibility is important because in contrast to a light rail alignment on a dedicated right-of-way, streetcar alignments are influenced by a variety of factors associated with the street environment. • Facilitates integration of streetcar and bus routes. Lower platform heights are typically necessary for permitting buses to share streetcar stops. • The lower platform height will typically be easier to blend into sidewalks and the street, especially where side platforms are used. Typical "blending" issues include minimizing impact on narrow sidewalks, maintaining the slopes required for ADA access, and compatibility with curb design criteria and drainage flows. • With the use of bridgeplates, the near-level platform can be located on a curve. The permissible degree of curve is dependent on several factors relating to the geometry of the vehicle.	• Small step (3 to 6 in.) required to board vehicle from platform. • Bridgeplates add further complexity to already-complicated door systems. Bridgeplates are also subject to damage (passengers jumping on bridgeplates, stepping on them before they are fully deployed, overloading them) and other maintenance issues. However, load leveling (required for fully level boarding) is not without its own maintenance issues. • Snow and ice conditions may cause problems with bridgeplate operation, particularly if snow is allowed to accumulate. • Use of bridgeplates may increase dwell time, which may be a significant factor in high-ridership applications or where the streetcar blocks traffic when stopped. Dwell time is also dependent on a number of other issues, including the number and location of accessible doorways, platform configuration, passenger loading levels, etc. • Tactile warning strip area on platform edge may require modification, providing a flat "landing area" for the edge of the bridgeplate.