A NEW RAILROAD COMMUTER CAR ENTRANCEWAY DESIGN FOR MIXED HIGH AND LOW LEVEL PLATFORMS

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1. ABSTRACT

A new entranceway design for railroad cars (door, steps, and other components) for rail lines with both high and low level station platforms is presented. This design overcomes the many serious problems that result from the use of the current entranceway design in conjunction with a mixture of high and low platforms on U.S. commuter and intercity railroads (especially common in the Northeast). These include:

- long dwell times and resultant slower service,
- passenger (and employee) accidents and injuries,
- difficulties in complying with ADA accessibility requirements,
- increased train crew size, and
- inadequate clearance for freight trains (and their cargo) at high level platforms.

Various partial solutions to these problems have been proposed, but none deals effectively with all of the problems. This design addresses all of these problems simultaneously, and is intended to be used on both new railcars and retrofitted into existing cars. Some order of magnitude indications of cost, safety, and revenue benefits are summarized.

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This brief description is divided into sections as indicated below. (Technical and special terms are identified by **bold type** where they are first used or are defined.)

2. PROBLEMS

The existing **(traditional) passenger railcar entranceway design** in combination with **high level (HL) and low level (LL) platforms** creates many serious problems for passenger and freight service. These are described briefly below. (Details are in ref. (*1*), listed on p. 10.):

1. Safety-Accidents and Injuries – Doors and traps are typically left open between LL stations that are close to one another, permitting passengers (and employees) to board or alight from moving trains. Such **insecure entranceways** lead to serious injuries and deaths. The actual boarding and alighting injury rate (of U.S. commuter rail passengers and employees) in 1995-2000 averaged 3.48 injuries/million passengers on mixed platform/traditional entranceway systems, compared to only 0.45 and 0.91 on systems with secure entranceways and only HL platforms or only LL platforms, respectively. (See ref. (*2*) for details.)

2. **ADA** Accessibility Problems – Wheelchair passengers can be accommodated at HL platforms, but only by time-consuming manual placement of a **bridge plate** between the car and platform (necessary because of the non-compliant horizontal (and possibly vertical) gap between the car and the platform). At LL platform stations, **mini-HL platforms** have been installed, often set back from the usual location (to clear freight trains and cargo). Their use often requires a second stop of the train. Thus mobility-impaired passengers are treated differently from others, and the means to accommodate them results in service delays.

3. Long LL Platform Dwell Times – Because crewmembers must be certain no one is trying to board or alight when the trains starts, usually some entranceways are not opened, lengthening the **stop (dwell) time**. Operating procedures for the use of entranceways further lengthens the time, slowing schedules.

4. High Operating Costs –The manual operation of the traps (and sometimes doors) and the need for entranceway surveillance results in the need for more crewmembers. Mixed platform systems experienced a vehicle operating labor cost in 2000, as a percentage of total operating cost, about one-third higher than systems with secure entranceways.

5. Compatibility with Freight Service – Many freight cars are wider than passenger cars, and do not clear standard location HL platforms safely. Switching of cars often requires crewmembers to ride on the side of cars, making HL platforms a very serious safety hazard. Furthermore, railroads have developed many freight routes to accept **excess dimension loads**—high and/or wide loads that extend well beyond the sides and/or roof of standard freight cars. Solutions are expensive—separate tracks, **gantlet tracks**, or **retractable HL platforms**. Freight railroads have generally opposed HL platforms or restricted them to certain locations where they would not interfere with freight service.

6. LL Boarding and Alighting Difficulty: the **Large First Step Gap** – By design the first step is 9 inches (228.6 mm) above and 5 inches (127 mm) away from a properly located LL platform --an awkwardly large step (horizontally) for many persons. In practice, the vertical gap can be much larger, as high as 17 inches (431.8 mm), making entry into a car from a LL platform difficult and slow for everyone.

3. THE NEW ENTRANCEWAY DESIGN

The new design combines the stairway, trap, and a built-in bridge plate in such a way that it provides full access and door security with both HL and LL platforms. It is also designed to bridge the gap to a HL platform set back (away from the track)-- termed a **set-back HL platform--**so that it provides adequate clearance for freight trains. It provides access for wheelchair passengers at all HL platforms. Transition of the entranceway from its configuration for one type of platform to another can be accomplished from a single location on the train, so that all entranceways are properly configured for all stations. Furthermore, this design utilizes the usual remotely controlled **HL sliding door**, but also a second stairway-level remotely controlled panel door (**stairway door**), to fully cover the openings while the train is moving. This prevents passengers from jumping onto or alighting from a moving train. In addition, it enables opening of all entranceways from a single location, thus ensuring maximum passenger flow and minimizing station dwell time.

3.1. Basic Design and LL Platform Operation

Essential features of the design are illustrated in Figure 1 (on the next page). The stairway and trap can be considered a **stairway-trap-block**, which rotates about the axis A-A to provide access for the different platform types. Figure 1a shows the block in position for a LL platform. The two car-side doors are also shown, in the open position for LL platform access. Both doors are opened simultaneously, and closed simultaneously, thus eliminating the open entranceway safety problem, and the concomitant dwell time delay.

The block incorporates a sliding lower step that can be extended at LL platforms, just before the doors are opened. This eliminates the LL first step gap problem. Use of the retractable step is optional, so that it need not be used at a platform that is unusually high or close to the train. At LL platforms, both doors are opened simultaneously, and closed simultaneously, thus eliminating the open entranceway safety problem. The sliding step would be retracted after the LL door is closed, so that the car conforms to the **AAR Plate B** requirements when it is moving. (The “trap surface (rear)” shown in Figure 1a will be described later.)

3.2. Transition between LL and HL Platforms

When traveling from a LL station to a HL station, the configuration of all of the entranceways (on one or both sides of) the train can be changed by remote control. Passengers must not be in the step block area, and this is ensured by locking a door that prevents use of the stairway-trap-block area. This feature is discussed in detail Section 3.4 below.

To change from the LL to HL platform configuration, the block is rotated about the axis A-A, as shown in Figure 1b, stopping when the trap surface is horizontal. To do this, one of the two car-side doors must be opened—depending on the direction of rotation (most likely the lower door, with clockwise rotation). Both doors are shown open in the figure simply for clarity. Attached to the outer edge of the stairway-trap-block with a hinge is a powered rotating bridge plate, and this is rotated perpendicular to the trap surface so that it will rest against the (closed) HL door when the trap is in the HL position. The reverse procedure is followed in going from HL platforms to LL platforms. (The text continues on p. 6)

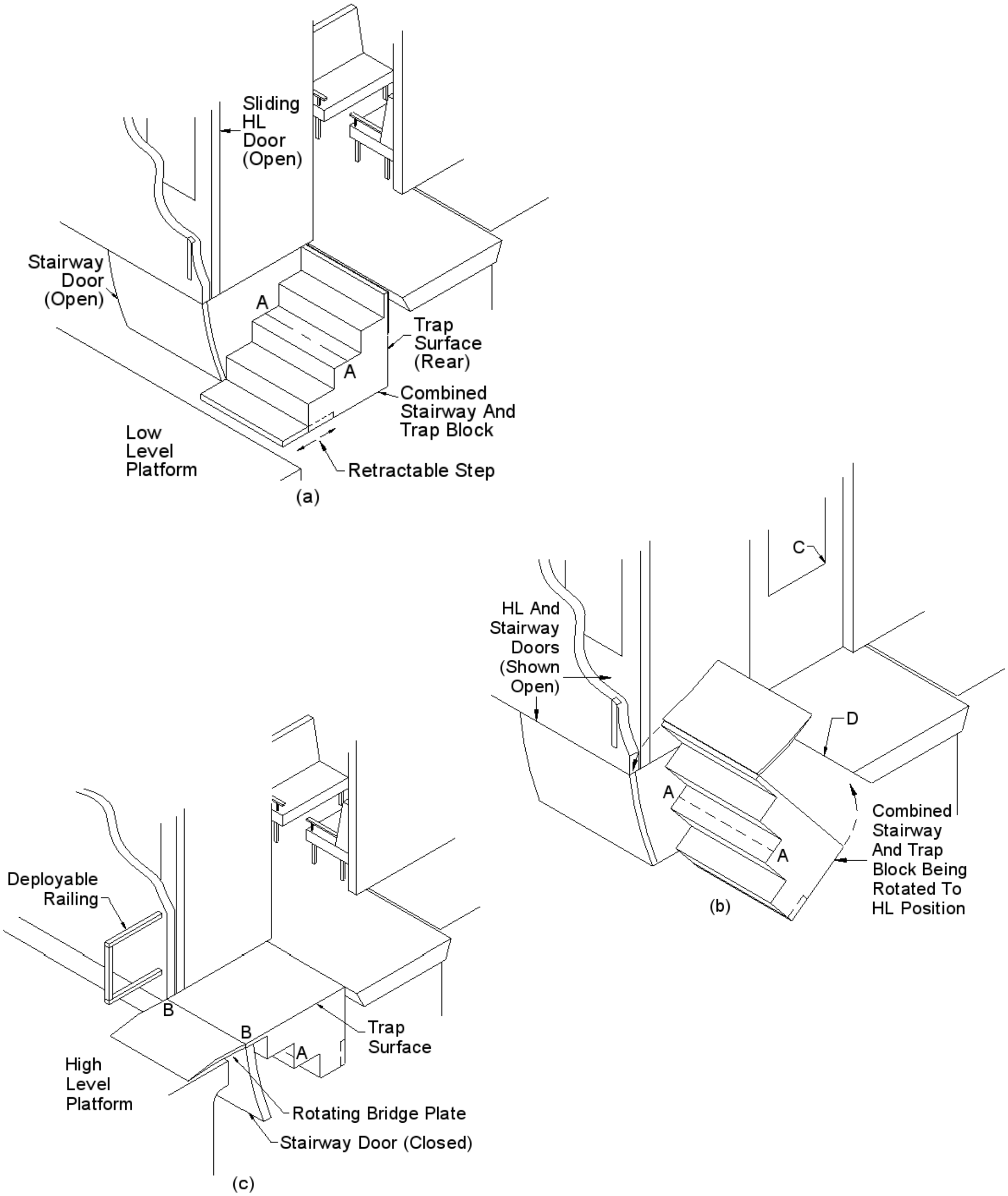

Figure 1. New Entranceway Design (with Entire Car to Right of Entranceway--Seating Area or End Wall--Omitted for Clarity) (a) at Low Level Platform, (b) Transitioning from LL to HL between Stations, and (c) at High Level Platform.

Currently, conventional traps are lowered when trains are traveling from a HL to a LL platform station (with the doors opened, except where an inside trap is used). The same timing would apply with this design. The reverse procedure is followed in going from HL to LL platforms. Moreover, if the stations on a line switch from one type of platform to another, and then back again, as occurs on some lines, the remote control of the transition enables rapid reconfiguration of all entranceways so that all of them can be used at each station.

3.3. HL (and Mini-HL and Set-Back HL) Platform Operation

When the train arrives at a HL platform, the first event is to lower the bridge plate (again all simultaneously, by remote control), so that it rests on the HL platform, as shown in Figure 1c. Simultaneously the entranceway railing on each side of the bridge plate would descend (also shown deployed in the figure). Then the HL doors are opened. Once all passengers have passed, the door is closed, the bridge plate is raised (rotated upward against the outside of the HL door), and the railing is raised simultaneously. The train can then depart the station.

The bridge plate is designed to completely cover any gap between a HL or set-back HL platform and the train entranceway. Thus the ADA accessibility problem, and the more general safety problem with a large trap-to-platform gap, is eliminated. Wheelchair passengers can be readily accommodated without the need for a crewmember to manually place a standard bridge plate at the entranceway. The railing would guide wheelchair (and passenger) movement. When passenger transfer is completed, the HL door is closed, the bridge plate and railing are then returned to the stowed position, and the train can depart.

The entranceway configuration for a HL platform will also work for a mini-HL or full set-back HL platform, of course. There are numerous advantages for this flexibility, not the least of which is the elimination of the need for the retractable HL platform (and its attendant costs) where clearance must be provided for freight trains. Thus set-back HL platforms can be used wherever it is felt that HL platforms are needed, without restricting freight service. It is also entirely compatible with mini-HL platforms that are set back from the usual HL position in order to provide freight clearance. (Details on freight service clearance issues are provided in Appendix A4.)

To ensure that the step block, doors, and appurtenances are in their proper positions at all times, the usual interlock devices must be incorporated, of course. There also could be a detector on the train or along the tracks that checks for proper positioning.

3.4. Design Features for Transition Safety

If the car has the traditional rail passenger car vestibule's feature of a door between the passenger compartment and the entranceway area (shown as door C in Figure 1b), this door would be locked during the transition. If not, a door can be placed just inboard of the step block area (at location D in Figure 1b), and this door locked during the transition. Such a door (a bi-fold door) is shown in Figure 2 (on p. 7). In the case of center or quarter point entranceways, the necessary door could be either at the opening to the seating area (creating a mid-car vestibule) or just inboard of the step block area. In addition, one or more passenger detectors (of weight, presence, etc.) would be used to ensure that no one is in the stairway-trap-block area before locking the door and commencing the transition.

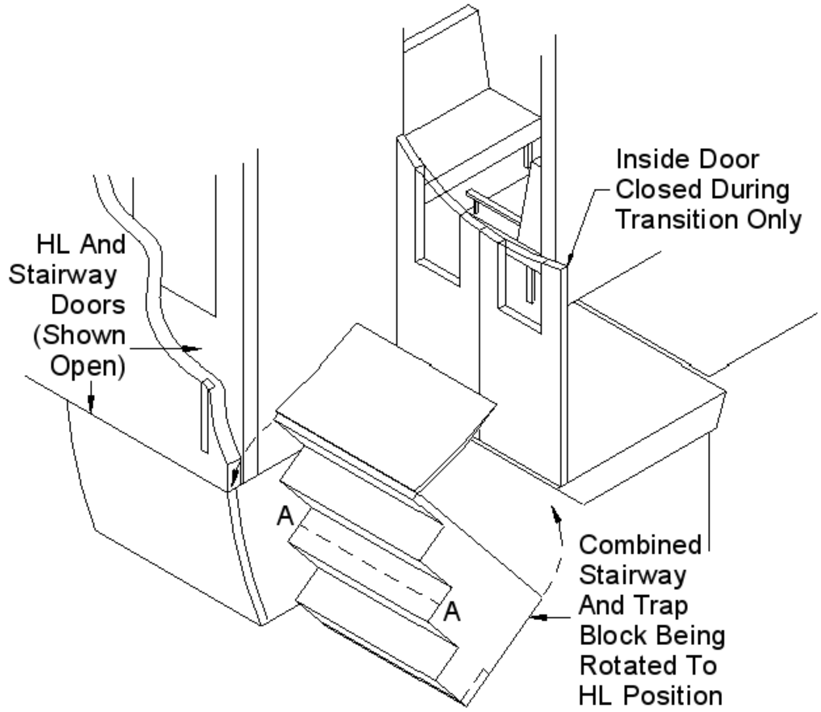

Figure 2. New Entranceway Design in Car having no Passenger Compartment Door, showing Bi-Fold Door at Side of Car's Center Aisle.

3.5. Compatibility with Various Car Designs and Entranceway Locations

A final important feature of this new design is its compatibility with both new car designs and older, existing cars. Recent commuter (and intercity) cars differ in entranceway location—center of body, quarter points, or ends--and vary in number of passenger lanes from one through three per entranceway. The design is intended for all of these types of applications. Figure 3 (on the next page) illustrates the new design in a car with center or quarter-point doors, at a HL (or set-back HL) platform (with the passenger compartment doors open, as would be the case while passengers enter and exit).

It would also be advantageous to replace the trap-step-door assemblies of existing traditional vestibule cars with this new design, and such retrofitting should be possible. In fact, most intercity cars with end vestibules now have rotating step blocks for the two or three lower steps. These are smaller and do not rotate a full 90 degrees, because their purpose is simply to provide a smooth streamlined exterior. (See 5, p. 347 for an example.) Thus this new entranceway design is compatible with all of the standard railroad passenger car body configurations used on mixed HL and LL platform railroads. (Details on variations of the basic design, and in on-car features and platforms, are given in (6).)

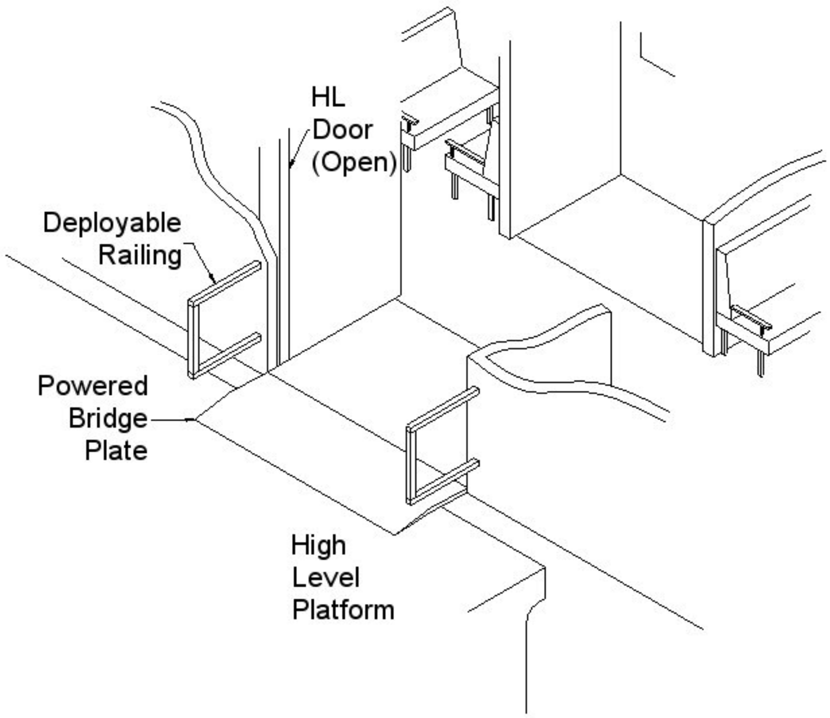

Figure 3. New entranceway design, two passenger lanes wide, at center or quarter-point of car, with doors open at a HL platform.

ADVANTAGES AND FEATURES OF THE NEW ENTRANCEWAY DESIGN

1. Provides a secure entranceway at both LL and HL platforms (i.e., all doors are closed before the train departs--at all stations), reducing injuries to passengers and employees.

2. Enables all doors to be opened at all stations, reducing dwell time, and speeding service.

3. Enables remote control of powered stairway (LL) and HL doors throughout the train, eliminating need for extra crewmembers for door operation and surveillance.

4. Enables HL platforms to be set back to clear standard freight cars safely.

5. Where necessary, HL platforms can be set back further to provide extra clearance for excess dimension loads or switching operations.

6. Transitions by remote control between the LL and HL configurations. Doors keep passengers out of the area ensuring no injuries can result from the transition.

7. Transition is rapid, enabling reconfiguration between closely spaced stations.

8. Meets ADA accessibility requirements at HL and mini-HL platforms effortlessly, speeding the boarding and alighting process, and eliminating the need for special effort by crewmembers to accommodate wheelchair and other mobility-impaired passengers.

9. Eliminates the LL first step gap where it exists (often of necessity, as at station platforms that cross streets).

10. Can be used with any standard entranceway configuration—at end vestibules, at midpoint or quarter points along the car side, etc., and with doorways of varying widths—one, two, or three passenger lanes.

11. Designed to fit into a standard end vestibule door and stepwell area, so that existing cars can be retrofitted with this design.

12. Can improve financial performance, through reduced costs, and increased revenue from reduced run times (and possibly increased frequency, as discussed in (*1*).

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APPENDIX A. EXISTING PLATFORM /ENTRANCEWAY DESIGNS

A1. Platforms

The two traditional platform designs -- low level (LL) and high level (HL) -- are illustrated in Figure A1. The LL platform design is the oldest, and it is found at most suburban stations and many large city stations. Because U. S. commuter railroads are part of the national system of freight and passenger railroads, national standards (as well as federal and state regulations) apply to platforms and also railroad cars. **AREMA (formerly AREA) specifications** call for the top surface of a LL platform to be 8 in. (203.2 mm) above the height of the rail, and its edge to be 5 ft. 1 in. (1549.4 mm) from the center of the track (3, p. 28-1-6).

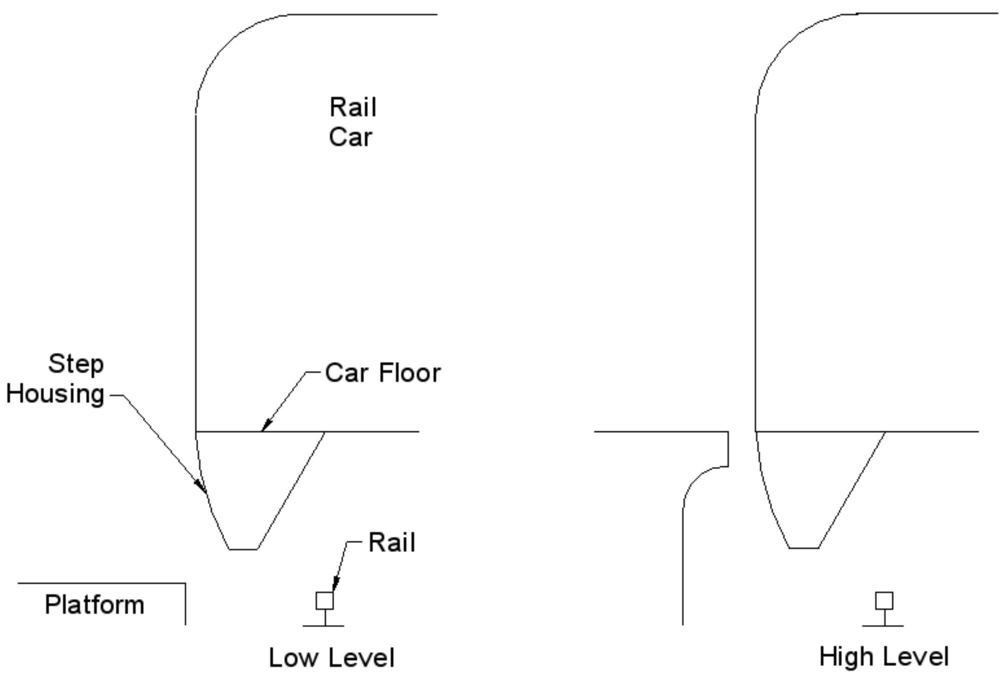

Figure A1. Commuter Railroad Low Level (LL) and High Level (HL) Platforms**.**

Although a few stations had them in the early 1900s, HL platforms have become more common in the last two decades. Many stations have been rebuilt with HL platforms, primarily to speed loading and unloading, and to assist in providing ADA accessibility (as described in Sec. A3 below). HL platforms should be 4 ft. (1219.2 mm) above the top of the rail, and 5 ft. 7 in. (1701.8 mm) from the edge to the track centerline (3, p. 28-1-6).

However, HL platforms also create problems. Since many freight cars are too wide to pass HL platforms safely, clearance for freight trains past HL platforms is usually provided by having either separate tracks or **gantlet tracks** (parallel rails that shift the train away from the other rails so as to provide adequate clearance). Recently some commuter lines have installed

retractable HL platforms, where the outer section of the platform is rotated upward and out of the way of trains. (A final variant, the mini-HL platform, is discussed in Sec. A3 below.)

A mixture of both HL and LL platforms will continue to characterize U.S. rail systems in the future. The reason is that neither can be used universally. HL platforms are required for some trains, such as Amtrak's new high speed Acela trains. And LL platforms are retained for many reasons, including cost, compatibility with freight service, and the use of some new commuter and intercity cars that are compatible with LL platforms only.

A2. Entranceway Design

The use of both LL and HL platforms on the same rail line has necessitated a special design for the entranceway to railroad passenger cars. This traditional railroad car entrance consists of a high level (HL) **door, stairway, and trap** arrangement as shown in Figure A2. At HL platforms only the door is opened. At LL platforms, the trap must be raised once the door is opened. (The trap normally extends under the door, though not in one design.) The raised (open) trap then allows passengers to use the stairway. Almost all passenger cars that are currently used on lines with both HL and LL platforms in the U.S. have this entranceway design, with one entranceway in the vestibule at each end of the car. Almost all have remotely controlled doors, enabling one train crewmember to open all doors at HL platforms, but requiring manual rotation of each trap if doors are to be opened and closed at LL platforms. Thus the use of this entranceway design with LL and HL platforms results in the many operational and safety problems described in Sec. 2.

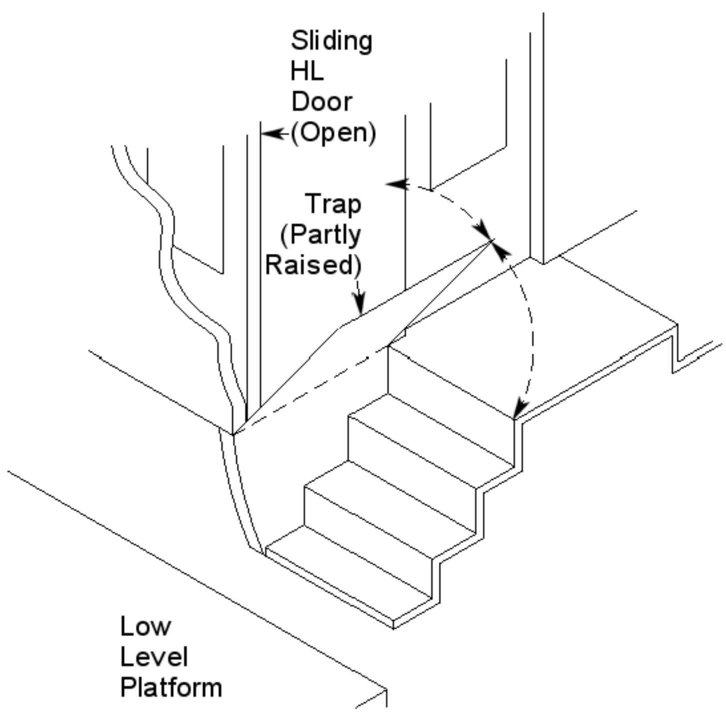

Figure A2. Traditional Railroad Entranceway Design (with End Wall of Car Omitted for Clarity).

A further problem with this design at LL platforms is that the tread of the lowest step is set back from the edge of the platform, and higher than a normal step. This is because of the cross section restrictions on railroad cars and locomotives, which are established by the Mechanical Division of the Association of American Railroads (AAR), in the form of Equipment Plates (3, p. 28-2-1). (**AAR Plate B** is the one designated for normal–meaning unrestricted--interchange service.) The bottom step tread should be, by design, 5 in. (127.0 mm) away from the platform, measured horizontally, and 9 in. (228.6 mm) above the platform. These two dimensions result in a large distance, to be referred to as the "**LL first step gap**," for the passenger to negotiate at the lower or first step. Often this gap is considerably larger due to track maintenance that raises the track height or shifts the track laterally away from the platform. Station platforms also are prone to settling, and can be close to or at rail height, for a 17 in. (431.8 mm) vertical gap. Loading from streets, necessary because of grade crossings (street crossings of tracks) at some stations, creates an identically high first step.

It is noteworthy that the new bi-level cars (actually full double deck plus normal level above wheel assemblies) used on many commuter rail lines outside the Northeastern U.S. have a feature designed to overcome the LL first step gap problem. Even though these cars have a first (lower) floor approximately the same height above the rail (17 in. or 431.8 mm) as the first step in a traditional entranceway, they are equipped with a step about 10 in. (254 mm) above the rail that is extended from the car side at stations to facilitate boarding and alighting (5). However, these cars are designed for use with LL platforms only. (They also are too high for many Northeastern rail lines.) Thus they provide no solution in the case of lines with HL platforms, or a mixture of HL and LL platforms.

Various means have been used to try to solve this long-standing problem, in conjunction with the traditional entranceway. In the past, the conductor or other train crewmember would place a box-like step ("box step") at each entranceway, but with smaller crews this is no longer possible. Recently some commuter rail agencies have installed an (approximately) 7.5 in. (190.5 mm) high by 16 ft. (4876.8 mm) long wooden platform (in two sections) on top of LL platforms, functionally similar to the box step. The short length of this **step-up platform** means that it serves only the adjacent entranceways of two cars. It is lightweight and slides so that if a passing train hits it, no derailment will occur, although the platform movement will create a safety hazard. One commuter rail line—the Northern Indiana Commuter Transportation District (NICTD)—has added a permanent additional lower step closer to the platform, but this extends beyond AAR Plate B limits. Thus the LL first step gap problem remains.

A3. ADA Accessibility Requirements

The problem of mixed platforms has recently become even more difficult, because of the need to accommodate wheelchair and other mobility-impaired passengers. To accomplish this, many agencies are installing a **mini-high level (mini-HL) platform** at many stations with LL platforms. These are short, about 20 ft. (6096 mm) in length, to reduce costs. The high level permits placing a "bridge plate", about 33 in. (838.2 mm) by 36 in. (914.4 mm), over the gap between the platform and car entranceway (trap). This enables a wheelchair to be rolled between the platform and train. This procedure is labor intensive and time consuming.

The use of a bridge plate is necessary because **Americans With Disabilities Act (ADA)** regulations limit the horizontal gap between a platform and train to 3 in. (76.2 mm), and the vertical separation to 1 1/2 in. (38.1 mm) (4). In the case of retrofitted railcars, these gaps can be as large as 4 in. (101.6 mm) and 2 in. (50.8 mm), respectively, with a 50% passenger load on the car. Current passenger cars are 10 ft. (3048 mm) wide at the floor, so the gap to a HL platform must be at least 7 in. (177.8 mm), using the standard location of HL platforms on passenger lines. Even if cars were built to the maximum width permitted by Plate B (10 ft. 8 in. or 3251.2 mm), the gap (1701.8 – 3251.2/2 = 76.2 mm) would be exactly the maximum allowed by the ADA. Naturally there would be some deviations, so the ADA requirements realistically can not be met without some type of bridge plate.

However, as discussed earlier (and detailed below), the fact that many freight cars (and loads carried) are wider than passenger cars requires that the mini-HL platforms be set back from the usual passenger platform location if freight trains use the track (in order to clear freight cars safely). The use of such **set-back HL platforms** increases the horizontal gap, reinforcing the need for a bridge plate.

In addition, there could be a slight lengthening of schedules to accommodate wheelchair riders, since the dwell time is likely increased. Also, often two stops are made, one at the regular LL platform, and another at the mini-HL platform.

A.4. Freight Service Compatibility Issues

While it is clear that standard location HL platforms (or mini-HL platforms) do not provide adequate clearance for many typical freight cars (or their cargo loads), the extent to which platforms must be set back will vary with the line. Of course, if no freight cars pass a HL platform (or if they are all of a narrow body design—as is true in a very few cases), then no set back is needed there. There are at least three distinct levels of set back that may be necessary:

The first is simply to safely clear standard freight cars that are wider than passenger cars. The AREA manual calls for a track centerline to freight platform (approximately the same height as a passenger platform) distance of 6 ft. 4 in. (1930.4 mm) (3, p. 28-1-6). Such a platform is set back 9 in (228.6 mm) farther from the track centerline than a standard HL passenger platform. Thus a setback of about 9 to 12 inches (228.6 to 304.8 mm) probably will be sufficient. The new entranceway easily accommodates this and more--at both mini-HL and full length HL platforms.

Most significant freight lines have been upgraded (sometimes over many decades) to accommodate high and wide loads. These **excess dimension loads** require more than the minimal clearances. The normal location of clearance limiting elements of a railroad have long been set so as to provide for excess dimension loads. For example, AREA standards for railroad bridges and tunnels provide a clear width of 9 ft. (2743.2 mm) from the track center (3, p. 28-1-3 and -4). Reducing clearances through encroachment of HL platforms obviously is opposed by both the freight railroads and affected shippers and industries. Variations in the current clearances among particular lines—from earthworks, highway overpasses, etc.--and in the plans and realistic options for future clearances on these lines, naturally leads to variations in the HL platform set-backs that would be required for freight service. It is reported that Conrail had agreed to permit new mini-HL platforms located 7 ft. 1 in. (2159.0 mm) from the track centerline on some of its freight lines. This example provides a set-back dimension that might be acceptable on some other lines, also. This location results in a passenger car side to platform gap of 2 ft. 6 in. (762.0 mm). This is clearly within the range of the new design.

Where a greater clearance is needed, the entranceway design might be applicable. If not, a separate track or gantlet track would be required.

APPENDIX B. CURRENT (PARTIAL) SOLUTIONS

This list summarizes the discussion in ref. (*1*).

1. Inside Trap and Two-Level Door - does not solve the ADA accessibility, LL first step gap, or freight clearance problems; any crew size reduction depends on distance between stations.

2. Remotely Controlled Trap and HL Door- does not solve the ADA accessibility, LL first step gap, or freight clearance problems, and only modestly reduces dwell time.

3. Two Sets of Entranceways- does not solve the ADA accessibility, LL first step gap, or freight clearance problems; reduces seats on car, increasing fleet size and operating cost.

4. Hi-Lo Step - does not solve the ADA accessibility, LL first step gap, or freight clearance problems; no current design meets railroad dimensional requirements, and may not meet AAR Plate B limitations.

5. Separate Tracks for Freight and Passenger Service – are expensive to build and operate, and may require widening the right-of-way; solves only the freight clearance problem.

6. Gantlet Track to Separate Freight and Passenger Service – is expensive to build and operate, and may require widening the right-of-way; may not fully solve the freight clearance problem (particularly for excess dimension loads).

6. Retractable HL platform – is expensive to build and operate; may not fully solve the freight clearance problem (particularly for excess dimension loads), and presents a risk of train-platform collision.

7. Elimination of Freight Service – is generally contrary to the interests of not only freight service users and railroads, but also the region served.

8. Step-up Platform – solves only the LL first step gap problem; its use creates a safety problem if it were to be struck by a train.